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Nature of soil reaction and status of EC, OC and macro nutrients in Ujjain Tehsil of Madhya Pradesh

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Abstract
A study was undertaken to evaluate the nature of soil reaction and status of EC, OC and macro nutrients in Ujjain tehsil of Madhya Pradesh. The GPS based 150 soil samples were collected from 0-15 cm depth by random sampling method. The soil analysis showed that the pH, electrical conductivity and organic carbon status ranged between 7.01-8.15, 0.10-0.79 dSm^{-1} and 0.30-0.60% with mean value of 7.61, 0.28 dSm^{-1}, and 0.48% respectively. These soils are characterized under neutral to alkaline in soil reaction and less than 1 dSm^{-1} soluble salt content (EC) which comes under safe limit for all soils. The available nitrogen, phosphorus, potassium and sulphur status ranges between 139-235, 8.00-25.60, 301-463 and 8.06-24.36 kg ha^{-1} respectively with mean value of 198.27, 15.8, 358.85 and 16.27 kg ha^{-1} respectively. It could be concluded that these soil data can be effectively utilize with proper nutrient management and regular monitoring to avoid any nutrients stress on crop.

Keywords: GPS, organic carbon, available nitrogen, available sulphur

Introduction
Soil characterization, particularly soil fertility assessment of an area or a region is an important aspect in view of sustainable agricultural production (Singh *et al*., 2017) [27]. As soil nutrients governs the fertility of soil and controls the productivity of crops grown on to soil (Bharti *et al*., 2017) [2]. Currently, crop productivity is declining or stagnating because of imbalanced and inadequate fertilizer application coupled with low efficiency of other inputs mostly in the tribal belt of the country. Also, efficiency of chemical fertilizer nutrients has declined tremendously under an intensive agricultural system in recent years (Meena *et al*., 2017) [19]. Nutrient supply in soil is a natural phenomenon and varies soil to soil, and some of the nutrients may sufficient where others deficient (Dotaniya and Meena, 2013) [7]. The stagnation in crop productivity cannot be boosted without judicious use of the essential plant nutrients to overcome the existing deficiencies or imbalances (Lenka *et al*., 2016) [18].

Soil is a vital and finite natural resource for agriculture. In this regard soil fertility plays a key role in increasing crop production. It comprises not only in supply of nutrients but also their efficient management. The most important constituents in soil is organic matter, an appreciable amount of organic matter in soil tremendously increase soil fertility. Decay of organic matter release nitrogen, phosphorus and mineral nutrients in a form available to plant. Availability of N, P, K, secondary and micronutrients induce better germination of seeds and hence subsequent better growth and stronger root development. Soil fertility is a dynamic natural property and it can change under the influence of natural and human induced factors. As human population continue to increase, human disturbance on the earth's ecosystem to produce food and fiber will place greater demand on soils to supply essential nutrients. Soil fertility fluctuates throughout the growing season each year due to alteration in the quantity and availability of mineral nutrients by the addition of fertilizers, manure, compost, mulch, and lime in addition to leaching. Hence, evaluation of fertility status of the soils of an area or a region is an important aspect in the context of sustainable agriculture (Kavita and Sujatha, 2015) [12].

The evaluation of soil fertility is perhaps the most basic decision making tool in order to impose appropriate nutrient management strategies (Brady and Weil, 2004) [3].

There are various techniques for soil fertility evaluation, among them soil testing is the most widely used in the world (Havlin *et al*., 2010) [8]. A proper evaluation of the fertility of a soil before planting the crop helps in adopting appropriate measures to make up for the shortcomings and ensuring a good crop production. Optimum productivity of any cropping system depends on adequate supply of plant nutrients. In present situation the data with respect to soil fertility of Ujjain tehsil is meager therefore there is a need to obtained such data for the production and maintaining the soil fertility.

Materials and methods

The analysis work of present investigation was carried out during the year 2018 in the Department of Soil Science & Agricultural Chemistry, College of Agriculture, Indore.

Geographical location of the Ujjain tehsil

The Ujjain tehsil is towards north of Ghatiya, which is surrounded by Indore in south, Dewas, in east and Badnagar on the western side. This tehsil comes under the Ujjain district of Madhya Pradesh state. Ujjain is situated on the bank of Kshipra river and is located in between 23°10′ 45.4800″N latitude and 75°47′ 5.6832″ E longitude.

Table 1: Geographical extant of the Ujjain tehsil

Total geographical area	60987.4 ha
Areas under cultivation	49607.1 ha
Area under irrigation	25837.0 ha
Grazing land	3149 ha
Total village	131
Kharif crops	Soybean, Maize, Sorghum etc.
Rabi crops	Wheat, Gram, Mustard etc.

Soil Characterization

Looking the crop production and soil related constraints in Ujjain tehsil systematic soil sampling was done. Surface soil samples were collected from 150 GPS point locations in Ujjain tehsil. For soil analysis standard methods were adopted.

