International Journal of Research in Agronomy 2024; SP-7(9): 681-690

E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(9): 681-690
Received: 13-06-2024
Accepted: 18-07-2024

Kuldeep Singh
Research Scholar, Department of Soil Science, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

Awinash Dwivedi
Assistant Professor, Department of Soil Science, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

Shivendra Kumar Mishra
Assistant Professor, Tula's Institute, Department of Agriculture, Dehradun, Uttarakhand, India

Ravi Patel
Research Scholar, Department of Soil Science, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

Shivendra Kumar Mishra
Assistant Professor, Tula's Institute, Department of Agriculture, Dehradun, Uttarakhand, India

Sanjay Singh Patel
Research Scholar, Department of Soil Science, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

Corresponding Author:
Shivendra Kumar Mishra
Assistant Professor, Tula's Institute, Department of Agriculture, Dehradun, Uttarakhand, India

Evaluation of soil fertility status using GPS techniques in Karguaji organic research farm, institute of agricultural sciences, Bundelkhand University Jhansi

Kuldeep Singh, Awinash Dwivedi, Shivendra Kumar Mishra, Ravi Patel, Shivendra Kumar Mishra and Sanjay Singh Patel

DOI: https://doi.org/10.33545/2618060X.2024.v7.i9Sj.1575

Abstract
The present investigation was under taken with a view to evaluate the fertility status in soils Karguaji organic farm of Institute of Agricultural Sciences, Bundelkhand Unversity, Jhansi district is located at Uttar Pradesh lying between 25° 44' N latitude and 70° 25' E longitude with 280 feet mean see level and normal annual rainfall is 550 mm. For evaluation of the soil fertility status of Karguaji organic farm the sample collected from the correct spot with help of global positioning system (GPS), a systematic survey was carried out. A surface (0-15 cm depth) soil sample was collected from the 5 land use pattern/locations. The experimental area was classified in five groups according to their land use pattern S1 -Upper Fallow land, S2- GPB experimental area, S3- SAC experimental area, S4- Barren low land area and S5- AGR (10 soil samples in each land use pattern. It can be concluded the results that most of the soils comes under different land use pattern of in Karguaji organic farm of Utter Pradesh under Bundelkhand region showed low status in available N, P and K and characterized under neutral (6.92) in soil reaction (pH) and less than 1.0 dS m^{-1} soluble salt content (EC) which comes under safe limit for all soils or no sensitive for suitable crop growth and developments. Most of soil samples observed sufficient level of DTPA-extractable B, Zn and Fe, Mn and Cu, higher level was observed in study area. The organic carbon level exhibited medium. Most of the soils of Karguaji organic farm were characterized by Low and sufficient to High categories macro and micro nutrients in the soils of different land use pattern of Karguaji organic farm. Hence, the soils require attention regarding nutrient management practices and regular monitoring of soil health for better crop production, in sustainable crop productivity.

Keywords: Soil physico- chemical Status, available macro& micronutrients, pH, soil fertility

Introduction

The populations of India continue to increase, human disturbance of the earth's ecosystem to produce food and fiber will place a greater demand on soils to supply essential nutrients. The practice of intensive cropping systems with high yielding varieties for increasing food production in India caused nutrient exhaustion in soils of India. The country contributes to 16 percent of the population and 2 percent of the total land of the world geographical area. Its population is growing at the rate of 15 million every year while size of an average land holding shrinking every year. In order to provide adequate food and fiber for over one billion people, the Indian agriculture is to be revolutionized from subsistent farming to intensive one by increasing cropping intensity, adopting high yielding varieties, use of more fertilizers and irrigation etc. All these will increase the agricultural production tremendously and will also increase demand of nutrients from soil reserves. The remarkable success in increasing agricultural production in India during the last 5 decades is a matter of deep satisfaction to all those who have contributed to it in a many of ways. Over the upcoming 25 years, and beyond, agricultural production will have to rise substantially in almost all crops. According to an assessment by the National Academy of Agricultural Science, the 1.4 billion people of India by the year of 2025 will require approximately 300 MT food grains, 40 MT oilseed, 58 MT sugar, 23 MT bales of cotton lint, 65 MT potatoes, 120 MT fruits besides more vegetables, tea, coffee, spices, fuel and wood etc. In order to achieve higher productivity and profitability, every farmer should realize that fertility levels must be measured as these measurements can then be used to manage soil fertility. It is determined by the presence or absence of nutrients i.e. macro and micronutrients. Balanced nutrient use ensures high production level and helps to maintain the soil health. The variability in fertility caused by application of fertilizers in individual farms is one factor that is difficult to account. However, it is possible to measure the natural variation in soil fertility by considering the factors which influence it. Slope, topography and soil types can account for most of the natural variation in fertility. It will be of great significance if Soil Test Crop Response based recommendation can be provided even on this basis. More site specific recommendations can still be provided on the basis of field soil testing to farmers who are applying very high doses of fertilizer and who show interest on testing their soils. The soil testing results indicate nothing about the potential of soil to produce or amount of nutrients to be added to achieve a desired yield (Nelsted and Peck, 1973) [35]. The interpretation of test results is carried out by correlating data obtained by analysis of soil samples with known field crop response. All plant needs certain mineral elements for proper growth, development, and maintenance. The basic structure of all organisms is build of C, H, O. Plants obtain these elements from water and air, so no input is required beyond being sure the plant has a water supply to meet its need. Turning the water and air into organic building block, however, is a complex process that requires the assistance of least macro (N, P, and K) and micro (Zn, Fe, Cu and Mn) nutrients are important soil elements that control its fertility. Soil fertility is one of the important factors in relation to evaluation of productivity status of the soils of an area and region. It is an important aspect in context of sustainable agriculture production. Soil fertility is an important factor, which determines the growth of plants. Soil fertility is determined by the presence or absence of nutrients i.e. macro and micronutrients. There are some other factors like organic matter or even soil texture which influence the availability of nutrients and the productivity. The technique applied to assess the presence of the nutrients volume is the soil in a form that is available to crops is known as ‘soil testing’. It is a pre- requisite to know the nutrient content in the soil and apply required amount of nutrients to optimize crop nutrition. Depending on the fertilizer origin, their amounts presents may be expressed as N, P_2O_5, and K_2O.

The advent of information technology have provided tools like Global Positioning System (GPS), Remote sensing, Simulation modeling and Geographical Information System (GIS), which help in collecting a systematic set of geo-referenced samples and Generating spatial data about the distribution of nutrients using remote sensing techniques is an effective way to analyze and map the variability of nutrients across different regions. According to Sharma (2004) [44], these maps help in delineating homogeneous units, which are essential for determining appropriate sampling sizes. This process not only ensures accurate representation but also saves considerable time and resources.. This will also helps to monitor the changes in micronutrients status over a period of time as sampling sites can be revisited with the help of GPS which is otherwise difficult in the random sampling (Sood *et al.* 2004) [48].

