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Evaluation of soil nutrient status of an inceptisol of Surguja district, Chhattisgarh

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Abstract
One of the most crucial and essential components of contemporary agriculture is the careful management of nutrients. We must be aware of the geographical variations in soil fertility for this to occur. To ascertain this a study was conducted to assess the fertility status of soils of KVK farm Ambikapur and research farm, College of Agriculture, Ambikapur under Surguja district of Chhattisgarh. The soil physico-chemical characteristics (pH, EC, OC), available macronutrient (N, P, K,) and secondary nutrient S were analyzed in soil. Based on the results, soil fertility status for the various nutrients were created. Total 101 soil samples were analyzed out of which 50 soil samples of KVK farm and 51 samples were from research farm, college of Agriculture, Ambikapur. For all of the samples that were taken, the study area's soil reaction was found to be in the acidic range with an EC below 1.0 dS/m. The soil's organic carbon content was low, nitrogen was low, in both the farms whereas phosphorus was medium and potassium has medium to high fertility category in KVK farm. However in soils of KVK farm most of the samples falls under medium category for available S, whereas most of the samples of research farm of College of Agriculture, Ambikapur comes under low category.

Keywords: Soil fertility status, organic carbon, available N, P, K

Introduction
Increased crop production is mostly dependent on soil fertility, which is the earth's innate ability to provide nutrients to plants in an appropriate quantity and proportion. Nitrogen, phosphorus, and other mineral nutrients are released as organic waste decomposes and are made available to plants. Soil fertility is the quality that enables the soil to provide the proper compounds in the proper amounts and in the proper balance for the growth of specified plants when other factors, such as light, temperature, moisture, and physical condition of the soil, are favorable. Crop production is largely influenced by the soil's ability to supply nutrients, or "fertility," which is a term that can be used. The best method for determining the soil's level of fertility is soil fertility evaluation, which aids in the achievement of sustainable agriculture's objectives. The efficiency of grain production has been slowed down, and this has resulted in lower farm income, due to an inadequate and unbalanced supply of nutrients. One approach to lower production costs and boost crop production profits is the evaluation of the soil's fertility state. We can create specific fertiliser recommendations with the use of a soil testing tool. In order to identify the need for different fertilisers throughout the course of a season or year and develop estimates for increased demand based on cropping pattern and intensity, Where a soil's fertility status is known in terms of soil test values, the soil test values can be classified into low, medium, and high fertility types, as stated by Welch *et al.*, (1987) [15] and Rashid and Memon (1996) [16].

Materials and Methods
The study was carried out at KVK farm and research farm, College of Agriculture, Ambikapur in Surguja district. Surguja is located in the northern part of Chhattisgarh State of India. It lies between 23˚ 37' 25'' to 24˚ 6' 17'' north latitude and 81˚ 34'40'' to 84˚ 4'40'' east longitude. The climate of district is characterized by a hot summer and well distributed rainfall during the monsoon season.
The investigation was carried out by taking soil samples from two sites belonging to KVK farm and research farm, College of Agriculture, total 50 samples were collected from KVK farm and 51 from research farm, College of Agriculture Ambikapur. The study area was divided into representative portions, and each field was regarded as a separate soil sampling

unit. It was made a point to ensure that the fields were virtually uniform in terms of things like slope, texture, and colour. Soil samples were collected from 0-15 cm depth with the help of screw-style augur. The samples were tested for chemical parameters, including pH by a pH metre, electrical conductivity (EC) by the solu-bridge method (Jackson 1967) [5], organic carbon (OC) by the method of Walkley and Black (1934) [17], available nitrogen (N) using the method described by Subbiah and Asija (1956) [13], phosphorus (P) by the method of Brays 1 method, available potassium (K) by the method of Hanway and Heidal, (1952) [4]. Available sulphur (S) by method of Williams and Steinbergs (1959) [18], The analytical results of soil sample was categorized as low, medium and high categories for organic carbon and macronutrients based on standard rating values.

Nutrient index and fertility rating

According to Ramamoorthy and Bajaj (1969) [11] nutrient index values (NIV) for various soil parameters were determined from the amount or proportion of samples with low, medium, or high nutrient status and classified into different fertility groups.

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

Where,
NIV = nutrient index value
PL= % samples fall under low category.
PM= % samples fall under medium category.
PH= % samples fall under high category.
In this assessment, NIV of less than 1.33, 1.33-2.33 and 2.33 indicates low, medium and high fertility level respectively for the each nutrient.