Sample processing

Soil samples (0-15 cm) were collected during May 2018. The soil samples were collected from 15 cm depth with the help of steel soil auger. Collected soil samples were dried and crushed with the help of wooden rod and passed through 2 mm sieve.

Table 2: Techniques used for analysis

S. No.	Analysis	Techniques used
1	Soil pH	Glass electrode method (Piper,1950) [25] [soil water suspension (1: 2)]
2	Electrical conductivity (dSm^{-1})	(Piper,1950) [25] [soil water suspension (1: 2)]
3	Organic carbon (%)	Wakley and Black (1934) [31]
4	Available nitrogen ($kg\ ha^{-1}$)	Alkaline permanganate method (Subbiah and Asija,1956) [28]
5	Available phosphorus ($kg\ ha^{-1}$)	Olsen's method (Olsen *et al*.1954) [21]
6	Available potash ($kg\ ha^{-1}$)	Flame photometer (Jackson, 1973) [9]

Table 3; The status of nutrient content of the soils of Ujjain tehsil of Ujjain district was classified into different nutrient availability classes as per the criteria given by Singh *et al.* (2007) [27]

Parameters	Low	Medium	High
N ($kg\ ha^{-1}$)	<250	250-400	>400
P ($kg\ ha^{-1}$)	<10	10-20	>20
K ($kg\ ha^{-1}$)	<250	250-400	>400
S ($mg\ kg^{-1}$)	<10	10-20	>20

Statistical Analysis

Statistical analysis was done as per the method given by Panse and Sukhatme (1985) [23].

Results and discussion

Soil reaction

The pH of soils of Ujjain tehsil ranges from 7.01-8.15 with a mean value of 7.61, standard deviation 0.23 and coefficient of variation 2.99% (Table 4). Out of 150 soils sample 42 soil samples were neutral in pH and 108 samples were slightly alkaline. Similar pH values were earlier reported by Kothyari *et al.* (2018) [13] in the soils of Sawai Madhpur district of Rajasthan, where it ranged from 6.77 to 8.5.

Electrical conductivity (EC)

Electrical Conductivity (EC) of soil ranges from 0.10-0.79 dSm^{-1} with a mean value of 0.28 dSm^{-1}, standard deviation 0.15 and CV% 51.92 (Table 4). Most of the soil samples were normal in respect of total soluble salt concentration. The surface soil samples were relatively low in salts content. This might be due to leaching of salts from the soil surface to lower depths due to irrigation and their accumulation in lower depths. Even at the time when irrigation was introduced the distribution of salts showed a concentration of salts in the lower solum as reported by Ved *et al*. (2008) [29]. in Malaprabha project area. Similar results were reported by Kothyari *et al.* (2018) [13]. Which showed that the EC of Sawai Madhopir soils range between 0.33 to 0.90 dSm^{-1}.

Organic Carbon (OC)

The organic carbon content (Table 4) of the soils of Ujjain tehsil ranged from 0.30-0.60 % with an average value of 0.48 %. Considering the soil test rating for organic carbon (<0.25 as very low, 0.25 – 0.50 as low; 0.50 – 0.75 as medium and >0.75 as high in the status of organic carbon) the soils of Ujjain tehsil fall under low and medium rating classes of OC content. In general out of 150 samples, 68.6% samples were categorized under low OC status, 31.4% samples under medium OC status. The general statistics show that mean value of 0.48%, standard deviation 0.07 and coefficient of variation (CV %) 14.00 for organic carbon content. The high temperature prevailing in the area is responsible for the rapid burning of organic matter, thus resulting in low organic carbon content of these soils. Similar results were also noted by Patidar *et al.* (2017) [24]. in the soils Ralyawan village of Jhabua district of Madhya Pradesh and Kumar *et al.* (2017) [16]. in the soils of Jaisalmer district of Rajasthan.

Available N

The available N content (Table 4) of the soils of Ujjain tehsil ranged from 139 to 235 $kg\ ha^{-1}$ with an average value of 198.27 $kg\ ha^{-1}$. Considering the soil test rating for available N (<250 as low, 250-400 as medium and >400 as high in the status of N) the soils of Ujjain tehsil fall under low status (<250 $kg\ ha^{-1}$) in available N content. The general statistics

calculated from 150 soil samples revealed the standard deviation 19.49 and coefficient of variation (CV %) 9.83 for available N content. The reason for low content of available nitrogen might be due to the fact that N is lost through various mechanism like volatilization, nitrification, denitrification, microbial fixation, leaching and runoff which resulted in low amount of available N in soil. The variation in N content may be related to soil management, application of FYM and fertilizer to previous crop etc. (Kumar, 2000) [14]. The total nitrogen content in the soils is dependent on temperature, rainfall and altitude. Another possible reason may also be due to low organic matter content in these areas due to low rainfall and low vegetation facilitate faster degradation and removal of organic matter leading to nitrogen deficiency. Kumar *et al*. (2009) [17]. in Dumka and Lachimpur series, Kashiwar *et al.* (2018) [11]. in soils of Agricultural Farm of Rajiv Gandhi South Campus Mirzapur Uttar Pradesh, observed a similar trend of nutrient status in their study area soils.