Materials and Methods

The investigation to evaluate the soil fertility status of Karguaji organic farm, Jhansi district of (Uttar Pradesh) in Karguaji organic farm, mainly red soil (Laterite) exists and locally named as, Parawa soil. Jhansi district is located at Uttar Pradesh lying between 25° 44’ N latitude and 70° 25’ E longitude with 280 feet mean see level and normal annual rainfall is 550 mm. The region generally experiences hot, sub humid climate and the hottest and coolest months are June and January, respectively. The maximum temperature during the summer may exceed up to 47 °C and the minimum temperature often falls below 6 °C during winter season. The experimental area was classified in five (S1= Upper Fallow land, S2= GPB experimental area, S3= SAC experimental area, S4= Barren low land area and S5= AGR experimental area) groups according to their land use pattern. For evaluation of the soil fertility status of Karguaji organic farm under Jhansi district, a systematic survey was carried out. Soil sampling points were determined according to land use patterns. Generally in each land use patterns, one type of soil was found. The area was surveyed in each land use patterns and sampling was done considering ten soil samples from each land use patterns should be taken. After sampling, the points were marked by GPS with Latitude and Longitude. The soil samples were collected from 0-15 cm depth (surface soil) with the help of local spade or soil screw auger.

Table 1: Rating of the soil test values of the available macro-nutrients:

Nutrients		Rating of the soil test values	
Parameters	Low	Medium	High
O. C. (%)	< 0.50	0.5 – 0.75	> 0.75
Av. N (kg.ha^{-1})	< 280	280 – 560	> 560
Av. P (kg.ha^{-1})	< 12.5	12.5 – 25	> 25
Av. K (kg.ha^{-1})	< 135	135 – 335	> 335

Table 2: Criteria for assessment of micro-nutrients in soils:

Nutrients		Micronutrients (ppm or mg kg^{-1})	
Parameters	Deficient	Sufficient	Higher level
Av. Fe (mg kg^{-1})	<4.5	4.5-9.0	> 9.0
Av. Mn (mg kg^{-1})	<3.5	3.5-7.0	> 7.0
Av. Cu (mg kg^{-1})	<0.2	0.2-0.4	> 0.4
Av. Zn (mg kg^{-1})	<0.6	0.6-1.2	> 1.2

Table 3. Limits for the soil test values used for rating the soils:

Classification for pH values				
Strongly acid	Moderately acid	Slightly acid	Neutral	Slightly alkaline
<5.0	5.1- 6.0	6.1-6.5	6.6-7.5	7.6-8.5
Classification for total soluble salt content (EC as dS m^{-1})				
	<0.1	0.1-0.2	0.2-0.3	>0.3
Parameters	Very Low	Low	Medium	High
O.C. (%)	<0.25	0.25-0.50	0.50-0.75	>0.75
Macro-nutrients				
Av. N (kg ha $^{-1}$)		<280	280-560	>560
Av. P (kg ha $^{-1}$)		<12.5	12.5-25	>25
Av. K (kg ha $^{-1}$)		<135	135-335	>335
Micro-nutrients				
		Deficient	Sufficient	High level
Av. Fe (mg kg-1)		<4.50	>4.50	>9.00
Av. Mn (mg kg-1)		<3.50	>3.50	>7.00
Av. Cu (mg kg-1)		<0.20	>0.20	>0.40
Av. Zn (mg kg-1)		<0.60	>0.60	>1.20

The Investigating area soil were analysis like soil reaction (pH), Electrical conductivity (EC), Organic carbon (OC), available macro-nutrients (Nitrogen, Phosphorous, Potasium, and Sulphur) and DTPA- extractable micro-nutrients (Iron, Copper, Zinc, Boron and Manganese). Organic carbon content of the soil sample was determined by (Walkley and Black, 1934). One gm soil was dissolve with 10 ml 1.0*N* potassium dichromate

($K_2Cr_2O_7$) and followed by adding 20 ml of con.H_2SO_4 in dark condition for 30 min. Then excess dichromate was determined by titration with 0.5 *N* ferrous ammonium sulphate [$Fe(NH_4)(SO_4)_2.6H_2O$] after adding 10 ml conc. H_3PO_4 using diphenyl amine indicator. The data on available zinc, copper, iron and manganese of soils were characterized for deficient and adequate status using the threshold values 4.5 mg kg^{-1} of soil for Fe, 0.2 for Cu, (Katyal and Randhawa, 1983) [19], 3 mg kg^{-1} of soil for Mn (Shukla and Gupta,1995) [42] and 0.6 mg kg^{-1} of soil for Zn (Katyal,1985) [20].

Results and Discussion

The results obtained from the present study are presented in this section dealing with the assessment of the soil fertility status in different land of the Karaguaji organic farm of Bundelkhand University under Jhansi district. The Red soil (*Alfisols*) is found under study area has been evaluated for nutrient availability in respect of the major elements (nitrogen, phosphorous and potassium), the soil test values recorded for the entire study area and nutrient status were worked out for categorization of soils into different fertility class.

Physico-chemical characteristics

Soil reaction (pH)

A study on soil pH presented in table 4.1 revealed that the soils pH of different land use pattern was neutral in reaction and overall pH ranged from 6.48 to 7.48 with overall mean value 6.92 in red soils (*Alfisols*) of the study area under Karguaji organic farm of Bundelkhand University, Jhansi. The mean values of soil reaction (pH) in different land use pattern were in the order of: S5 < S1 < S4 < S3 < S2 (Table 4.1). Singh *et al.*, (2009) [23] reported that surface and subsurface soils were neutral to slightly alkaline in reaction in the soils of district Ghazipur. Considering the table 3.4, the soils having pH < 5.0 are considered strongly acidic, pH 5.0 to 6.0 as moderately acidic, pH 6.1 to 6.5 as slightly acidic, neutral considered for pH 6.6 to 7.5 and slightly alkaline soils are considered for pH 7.6 to 8.5. The mean value of soil pH in different land use pattern ranged from 6.20 to 7.80, 6.60 to 7.60, 6.50 to 7.30, 6.20 to 7.20 and 6.90 to 7.50 in soil of different land use system. In general, out of 50 samples, soils were found neutral in reaction under the study area. It showed lower variability (coefficient of variation (CV = 2.22%) in S5 land use pattern and overall variability (coefficient of variation (CV = 4.42%) under different land use pattered in Karguaji organic farm. The difference of soil pH in agricultural practices and the trend of decreasing rainfall (Krishan *et al*. 2015). Higher rainfall leads to leaching of base cations like Ca and Mg and hence decreases pH. In the case of Jhansi district, it was difficult to reveal the dependence of other soil fertility properties on pH Garnaik *et al*. (2020) [11] were also reported that agro-ecological sub-regions soil reaction (pH) level in various order: NEU < CAP < SSH < PAP < SWAP. The averaged soil pH In the Sub-mountainous of Shivalik Hills between 7.44- 6.73 to 8.23. It showed lower spatial difference (coefficient of variation (CV) = 5.4%), whereas in the Northeast Undulating region, pH varied from 6.11 to 7.98 with an average of 7.04. Rai *et al*., (2018) [38] reports similar findings on pH of the surface soils. Kashiwar *et al*. (2018) [18] was found the similar results in soils of Mirzapur, Uttar Pradesh the pH ranged from 5.9 to 6.5 with mean of 6.14 slightly acidic in nature.