Result and Discussion

Soil reaction

Soil reaction for 50 soil samples from KVK farm were varied from 4.7 to 5.9, with a mean value of 5.28 indicating an acidic soil reaction (Table 1). Similarly out of the total soil samples of research farm, College of Agriculture (51 samples) the soils were found acidic in nature with pH ranged from 4 to 5.3 (Table 2). The low values of soil reaction as indicated by soil pH shows soils are acidic which may be due to leaching loss of basic cations from the soil surface because of high rainfall of study area as also reported by Barooah *et al*., (2020) [19].

Electrical conductivity

The electrical conductivity of the soil water suspension of KVK farm ranged from 0.05 to 0.38 dS m^{-1} (Table 1), while that of research farm EC ranged from 0.04 to 0.06 dS m^{-1} with a mean value of 0.11 dS m^{-1} and 0.075 dSm^{-1} respectively, (Table 2). This showed that the soils were suitable for growing nearly all of the crops. It was all noted that all samples (100%) had low value of EC. It indicated that there is no soil limitation for crop production from soluble salt concentration in soil. All the soil samples falls under the normal range (<1.0 d Sm^{-1}). The extremely low EC value of the area can be attributed to semi-arid to sub-arid climate which accumulated for considerable leaching of all soluble salts from the top soil layer and also to the fact that the area's geography makes it possible for sufficient runoff losses of water that contain soluble salts (Balakrishna, 2017) [1].

Organic carbon

In KVK farm the Organic Carbon content were ranged from 1.1 g kg^{-1} to 6.7 g kg^{-1} with a mean value of 4.7 g kg^{-1}. The findings showed that the 48% of soil samples were found in low OC values (<0.5%) while 52% of soil samples were found in medium OC values (0.5-0.75) (Table 1). Very close variations were also found in research farm, College of Agriculture where soil organic carbon content was 1.2 to 7.4 g kg^{-1} with an average of 3.9 g kg^{-1} From all the soil samples, majority of the soil samples i.e. 78.44% were found to be in low in OC and 21.56% samples were in medium organic carbon status (Table 2). The low to medium C concentration of the soil in this area can be attributed to climate factors. Due to the region's current tropical climate, which is relatively warm, there are favourable circumstances for high soil organic carbon oxidation through soil microbial activity (Jatav *et al*. 2012) [6].

Available nitrogen

The percentage distribution of soil samples for available N is in the low range and all the samples comes under low rating of fertility (<280 kg ha^{-1}) for available N. In KVK farm the Available N content in soil ranged from 113-176 kg ha^{-1}, with a mean value of 147.76 kg ha^{-1} (Table 1.) and in research farm College of Agriculture, Ambikapur N content in soil ranged from 87.1-223.2 kg ha^{-1} (Table 2.). It is crucial to note that the entire region looks to be N deficient, which may be caused by the fact that these soils had a relatively low level of organic carbon, which is most important source of N. It could also be attributable to widespread leaching and runoff of various forms of nitrogen from the soil (Mandal's, 2018) [9]

Available phosphorus

Available P content in KVK farm varied from 36.45 to 63.91 kg ha^{-1}, with a mean value of 52.32 kg ha^{-1}. 100 percent of soil samples were found in the medium range. However in research farm, College of Agriculture, Ambikapur the status of the available phosphorus varied from 28.7 to 64.6 kg ha^{-1} with an average value of 48.4 kg ha^{-1}.Out of the 51 soil samples majority of the samples i.e. 94.11% was found to be in medium range and 5.89% were in the low range. The poor P status can be attributed to the low organic carbon content, P fixing by montmorillonitic clay, Al, and Fe oxide, which is common in the research area (Verma *et al*., 2009) [20]

Available potassium

Soil available K content fell into the moderate to high category and ranged from 143 to 407 kg ha^{-1}, with an average value of 266.121 kg ha^{-1}, and 84% and 16% of the samples fell into the categories of medium and high, in KVK farm (Table 1). Whereas in research farm, College of Agriculture, Ambikapur the available potassium varied from 164.3 to 426.38 kg ha^{-1} with a mean value of 299.8 kg ha^{-1}. It was found that 60.78% and 39.22% of samples were under medium and high category respectively (Table 2). The expanding clay mineral (Montmorillonite) of the research area is responsible for the medium to high potassium status of the soil. It tends to trap K inside the clay lattice and adsorb onto surface negative sites. However, it releases these K as soon as the external K reserve is exhausted while still keeping a healthy K pool to meet plant needs. It might also result from additional elements like fertilisation and parental material reserves (Balakrishna, 2017) [1]