Available P

The general statistics calculated from analyzed soil samples revealed that the available – P content ranged from 8.0-25.60 kg ha^{-1} with a mean value of 15.08 kg ha^{-1}, standard deviation 3.96 and coefficient of variation 26.25 % (Table 4). The variation in available P is quite large which might be due to variation in soil properties viz., pH, organic matter content, texture and various soil management and agronomic practices adopted by the farmers of the region. Ujjain tehsil share 10% high, 76% medium and 14% low with respect of available phosphorus. When water soluble P is added to the soil, it is converted very quickly to insoluble solid phase by reacting with soil constituents. These may include calcium carbonate, Fe and Al oxides (Dean and Rubins, 1947 [6]. and Chu *et al.* 1962[5]) and partly organic matter. These reactions affect the availability of P and as a result of these reactions, a very small amount of total P is present in soil solution at any time reflected by soil testing. However, a low to medium range of soil available P under study area may be mostly affected by past fertilization, pH, organic matter content, texture various soil management and agronomic practices (Verma *et al*. 2005) [30]. The present findings are in line with those of Mostara (2002) [20]. who reported that majority of soils in Karnataka and more so in Malprabha command were medium in phosphorus content. Similar results were also noted by Wanjari *et al*. (2016) [32]. in the soils of Satpuda region of Maharastra and Jatav and Misra (2012) [10]. in the soils of Baloda block in Janjgir district of Chhatisgarth.

Available K

The available potassium content in major portion of the study area was under medium to high category. Out of 150 samples, 83.4% fall under medium and 16.6 % high status. Adequate (medium or high) available K in these soils may be attributed to the prevalence of potassium-rich minerals like Illite and Feldspars (Sharma *et al.*, 2008) [26]. Similar results were also noted by Kumar *et al*. (2015) [15]. in soils of Raipur district Chhatisgarth and Kumar *et al*. (2017) [16]. in soils of Jaisalmer district of western Rajasthan. Major portion of area under medium to high were seen in study soils, because these soils have less fine fractions in their soil. The highest and lowest mean values of available potassium were recorded 463 and 301 kg ha^{-1} K in region, respectively of Ujjain tehsil (Table 4).

Available S

The available S content (Table 4) of the soils of Ujjain tehsil ranged from 8.06-24.36 mg kg^{-1} with an average value of 16.27 mg kg^{-1}. Considering the soil test rating for available S (< 10 mg kg^{-1} as low, 10-20 mg kg^{-1} as medium and >20 mg kg^{-1} as high in the status of S), the soils of Ujjain tehsil fall under low, medium and high status in available S content. In general out of 150 samples, 7.3% samples fall under low status, 75.4% samples were medium in S status and 17.3% samples were high in S status. Low and medium level of available sulphur was recorded due to lack of sulphur addition and continuous removal of S by crops Chouhan *et al.* (2012) [4]. Similar results were also reported by Singh *et al.* (2013). in Garhwal region of western Himalayas. Black soils have gypsum ferrous nature of sulphur which is non-available (Balanagoudar, 1989) [1]. Similar results were also reported by Pandey (2016) [22]. who collected 337 GPS based random surface (0–15 cm) soil samples from all 19 blocks of district Sitapur, Uttar Pradesh during May and June 2014 The collected soil samples were analyzed for available S and results fall under low and medium class.

Table 4: A Salient soil properties of the Ujjain tehsil

S. No.	Analysis	Range	Mean	SD	CV (%)
1	Soil pH	7.01-8.15	7.61	0.23	2.99
2	Electrical conductivity (dSm^{-1})	0.10-0.79	0.28	0.15	51.92
3	Organic carbon (%)	0.30-0.60	0.48	0.07	14.00
4	Available nitrogen (kg ha^{-1})	139-235	198.27	19.49	9.83
5	Available phosphorus (kg ha^{-1})	8.00-25.60	15.08	3.96	26.25
6	Available potash (kg ha^{-1})	301-463	358.85	36.14	10.07
7	available sulphur (mg kg^{-1})	8.06-24.36	16.27	3.73	22.92

Conclusion

It can be concluded from the above results that the soils of Ujjain tehsil of District Ujjain Madhya Pradesh are low in available N, medium in available P, medium to high in available K and medium to high in available S. These soils are characterized under neutral to alkaline in soil reaction (pH) and less than 1 dSm^{-1} soluble salt content (EC) which comes under safe limit for all soils. The prepared soil data base is very useful for fertilizer recommendations for different crops to economize their production. The proper nutrient management and regular monitoring should be adopted to avoid any possible deficiency of the plant nutrients.

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