Table 1: Detail of statistical of the soil reaction (pH) in the different land use pattern of Karguaji organic farm of Jhansi district

Land Use Pattern	Mean	Standard deviation	Minimum	Maximum	Coefficient of variation (%)	Soil pH Category
S1	6.70	0.45	6.20	7.80	6.74	Neutral
S2	6.96	0.32	6.60	7.60	4.62	Neutral
S3	6.95	0.26	6.50	7.30	3.81	Neutral
S4	6.74	0.32	6.20	7.20	4.73	Neutral
S5	7.25	0.16	6.90	7.50	2.22	Neutral
Overall Mean	6.92	0.30	6.48	7.48	4.42	Neutral

S1= Upper fallow land, S2= GPB experimental area, S3= SAC experimental area, S4= Barren low land area and S5= AGR experimental area

Electrical conductivity (EC, dS m^{-1})

The electrical conductivity data is presented in table 2. The average mean values of data revealed that the soils electrical conductivity ranged from 0.27 to 0.46 in different land use pattern of Karguaji organic farm under Bundelkhand University, Jhansi. The average statically value of electrical conductivity in different land use pattern were in the order S4 < S2 < S3 < S1 < S5. The usual EC can be explained by the leaching of salts to lower strata because of its light texture, high surface runoff, and precipitation. The overall mean of the Karguaji organic farm was 0.34 with minimum and maximum values 0.27 and 0.46 respectively and EC values falls under non-saline category. The Typical EC could be recognized to salts seeping into lower horizons as a result of the light textured nature of the soils. All the soil samples have safe range of electrical conductivity with respect to crop growth and development. The mean data showed lower variability (or coefficient of variation (CV) = 10.29%), whereas in the S3. The variation of soil EC is agricultural practices and the trend of decreasing rainfall (Krishan *et al*. 2015). Higher rainfall leads to leaching of base cations like Ca and Mg and hence decreases EC. The results have shown that all the EC values were under normal range (<1.0 dS m^{-1}), therefore these soils are denoted as non-saline and it was reported by Bali *et al.*, (2010) [5]. Similar results were also found in soils of Pamgarh block in Janjgir- Champa district (C.G.), in which EC ranges from 0.05 to 0.86 dS m^{-1} (Mean – 0.13 dS m^{-1}) as reported by Shukla (2011) [48]. Greater variability within a particular agro-ecological zone indicates that more thorough sampling is required to accurately assess this attribute. It is necessary to investigate the relationship between electrical conductivity and fertilizer use. Serrano *et al.*, (2017) observed the effect of fertilizer practices on salt distribution in soils. Garnaik *et al.* (2020) [11] were also reported that electrical conductivity (EC) values in various agro-ecological sub-regions were in the following order in the sub-mountainous Shivalik Hills in India: NEU < SSH < PAP < CAP < SWAP. Rai *et al.* (2018) [38] present comparable results regarding the EC of the surface soils. Similar findings were discovered by Kashiwar *et al*. (2018) [18] in the soils of Mirzapur, Uttar Pradesh, where the EC ranged from 0.25 to 0.76 with a mean of 0.53 dS m-1 and were non-saline in nature. Singh *et al*. (2019) [49], Kumar *et al*. (2018) [24], Khan *et al*. (2017) [21], and Madhu *et al*. (2017) [27] have all reported findings that are similar.

Table 2: The statistical details of the electrical conductivity (EC, dS m-1) in the various land use patterns of the Karguaji organic farm in Jhansi district are presented in Table 2.

Land Use Pattern	Mean	Standard deviation	Minimum	Maximum	Coefficient of variation (%)	Soil EC Category
S1	0.36	0.09	0.26	0.57	26.39	Non- Saline
S2	0.34	0.06	0.25	0.45	17.69	Non- Saline
S3	0.35	0.04	0.29	0.41	10.29	Non- Saline
S4	0.31	0.06	0.25	0.43	19.33	Non- Saline
S5	0.37	0.05	0.28	0.42	12.87	Non- Saline
Overall Mean	0.34	0.06	0.27	0.46	17.31	Non- Saline

S1= Upper fallow land, S2= GPB experimental area, S3= SAC experimental area, S4= Barren low land area and S5= AGR experimental area

Organic carbon (OC, %)

With the exception of S5, the data in Table 3 showed that the majority of soils had low levels of organic carbon. In contrast to other land use systems, the S4 land use pattern was discovered to have a higher high concentration of organic materials. With a mean value of 0.51%, it varied between 0.18 and 1.04 percent in various land use patterns at the Karguaji organic farm of Bundelkhand University, Jhansi. The average organic carbon content (OC) of all soil samples from the Karguaji organic farm under various land use patterns was medium (0.51%). With means of 0.42, 0.35, 0.47, 0.78, and 0.52% in S1, S2, S3, S4, the mean organic carbon content varied from 0.15 to 0.97, 0.10 to 0.93, 0.22 to 0.84, 0.30 to 1.60, and 0.15 to 0.88%.

with means in the land use patterns of S1, S2, S3, S4, and S5 of 0.42, 0.35, 0.47, 0.78, and 0.52%, respectively. Different land use patterns' soils fall into the low to medium organic carbon category. The S4 land use pattern exhibited higher variability (coefficient of variance (CV) = 45.46%). At the Karguaji organic farm, the OC values range from 0.18 to 1.04 (mean 0.51 and CV = 54.19%) in the various land use patterns. The following sequence was revealed by the Karguaji organic farm's varied land use pattern: S1< S2< S3< S5< S4. According to Garnaik *et al.* (2020) [11], in the sub-mountainous Shivalik Hills region of India, the order of OC concentration in different agro-ecological sub-regions was SWAP < PAP < NEU < CAP < SSH. Elevated India's Shivalik Hills region is sub-mountainous. The rate of oxidation of organic material was accelerated by high soil temperature and adequate aeration, which decreased the amount of organic carbon in the soil. These soils have a medium organic carbon concentration because of the quick burning of organic matter caused by the high temperatures in the area. Sharma *et al.* (2008) [47] similarly observed similar results in the soils of the district of Amritsar. The results of Jatav (2010) [16] in the soils of the Inceptisols group of the Baloda block of the Janjgir-Champa district, Vaisnow (2010) [55] in the soils of the Vertisols of the Dhamtari block under the Dhamtari district in Chhattisgarh, and Shukla (2011) [48] in the soils of the Pamgarh block in the Janjgir-Champa district (C.G.) also support the above findings.

Table 3: Detail statistics of organic carbon (OC, %) in the different land use pattern of Karguaji organic farm of Jhansi district

Land Use Pattern	Mean	Standard deviation	Minimum	Maximum	Coefficient of variation (%)	Soil OC (%) Category
S1	0.42	0.24	0.15	0.97	57.60	Low
S2	0.35	0.25	0.10	0.93	72.29	Low
S3	0.47	0.22	0.22	0.84	46.80	Low
S4	0.78	0.36	0.30	1.60	45.46	High
S5	0.52	0.26	0.15	0.88	48.79	Medium
Overall Mean	0.51	0.26	0.18	1.04	54.19	Medium

S2 is the GPB experimental region, S3 is the SAC experimental area, S4 is the barren low land area, and S5 is the AGR experimental area. S1 is the upper fallow land.