Available Sulphur

Out of 101 soil samples, 50 is taken from KVK farm in which the S content ranged from 19.6 to 44.8 kg ha^{-1} with an average value of 31.75 kg ha^{-1} (Table 1). Additionally, it was discovered that 10%, 58%, and 32% of samples comes under had low, medium and high ratings, (Table 3) respectively for sulphur. However in 51 samples taken from research farm, College of Agriculture, the S status varied from 10.92 to 39.2 kg ha^{-1} with a mean value of 19.69 kg ha^{-1}. It was found that 72.55%, 21.57% and 5.88% of samples were the low, medium and high in sulphur rating, respectively (Table 2). A lack of organic carbon reserves, as well as runoff and leaching losses of sulphate ions from the surface layer of KVK fields and the research farm at the College of Agriculture, Ambikapur, may be responsible for the majority of the area's low to medium S status (Goswami *et al.*, 2014) [21].

Table 1: Salient properties of soil in the study area of KVK farm Ambikapur

S. No.	Parameters	Range	Average	S.D.
1	pH	4.7-5.9	5.28	0.276
2	EC (dS m^{-1})	0.05-0.38	0.11	0.047
3	Organic carbon (g kg^{-1})	1.1-6.7	4.7	0.100
4	Nitrogen (kg ha^{-1})	113-176	147.76	15.266
5	Phosphorus (kg ha^{-1})	36.45-63.91	52.32	7.51
6	Potassium (kg ha^{-1})	143-407	266.121	59.95
7	Sulphur (kg ha^{-1})	19.6-44.8	31.75	5.617

Table 2: Salient properties of soil in the study area of research farm, College of Agriculture, Ambikapur

S. No.	Parameters	Range	Average	S.D.
1	pH	4 -5.3	4.55	0.31
2	EC (dS/m)	0.04 -0.06	0.075	0.08
3	Organic carbon (g kg^{-1})	1.2 -7.4	3.9	0.14
4	Nitrogen (kg ha^{-1})	87.1 -223.2	166.8	30.86
5	Phosphorus (kg ha^{-1})	28.7 -64.6	48.40	9.25
6	Potassium (kg ha^{-1})	164.3-426.3	299.8	77.76
7	Sulphur (kg ha^{-1})	10.92-39.2	19.69	6.52

Table 3: Overall fertility classes based on the NIV of nutrients in soils of KVK farm Ambikapur

S. No.	Soil Character -istics	Range	Average	% Samples Category			NIV	Fertility Class
				Low	Medium	High		
1	N (kg ha^{-1})	113-176	147.76	100	0	0	1	L
2	P (kg ha^{-1})	36.45-63.91	52.32	0	100	0	2	M
3	K (kg ha^{-1})	143-407	266.121	0	84	16	2.16	M
4	S (kg ha^{-1})	19.6-44.8	31.75	10	58	32	2.22	M

Table 4: Overall fertility classes based on the NIV of nutrients in soils of research farm, College of Agriculture, Ambikapur

S. No.	Soil Character -istics	Range	Average	% Samples Category			NIV	Fertility Class
				Low	Medium	High		
1	N (kg ha^{-1})	87.1 – 223.2	166.8	100	0	0	1	L
2	P (kg ha^{-1})	28.7 – 64.6	48.4	5.89	94.11	0	1.94	M
3	K (kg ha^{-1})	164.3-426.3	299.8	0	60.78	39.22	2.39	H
4	S (kg ha^{-1})	10.92-39.2	19.69	72.55	21.57	5.88	1.33	L

Conclusion

The soils of KVK Farm and research farm, College of Agriculture, Ambikapur, District Surguja Chhattisgarh, were discovered to have predominantly acidic soils (pH 5.9), and their electric conductivity with safe limit (<1 dS m^{-1}) most of the crop, falling under "normal" category. These qualities make the soils virtually universally suited for agricultural cultivation, the low pH or acidic nature warrants for application of suitable amendment viz. lime, the soil was found to be deficient in available N which may be due to low organic carbon in soils. Medium levels of phosphorus was found in both the farms, and medium level of potassium and sulphur was found in KVK farm, while in research farm, College of Agriculture potassium was high and low sulphur fertility status was found.

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