Status of available macronutrients (N, P, K, and S) in soils

Nitrogen that is available (Av. N)

Table 4 displays the average values of available nitrogen (Av. N), which indicates that all soils, with the exception of S4 land use pattern, have lower overall available nitrogen. In the various land use patterns of the Karguaji organic farm of Bundelkhand University, Jhansi, it varied from 100.73 to 336.87 kg ha $^{-1}$, with a mean value of 212.06 kg ha $^{-1}$. All of the soil samples had low available N content, according to the soil test rating system, which classifies available N as <280 as low, 280–560 as medium, and >560 kg ha $^{-1}$ as high. The overall mean available N content ranged from 169.11 to 341.36, 47.0 to 334.0, 104.0 to 327.0, 112.52 to 353.0 and 71.00 to 329.0 kg ha $^{-1}$ with mean of 233.49, 141.56, 189.27, 278.33 and 217.65 kg ha $^{-1}$ in S1, S2, S3, S4 and S5 land use pattern respectively. The soils of Karguaji organic farm had come under in low available nitrogen content. It showed lower variability (coefficient of variation (CV) = 21.62%), whereas in the S1 land use pattern. The overall available N content values ranging from 100.73 to 336.87 (mean 212.06 and CV = 38.46%) in the different land use pattern. Various land use pattern of Karguaji organic farm showed the following order: S2 < S3 < S5 < S1 < S4. An average value of Av. N content of the soil was found minimum *i.e.* 47.00 kg ha $^{-1}$ for the village S2 and maximum *i.e.* 353.00 kg ha $^{-1}$ for S4 (Appendix-I) respectively. These results are also in agreement with the findings of Jatav (2010) [16] in the soils of *Inceptisols* group of Baloda block of Janjgir-Champa district of Chhattisgarh and Shukla (2011) [48] in the different soil orders of Pamgarh block in Janjgir-Champa district. Although, it is fact that the available N analyzed by alkaline KMnO4 method as suggested by Subbiah and Asija, (1956) do not exhibit the exact availability of N in dry soil. It is the measure of the oxidizable N in dry soil. Garnaik *et al.* (2020) [11] were also reported that available N values in various agro-ecological sub-regions were in the order: SWAP < CAP < PAP < SSH < NEU in the Sub-mountainous Shivalik Hills region of India. Rai *et al.*, (2018) [38] reports similar findings on Av. N of the surface soils. Kashiwar *et al.* (2018) [18] was found the similar results in soils of Mirzapur, Uttar Pradesh the nitrogen was low in fertility status. Similar findings also are reported by Singh *et al.*, (2019) [49]; Kumar *et al.*, (2018) [24]; Khan *et al.*, (2017) [21] and Madhu *et al.*, (2017) [27].

Table 4: Detail statistics of Available N (kg ha $^{-1}$) in the different land use pattern of Karguaji organic farm of Jhansi district

Land Use Pattern	Mean	Standard deviation	Minimum	Maximum	Coefficient of variation (%)	Soil Av. N (kg ha $^{-1}$) Category
S1	233.49	50.49	169.11	341.36	21.62	Low
S2	141.56	86.62	47.00	334.00	61.19	Low
S3	189.27	77.32	104.00	327.00	40.85	Low
S4	278.33	78.01	112.52	353.00	28.03	Medium
S5	217.65	88.40	71.00	329.00	40.62	Low
Overall Mean	212.06	76.17	100.73	336.87	38.46	Low

Upper fallow land (S1), low-lying barren area (S4), GPB experimental area (S2), SAC experimental area (S3), and AGR experimental area **(**S5)

Available phosphorous (Av. P)

The aggregate accessible phosphorus of the soils falls into a lower categorization, according to the mean values of available phosphorus (Av. P) shown in Table 5. In the various land use patterns of the Karguaji organic farm of Bundelkhand University, Jhansi, it varied from 4.50 to 12.02 kg ha $^{-1}$, with a mean value of 8.03 kg ha $^{-1}$. All of the soil samples in the various land use patterns of the Karguaji organic farm were determined to have low accessible P content, based on the soil test grade for available P, which is <12.50 as low, 12.50 - 25.00 as medium, and >25 kg ha $^{-1}$ as high. Between 4.5 and 10.50, 4.5 to 12.11, 4.5 to 12.50, 4.5 to 12.58, and 4.5 to 12.50, the overall mean Av. P content 12.40 kg ha $^{-1}$, with means in the land use patterns of S1, S2, S3, S4, and S5 being 7.18, 8.03, 8.19, 8.80, and 7.95 kg ha $^{-1}$, respectively. The Karguaji Organic Farm's soils, which have varying land use patterns, have low levels of accessible phosphorus. Compared to the S1, it had reduced variability (coefficient of variation (CV) = 29.54%). The overall Av. P content values in the various land use patterns at the Karguaji organic farm range from 4.50 to 12.02 (mean 8.03 and CV = 36.91%). Generally speaking, these patterns were closely tied to patterns in the use of P fertiliser (Anonymous, 2019). The Karguaji Organic Farm's distinct land use pattern revealed the following hierarchy: S1 < S5 < S2 < S3 < S4. Soil contains phosphorus in a solid phase that is not entirely soluble.When water-soluble P is introduced to the soil, it reacts with the elements of the soil extremely fast to become an insoluble solid phase. These could include the soil's partially organic carbon, calcium carbonate (Olsen, 1953) [37], iron and aluminium oxides (Dean and Rubins, 1947; Chu *et al*., 1962) [9]. Soil testing reveals that very little total P is ever available in soil solution forms due to these processes, which also have an impact on P availability. However, a low range of accessible P in the soil under study may be primarily influenced by agronomic practices, pH, organic carbon content, texture, past fertilisation, and other soil management techniques (Verma *et al*. 2005) [57]. The available phosphorus mean value that was highest was found in Aichaura (27.00 kg ha $^{-1}$) and Char village of Manikpur block (4.23 kg ha $^{-1}$). These findings are consistent with those published in the Dumka and Lachinpur series of Jharkhand by Nirawar *et al*. (2009) [36] and Kumar *et al*. (2009) [23]. According to Garnaik *et al*. (2020) [11], available N values in different agro-ecological sub-regions in the sub-mountainous Shivalik Hills region of India were in the following order: SSH < CAP < PAP < SWAP < NEU. Regarding Av. P of the surface soils, Rai *et al*. (2018) [38] report comparable results. Similar findings were discovered by Kashiwar *et al*. (2018) [18] in the soils of Mirzapur, Uttar Pradesh, where the fertility status of nitrogen was low to medium. Similar results are also published by Kumar and Singh *et al*., 2019 [49]; Khan *et al*. (2017) [21], Madhu *et al*. (2017) [27], and Kumar *et al*. (2018) [24].

Table 5: Provides descriptive statistics of Available P (kg ha $^{-1}$) in the various land use patterns of the Jhansi district's Karguaji organic farm

Land Use Pattern	Mean	Standard deviation	Minimum	Maximum	Coefficient of variation (%)	Soil Av. P (kg ha $^{-1}$) Category
S1	7.18	2.12	4.50	10.50	29.54	Low
S2	8.03	2.73	4.50	12.11	34.01	Low
S3	8.19	3.25	4.50	12.50	39.65	Low
S4	8.80	3.70	4.50	12.58	42.00	Low
S5	7.95	3.13	4.50	12.40	39.36	Low
Overall Mean	8.03	2.99	4.50	12.02	36.91	Low

Upper fallow land is designated as S1, low-lying barren region as S4, GPB experimental area as S2, SAC experimental area as S3, and AGR experimental area as S5.

Available potassium (Av. K)

The distribution of potassium that can be extracted from neutral ammonium acetate (pH=7.0) across the various land use patterns of the Karguaji organic farm at Bundelkhand University, Jhansi, is shown in Table 6. According to the average levels of accessible potassium (Av. K.), all soils fall into a lower group when it comes to soil fertility. In the diverse land use pattern of the Karguaji organic farm, the overall mean values varied from 71.40 to 135.43 kg ha $^{-1}$, with a mean value of 102.49 kg ha $^{-1}$. All of the soil samples under the Karguaji organic farm had lower available K content in different land use patterns when compared to the available P rating of the soil test (< 135.00 as low, 135.00 - 335.00 as medium, and >335.00 kg ha $^{-1}$ as high). In S1, S2, S3, S4 and S5 land use patterns of Karguaji organic farm, the mean values of Av. K content ranged from 89.0 to 162.47, 58.00 to 138.45, 58.00 to 121.47, 76.00 to 132.24, and 76.00 to 122.52 kg ha $^{-1}$ with mean of 115.74, 95.43, 92.50, 109.72 and 99.07 kg ha $^{-1}$, respectively. The Karguaji Organic Farm's soils with varying land use patterns exhibited low levels of accessible potassium. Compared to the S5, it displayed reduced variability (coefficient of variation (CV) = 15.36%). The overall average K content values in the various land use patterns of the Karguaji organic farm range from 71.40 to 135.43 (mean 102.49 and CV = 22.84%). In general, these patterns had a clear connection to the mining of Av and K fertilization K throughout the region's various farming systems. Singh & Associates, 2003). The following sequence was revealed by the Karguaji organic farm's varied land use pattern: S3 S2~ S5~ S4~ S1. The average soil K content was determined to be, respectively, minimum (58.00 kg ha $^{-1}$) for the S3 land use pattern and maximum (162.47 kg ha $^{-1}$) for the S1 land use pattern of the Karguaji organic farm. According to Garnaik *et al*.

(2020) [11], available K values in different agro-ecological sub-regions in the Sub-mountainous Shivalik Hills region of India were in the following order: CAP < SSH < NEU < SWAP < PAP. Rai *et al*. (2018) [38] present comparable results regarding the surface soils' Av. K. Similar findings were discovered by Kashiwar *et al*. (2018) [18] in the soils of Mirzapur, Uttar Pradesh. The fertility status of the nitrogen was medium to high. Singh *et al*. (2019) [49], Kumar *et al*. (2018) [24], Khan *et al*. (2017) [21], and Madhu *et al*. (2017) [27] have all reported findings that are similar.

Table 6: The available K (kg ha^{-1}) in the various land use patterns of the Karguaji organic farm in the Jhansi district is described in Table.6.

Land Use Pattern	Mean	Standard deviation	Minimum	Maximum	Coefficient of variation (%)	Soil Av. K (kg ha $^{-1}$) Category
S1	115.74	26.27	89.00	162.47	22.70	Low
S2	95.43	33.50	58.00	138.45	35.10	Low
S3	92.50	22.97	58.00	121.47	24.84	Low
S4	109.72	17.80	76.00	132.24	16.22	Low
S5	99.07	15.22	76.00	122.52	15.36	Low
Overall Mean	102.49	23.15	71.40	135.43	22.84	Low

S2 is the GPB experimental region, S3 is the SAC experimental area, S4 is the barren low land area, and S5 is the AGR experimental area. S1 is the upper fallow land.

.

Available sulphur (Av. S)

The available sulphur mean values (Av. S) are shown in table 7. The average soil fertility rating (Av. S) for all soils is medium, according to the mean value data. With a mean value of 12.21 kg ha^{-1}, it varied between 09.29 and 15.43 kg ha^{-1} in various land use patterns at the Kargiaji organic farm of Bundelkhand University, Jhansi. Plant roots took up sulphur from the soil solution as SO4-2. In light of these facts, the soil test rating for available S under study region can be categorised according to the classification provided by Hariram and Dwivedi (1994) as deficient (< 10.0 kg ha^{-1}) as low, (10.0-20.0 kg ha $^{-1}$) as medium, and (> 20.0 kg ha^{-1}) as an adequate category. S was classified as medium in terms of the various land use patterns of the Kargiaji organic farm, based on the available categories.

Table 7: Descriptive statistics on Available S (kg ha $^{-1}$) in the various land use patterns of the Jhansi district's Karguaji organic farm

Land Use Pattern	Mean	Standard deviation	Minimum	Maximum	Coefficient of variation (%)	Soil S (kg ha $^{-1}$) Category
S1	11.06	1.89	8.40	14.56	17.04	Medium
S2	11.98	2.02	9.45	15.86	16.84	Medium
S3	11.87	1.75	8.24	14.56	14.77	Medium
S4	13.20	1.83	9.61	16.76	13.88	Medium
S5	12.95	1.63	10.73	15.39	12.62	Medium
Overall Mean	12.21	1.82	9.29	15.43	15.03	Medium

Upper fallow land is designated as S1, low-lying barren region as S4, GPB experimental area as S2, SAC experimental area as S3, and AGR experimental area as S5.

3DTPA-extractable micro-nutrients (Zn, Fe, Mn, Cu and B) status of soils

Tables 8 through 12 provide a summary of the data pertaining to the state of the micronutrients zinc (Zn), copper (Cu), iron (Fe), manganese (Mn), and boron (B) extractable by Diethylene triamine pentaacitic acid (DTPA) in various land use patterns of the Karguaji organic farm of Bundelkhand University, Jhansi under investigation.

DTPA- extractable Zinc (DTPA - Zn)

The average levels of zinc (DTPA-Zn) extractable by diethylene triamine pentaacitic acid (DTPA) are shown in table.8. The average results showed that, under various land use patterns of the Karguaji organic farm, the overall DTPA-Zn of the soils is having sufficient in category of soil fertility rating. With a mean value of 0.75 mg kg-1 throughout the various land use patterns of the Karguaji organic farm, it varied from 0.65 to 0.84 mg kg-1. According to Lindsay and Norvell's 1978 classification, the soil test grade for DTPA-Zn in the study region can be categorised as insufficient (<0.60 mg kg^{-1}) as deficient, sufficient (0.60-1.20 mg kg^{-1}) as sufficient, and higher (> 1.20 mg kg^{-1}) as a higher category. These categories indicated that DTPA-Zn was enough for the status of the organic farm in Karguaji's various land use patterns. The overall mean DTPA-Zn concentration varied between 0.35 and 1.45, 0.41 and 1.25, 0.37 and 1.74, 0.58 and 1.53, and 0.46 and 1.46 mg kg-1. In the S1, S2, S3, S4 and S5 land use pattern of Karguaji organic, the mean values were, respectively, 0.65, 0.67, 0.74, 0.85, and 0.84 mg kg^{-1}. The total fertility level of the soils in the various land use patterns of the Karguaji organic farm was found to be below adequate DTPA-Zn content. While in the S4 land use pattern, it displayed higher variability (coefficient of variation (CV) = 35.55%). The DTPA-Zn concentration values in the various land use patterns of the Karguaji organic farm range from 0.43 to 1.49 (mean 0.75 and CV = 44.21%). The average data was Karguaji Organic Farm's land use pattern was distinct. The order of the DTPA extractable zinc status was S1 < S2 < S3 < S5 < S4. A minimum of 0.35 mg kg-1 for the S1 land use pattern and a maximum of 1.86 mg kg-1 for the S3 land use pattern determined for the average value of the DTPA-Zn content of the soil.

Hot water extractable boron (B)

The hot water extractable boron (B) mean values are shown in table.9. The average results showed that the Karguaji organic farm's soils had an adequate amount of boron generally in terms of soil fertility. With a mean value of 0.64 mg kg-1 throughout the various land use patterns of the Karguaji organic farm, it varied from 0.41 to 0.90 mg kg-1. The Karguaji Organic Farm's mean data revealed a distinct land use pattern, and the hot water extractable boron status was displayed in the following order: The land use pattern of Bundelkhand University, Jhansi's Karguaji organic farm is S4 < S1 < S5 < S2 < S3.

Table 8: Summarized of DTPA- Zn (mg kg soil^{-1}) in the different land use pattern of Karguaji organic farm of Jhansi district

Land Use Pattern	Mean	Standard deviation	Minimum	Maximum	Coefficient of variation (%)	Soil DTPA- Zn (mg kg Soil^{-1}) Category
S1	0.65	0.32	0.35	1.45	49.61	Sufficent
S2	0.67	0.24	0.41	1.25	36.19	Sufficent
S3	0.74	0.42	0.37	1.74	56.87	Sufficent
S4	0.85	0.30	0.58	1.53	35.55	Sufficent
S5	0.84	0.36	0.46	1.46	42.82	Sufficent
Overall Mean	0.75	0.33	0.43	1.49	44.21	Sufficent

Upper fallow land (S1), low-lying barren area (S4), GPB experimental area (S2), SAC experimental area (S3), and AGR experimental area (S5)

Table 9: The detail statistics of Available B (mg kg soil^{-1}) in the different land use pattern of Karguaji organic farm of Jhansi district

Land Use Pattern	Mean	Standard deviation	Minimum	Maximum	Coefficient of variation (%)	Soil DTPA- B (mg kg Soil^{-1}) Category
S1	0.49	0.13	0.32	0.72	27.16	Sufficient
S2	0.81	0.21	0.57	1.31	25.78	Sufficient
S3	0.90	0.33	0.56	1.60	36.67	Sufficient
S4	0.41	0.11	0.26	0.62	26.60	Sufficient
S5	0.56	0.16	0.29	0.84	28.29	Sufficient
Overall Mean	0.64	0.19	0.40	1.02	28.90	Sufficient

S1= Upper fallow land, S2= GPB experimental area, S3= SAC experimental area, S4= Barren low land area and S5= AGR experimental area

DTPA- extractable Iron (DTPA - Fe)

Table 10 displays the average values of DTPA-Fe (DTPA-extractable iron). The average data showed that the soils' total DTPA-Fe content is having Higher in the category of soil fertility rating across most land use patterns, with the exception of S1 under Bundelkhand University's Karguaji organic farm in Jhansi. In various land use patterns, it varied from 7.52 to 13.94 mg kg-1, with a mean value of 10.87 mg kg-1. According to the classification provided by Lindsay and Norvell, (1978), the soil test grade for DTPA-Fe in the study region may be categorised as (<4.50 mg kg-1) as deficient, (4.50-9.00 mg kg-1) as sufficient, and (> 9.00 mg kg-1) as a higher category. The mean DTPA-Fe data according to these categories showed a higher level status in

Table 10: Detailed statistics of DTPA- Fe (mg kg soil^{-1}) in the different land use pattern of Karguaji organic farm of Jhansi district

Land Use Pattern	Mean	Standard deviation	Minimum	Maximum	Coefficient of variation (%)	Soil DTPA- Fe (mg kg Soil^{-1}) Category
S1	8.41	1.95	5.06	11.48	23.18	Sufficent
S2	10.97	1.95	7.62	14.04	17.78	Higher level
S3	10.30	1.95	6.95	13.37	18.93	Higher level
S4	12.15	1.95	8.80	15.22	16.05	Higher level
S5	12.52	1.95	9.17	15.59	15.58	Higher level
Overall Mean	10.87	1.95	7.52	13.94	18.30	Higher level

S1= Upper fallow land, S2= GPB experimental area, S3= SAC experimental area, S4= Barren low land area and S5= AGR experimental area

DTPA- extractable Manganese (DTPA - Mn)

Table .11 displays the average values of DTPA-extractable Manganese (DTPA-Mn). The average results showed that, altogether, DTPA-Mn of the soils has a high level in the category of soil fertility rating diverse land use pattern of Bundelkhand University, Jhansi, Karguaji organic farm. With a mean value of 28.51 mg kg-1 across the various land use patterns of the Karguaji organic farm, it varied from 12.62 to 48.80 mg kg-1. According to the classification provided by Lindsay and Norvell (1978), the soil test rating for DTPA-Mn under study area may be categorised as (<3.50 mg kg-1) as deficient, (3.50-7.00 mg kg-1) as sufficient, and (> 7.00 mg kg-1) as a higher category. These categories indicated that the DTPA-Mn mean data was at a higher status in the organic farm of Karguaji's varied land use pattern. These results corroborate the findings of Singh *et al*. (2009) [23] on the DTPA-extractable Mn in the soils of district Gajipur, Uttar Pradesh, as well as results published by Rajeshwar *et al*. (2009) in the soils of the Krishna district of Andhra Pradesh.

Table 11: The descriptive statistics of DTPA- Mn (mg kg soil^{-1}) in the different land use pattern of Karguaji organic farm of Jhansi district

Land Use Pattern	Mean	Standard deviation	Minimum	Maximum	Coefficient of variation (%)	Soil DTPA- Mn (mg kg Soil^{-1}) Category
S1	25.83	13.95	9.94	46.12	53.98	Higher level
S2	27.97	13.95	12.08	48.26	49.85	Higher level
S3	29.37	13.95	13.48	49.66	47.47	Higher level
S4	29.95	13.95	14.06	50.24	46.56	Higher level
S5	29.43	13.95	13.54	49.72	47.38	Higher level
Overall Mean	28.51	13.95	12.62	48.80	49.05	Higher level

S1= Upper fallow land, S2= GPB experimental area, S3= SAC experimental area, S4= Barren low land area and S5= AGR experimental area

DTPA- extractable Cupper (DTPA - Cu)

Table 12 displays the average values of DTPA-extractable Cupper (DTPA-Cu). The average data showed that the soils' DTPA-Cu levels are generally higher in the category of soil fertility rating for the various land use patterns of the organic farm in Karguaji. With a mean value of 0.65 mg kg^{-1} throughout the various land use patterns of the Karguaji organic farm, it varied from 0.61 to 0.67 mg kg^{-1}. According to the classification provided by Lindsay and Norvell (1978), the soil test rating for DTPA-Cu under study region may be classed as (<0.20 mg kg-

1) as deficient, (0.20-0.40 mg kg^{-1}) as sufficient, and (> 0.40 mg kg-1) as a higher category. These categories showed that the DTPA-Cu mean data had a higher rank in the various land patterns. The way the organic farm in Karguaji is used. The total mean DTPA-Cu concentration varied between 0.49 and 0.83, 0.33 to 0.87, 0.38 to 1.10, 0.37 to 0.91, and 0.30 to 0.84 mg kg-1. In the S1, S2, S3, S4 and S5 land use pattern of Karguaji organic farm, the mean values were 0.65, 0.65, 0.65, 0.67, and 0.61 mg kg-1, respectively. These results corroborate the findings of Singh *et al*. (2009) [23] on the DTPA-extractable Cu in the soils of district Gajipur, Uttar Pradesh, as well as results published by Rajeshwar *et al*. (2009) in the soils of the Krishna district of Andhra Pradesh.

Table 12: Shows the descriptive statistics of DTPA-Cu (mg kg soil-1) in the various land use patterns of the Jhansi district's Karguaji organic farm.

Land Use Pattern	Mean	Standard deviation	Minimum	Maximum	Coefficient of variation (%)	Soil DTPA- Cu (mg kg $Soil^{-1}$) Category
S1	0.65	0.13	0.49	0.83	19.59	Higher level
S2	0.65	0.18	0.33	0.87	28.39	Higher level
S3	0.65	0.21	0.38	1.10	31.57	Higher level
S4	0.67	0.20	0.37	0.91	29.88	Higher level
S5	0.61	0.19	0.30	0.84	31.10	Higher level
Overall Mean	0.65	0.18	0.37	0.91	28.11	Higher level

Upper fallow land is designated as S1, low-lying barren region as S4, GPB experimental area as S2, SAC experimental area as S3, and AGR experimental area as S5.

Conclusions

It can be concluded from the above results that most of the soils comes under different land use pattern of in Karguaji organic farm of Utter Pradesh under Bundelkhand region showed low status in available N, P and K (table4.4 to 4.6) and characterized under neutral (6.92) in soil reaction (pH) and less than 1.0 dS m^{-1} soluble salt content (EC) which comes under safe limit for all soils or no sensitive for suitable crop growth and developments (table 4.1 to 4.2). Most of soil samples observed sufficient level of DTPA-extractable B, Zn and Fe, Mn and Cu, higher level was observed in study area (table 4.8 to 4.12). The organic carbon level exhibited medium (table 4.3). Most of the soils of Karguaji organic farm were characterized by Low and sufficient to High categories macro and micro nutrients in the soils of different land use pattern of Karguaji organic farm. Hence, the soils require attention regarding nutrient management practices and regular monitoring of soil health for better crop production, in sustainable crop productivity.

References

1. Ajay K, Vipin K, Jagpal S. Status of micronutrient cation in soil of southern western plain of Uttar Pradesh. Annals of Plant and Soil Research. 2009;1(2):90-91.
2. Andrabi SJ, GJ M, Shah SA. Physico-chemical characteristics and vertical distribution of micronutrients in some soils of Jammu and Kashmir at different altitudes. Environment and Ecology. 2010;28(2):792-796.
3. Ashok, Singh GR, Aggarwal S, Kumar P. NPK status of wheat growing soils in Auraiya district of Uttar Pradesh. International Journal of Agricultural Sciences. 2006;2(1):286-287.
4. Bajpai RK, Shrikant C, Upadhyay SK, Urkurkar JS. Long-term studies on soil physico-chemical properties and productivity of rice-wheat system as influenced by integrated nutrient management in Inceptisol of Chhattisgarh. Journal of Indian Society of Soil Science. 2006;54(1):24-29.
5. Bali SK, Kumar R, Hundal HS, Singh K, Singh B. GIS-aided mapping of DTPA-extractable zinc and soil characteristics in Punjab. Journal of Indian Society of Soil Science. 2010;58(2):189-99.
6. Bassirani N, Abolhassani M, Galavi M. Distribution of available micronutrients related to soil characteristics of Hissar, Haryana (India). African Journal of Agricultural Research. 2011;6(18):4239-4242.
7. Black CA. Methods of soil analysis. Madison: American Agronomy Inc.; c1965. p. 131-137.
8. Chu CR, Moschler WW, Thomas GW. Rock phosphate transformation in acid soils. Soil Science Society of America Proceedings. 1962;26:471-478.
9. Dean LA, Rubin EJ. Anion exchange in soils. Exchangeable phosphorus and anion exchange capacity. Soil Science. 1947;63:37-87.
10. Dwiwedi S, Sharma VK, Bhardwaj V. Status of available nutrients in soils of cold arid region of Ladakh. Journal of Indian Society of Soil Science. 2005;53(3):421-2.
11. Garnaik S, Sekhon BS, Sahoo S, Dhaliwal SS. Comparative assessment of soil fertility status of various agroecological regions under intensive cultivation in Northwest India. Environmental Monitoring and Assessment. 2020;192:320. DOI:10.1007/s10661-020-08290-6.
12. Gogoi B, Barua NG, Baruah TC. Effect of integrated supply of nutrients on soil microbial biomass carbon in an Inceptisol of Assam. Journal of Indian Society of Soil Science. 2010;58(2):241-244.
13. Goovaerts P. Geostatistical tools for characterizing the spatial variability of microbiological and physicochemical soil properties. Biology and Fertility of Soils. 1998;27:315-334.
14. Hanway JJ, Heidel H. Soil analysis methods used in Iowa State College soil testing laboratory. Bulletin. 1952;57:1-131.
15. Jackson ML. Soil chemical analysis. New Delhi: Prentice Hall of India Pvt. Ltd.; c1967. p. 205.
16. Jatav GK. Evaluation of soil fertility status in Inceptisol of Baloda blocks in Janjgir district of Chhattisgarh. M.Sc. (Ag.) Thesis, I.G.K.V. Raipur; c2010. p. 73.
17. Jena D, Mohanty B, Nayak SC. Distribution of available sulfur, zinc, copper, iron, manganese, and boron in deltaic alluvial soil (Ustipsamment) in relation to certain soil properties. Environment and Ecology. 2007;25(4):730-733.
18. Kashiwar SR, Nath T, Kumar D, Kundu MC, Dongarwa UR, Rajput BS. Evaluation of soil fertility status of Rajiv Gandhi South Campus (Banaras Hindu University), Mirzapur, Uttar Pradesh by using GIS. International Journal of Current Microbiology and Applied Sciences. 2018;7:3825-3836.
19. Katyal JC, Randhawa NS. In: Micronutrient. F.A.O. fertilizer and plant nutrition bulletin No. 5. Rome: p. 92; c1983.

20. Katyal JC. Research achievements of the All India coordinated scheme on micronutrients in soils and plants. Fertilizer News. 1985;30(4):67-81.
21. Khan MH, Kumar S, Kumar A, Mehra B. Remote sensing and GIS-based analysis of land use land cover and soil fertility status at inter-block level in Banda District of Uttar Pradesh. International Journal of Chemical Studies. 2017;5(6):73-80.
22. Kher D, Khajuria BM. Vertical distribution of DTPA-extractable micronutrients in relation to soil properties in Kandi belt of Jammu Region. Environment and Ecology. 2005;23S(Special 3):624-627.
23. Kumar R, Sarkar AS, Singh KP, Agarwal BK, Karmakar S. Appraisal of available nutrients status in Santhal Paraganas region of Jharkhand. Journal of Indian Society of Soil Science. 2009;57(3):366-369.
24. Kumar P, Kumar A, Kumar R, Arya S, Tomar N. Soil fertility assessment near Ganga canal in western plain zone of Uttar Pradesh. Pragya Shikshan Shodh Rachana. 2018;2(4):32-37.
25. Lathwal OP. Soil fertility status of district Kurukshetra (Haryana). Haryana Journal of Agronomy. 2006;22(1):74-6.
26. Lindsay WL, Norvell WA. Development of DTPA soil test for zinc, iron, manganese, and copper. Soil Science Society of America Journal. 1978;42:421-428.
27. Madhu BM, Arun AD. Soil fertility status of Jamuna Paar region of Allahabad District, Uttar Pradesh, India. International Journal of Current Microbiology and Applied Sciences. 2017;6(12):3069-3076.
28. Maji B, Chatterji S, Bandyopadhya BK. Available iron, manganese, zinc, and copper in coastal soils of Sundarbans, West Bengal in relation to soil characteristics. Journal of Indian Society of Soil Science. 1993;41(3):468-471.
29. Mandal LN, Haldar M. Influence of phosphorus and zinc application on the availability of zinc, copper, iron, manganese, and phosphorus in waterlogged rice soils. Soil Science. 1980;130:251-257.
30. Meena HB, Sharma RP, Rawat US. Status of macro and micronutrients in some soils of Tonk District of Rajasthan. Journal of Indian Society of Soil Science. 2006;54(4):508-512.
31. Melsted SW, Peck TR. The Mitscherlich-Bray growth functions. Soil testing: Correlation and interpretation of analytical results. American Society of Agronomy. 1977;29:1-18.
32. Muhr GR, Datta NP, Sankara Subramoney N, Lecy VK, Donahue RR. Soil testing in India. 2nd ed. New Delhi: U.S.A.I.D. Mission to India; c1965.
33. Murthy JR, Shrivastav PC. Soil fertility status in relation to terrace management of Majhera farm in lower Shiwaliks. Journal of Indian Society of Soil Science. 1994;41(1):150-152.
34. Nazif W, Perveen S, Saleem I. Status of micronutrients in soils of district Bhimber (Azad Jammu and Kashmir). Journal of Agricultural and Biological Sciences. 2006;1(2):35-40.
35. Nelsted SW, Peek TR. Field sampling for soil testing. In: Walsh IC, Benton JD, editors. Soil testing and plant analysis. Ren. SSSA, Madison, WI; c1973. p. 67-65.
36. Nirawar GV, Mali CV, Waghmare MS. Physico-chemical characteristics and status of available N, P, and K in soils from Ahemedpur tahsil of Latur district. Asian Journal of Soil Science. 2009;4(1):130-134.
37. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. USDA Circular 939. Piper CS. Soil and Plant Analysis. New York: Inter-Science Publication; c1950.
38. Rai A, Singh S. Available nutrients status in black soils of Varanasi district of eastern Uttar Pradesh. Journal of Applied and Natural Science. 2018;10(4):1238-1242.
39. Rajeswar M, Rao CS, Balaguravaiah D, Khan MA. Distribution of available macro and micronutrients in soils of Garikapadu of Krishna District of Andhra Pradesh. Journal of Indian Society of Soil Science. 2009;57(2):210-213.
40. Rammoorthy B, Bajaj JC. Available nitrogen, phosphorus, and potassium status of Indian soil. Fertilizer News. 1969;14(4):7-20.
41. Rashid A, Memon KS. Soil Sci. Islamabad: National Book Foundation; c1996.
42. Sahoo AK, Sah KD, Gupta SK. Organic carbon status in the Sundarbans mangrove soils. J Indian Soc Soil Sci. 1995;43(2):265-267.
43. Sen P, Majumdar K, Sulewski G. Importance of spatial nutrient variability mapping to facilitate SSNM in small landholding systems. Indian J Fert. 2008;4(11):43-50.
44. Sharma PK. Emerging technologies of remote sensing and GIS for the development of spatial data infrastructure. J Indian Soc Soil Sci. 2004;52:384-406.
45. Sharma PK, Sood A, Setia RK, Tur N, Mehra D, Singh H. Mapping of micronutrients in soils of Amritsar District (Punjab)—A GIS approach. J Indian Soc Soil Sci. 2005;56(1):23-33.
46. Sharma JC, Chaudhary SK. Vertical distribution of micronutrient cations in relation to soil characteristics in lower Shiwaliks of Solan District in North-West Himalayas. J Indian Soc Soil Sci. 2007;55(1):40-4.
47. Sharma PK, Sood A, Setia RK, Tur NS, Mehra D, Singh H. Mapping of macronutrients in soils of Amritsar district (Punjab)—A GIS approach. J Indian Soc Soil Sci. 2008;56(1):34-41.
48. Shukla AG. Evaluation of soil fertility in soils of Pamgarh blocks, district Janjgir-Champa of Chhattisgarh. M.Sc. (Ag.) Thesis, I.G.K.V. Raipur; c2011. p. 63-4.
49. Singh PS, Verma JP, Singh S, Kumar R. Evaluation of soil fertility status for available sulphur in various locations of Myorpur block, district Sonbhadra, Uttar Pradesh, India. J Biosci Agric Res. 2019;19(01):1597-605.
50. Singh YV, Singh PK, Yadav RN, Shahi SK, Singh RK, Sharma PK, Verma KS. Evaluation of soil fertility status from Tedia Village, Araji line Block, Varanasi District, Uttar Pradesh, India. Indian J Agric Allied Sci. 2016;2(1).
51. Singh VS, Agrawal HP, Prasad S. Distribution of DTPA-extractable micronutrients in the soils of district Ghazipur, Uttar Pradesh. J Indian Soc Soil Sci. 2009;57(3):370-2.
52. Subbiah BV, Asija GL. A rapid procedure for the determination of available nitrogen in soils. Curr Sci. 1956;25:259-60.
53. Talukdar MC, Basumatary A, Datta SK. Status of DTPA-extractable cationic micronutrients in soils under rice and sugarcane ecosystems of Golaghat district in Assam. J Indian Soc Soil Sci. 2009;57(3):313-316.
54. Tisdale SL, Nelson WL, Beaton JD, Halvin JL. Soil fertility and fertilizers. 5th ed. New Delhi: Macmillan Publishing Co.; c1997. p. 144, 180, 198, 201.
55. Vaisnow B. Evaluation of soil fertility status in vertisol of Dhamtari block, Dhamtari district, Chhattisgarh. M.Sc. (Ag.) Thesis, I.G.K.V. Raipur; c2010. p. 118-119.

56. Ved P, Singh AK, Lal K. Fertility status of soil of Bhasana sugar mill zone, Muzaffarnagar. Cooperative Sugar. 2008;39(11):35-39.
57. Verma VK, Setia RK, Sharma PK, Singh C, Kumar A. Pedospheric variations in distribution of DTPA-extractable micronutrients in soils developed on different physiographic units in central Punjab, India. Int J Agric Biol. 2005;7:243-246.
58. Verma VK, Setia RK, Sharma PK, Khurana MPS, Kang GS. Pedospheric distribution of micronutrient cations in soils developed on various landforms in North-East Punjab. J Indian Soc Soil Sci. 2007;55:515-520.
59. Waghmare MS, Bavalgare VG, Deshmukh VA, Takankhar VG. Status of available N, P, and K in some soils of Ausa tahsil of Latur district. Int J Trop Agric. 2009;27(1-2):327-331.
60. Walkley A, Black CA. An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Sci. 1934;37:29-38.
61. Welch CD, Nelson RW, Beaton JD. Opportunities to improve soil testing programs. Soil testing and plant analysis. Revised publication. Soil Sci Soc Am Inc; c1987. p. 1-10.
62. Yadav RL, Meena MC. Available micronutrients status and their relationship with soil properties of Degana soil series of Rajasthan. J Indian Soc Soil Sci. 2009;57(1):90-92.