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**Alok Patel**
Department of Soil Science and Agricultural Chemistry, B.H.U, Varanasi, Uttar Pradesh, India

**Sudhanshu Verma**
Department of Agronomy, B.H.U, Varanasi, Uttar Pradesh, India

**Shani Kumar Singh**
Department of Extension Education Institute of Agricultural Sciences, B.H.U, Varanasi, Uttar Pradesh, India

**Rajiv Kumar Singh**
Subject Matter Specialist, KVK Ballia (UP), India

**Correspondence**
**Alok Patel**
Department of Soil Science and Agricultural Chemistry, B.H.U, Varanasi, Uttar Pradesh, India

# Soil fertility status of Jaunpur District in Eastern Uttar Pradesh

**Alok Patel, Sudhanshu Verma, Shani Kumar Singh and Rajiv Kumar Singh**

**Abstract**
The experiment was conducted to investigate the fertility status of the Jaunpur district. The study consisted of field survey of area, collection of soil samples and its analysis of soil physical properties and chemical properties in Soil Science – Soil and Water Conservation Laboratory, Rajiv Gandhi South Campus, Barkachha, Banaras Hindu University, Mirzapur. Results were revealed that physical property *viz.* bulk density ranged between 1.22 to1.38 Mg $m^{-3}$, particle density ranged between 2.44 to 2.82 Mg $m^{-3,}$ WHC mean value of 41.59%, and most of the soils were loamy in texture and Chemical properties *viz.* soil pH varied from 7.1 to 8.5, EC ranged between 0.20 -2.10 $dSm^{-1}$,organic matter varied from range 0.16 to 0.36%, nitrogen varies from 186 to 269 kg, phosphorus ranges between 23.5 to 50.3 kg $ha^{-1}$ and potassium ranged from 325 to 489 kg $ha^{-1.}$

**Keywords:** Phosphorus, Potassium, Nitrogen, Soil sampling, Soil testing

## Introduction
Soil is the critical component of the earth system, functioning not only for the production of food, fodder and fibre but also in the maintenance of local, regional and global environmental quality. Soil is crucial for life on earth and is thus one of the most important natural resources. Plants require at least 17 elements for normal growth and for completion of their life cycle. Those plant nutrients used in the largest amounts, carbon, hydrogen and oxygen, are Universol elements supplied by air and water. The other 14 elements are taken up by plants only in mineral from the soil or must be added as fertilizers. The soils of Jaunpur district of eastern Uttar Pradesh exhibits catenaries relationship with increasing drainage intensity down the slope, change in collar from yellowish brown or reddish brown to reddish grey and texture from loam to clay loam, clay or silt clay and sandy loam. The Jaunpur is a district place of the state Utter Pradesh. Geographical area of Jaunpur is 4038 $km^2$(latitude 24,24$^0$ N to 26,12$^0$N and longitude 82·70$^0$Eto83·50$^0$).The district is bounded by Sultanpur to its north, Azamgarh to north-east, Ghazipur to east, Varanasi to its south east, Santkabir Nagar to the south, Allahabad to the south-west and Pratapgarh to the west. The topography consists mainly of hilly and plateau lands but has lot of local variations too. The soil of this region varies considerably but most of the area has red lateritic soils, experiences semi-arid and arid climate with an average annual minimum and maximum temperature 10 °C and 44 °C respectively. Rainfall is the main source of groundwater recharge in the study area and the region receives an average annual rainfall of ~987 mm. Most of the agricultural activities mainly depend on rainfall, since the availability of groundwater resources is scarce. The majorlitho-units of the study area comprise of granitic and phyllites rocks, which are overlaid by red, sandy soil cover and the drainage is dendritic to sub-dendritic. The soils of Jaunpur district are sierozems, having alluvium deposited by rivers Gomati and Sai the rivers of Jaunpur. At many places, soils are intermixed with sandy material. These soils in general have high salt content and or high exchangeable sodium, particularly in areas of high water table having depressions. Their yellowish brown soils have loam to silty clay loam texture with massive structure and are calcareous in nature. The drainage conditions of soil ranges from good to moderate. The soils in eastern zone are mainly alluvial and prone to recurring floods and waterlogging. The calcareous nature of recent deposit has been observed in the soils. The soils are deep and sandy loam to loam in texture.

## Method and Materials
The experiment entitled **"Soil fertility status of Jaunpur district in Eastern Uttar Pradesh"** was conducted to investigate the fertility status of the Jaunpur district. The study consisted of field survey of area, collection of soil samples and its analysis in Soil Science – Soil and Water

Conservation Laboratory, Rajiv Gandhi South Campus, Barkachha, Banaras Hindu University, Mirzapur.The Jaunpur is a district place of state Uttar Pradesh. Geographical area of Jaunpur is 4038 $km^2$ (latitude $24,24^0$ N to $26,12^0$ N and longitude $82,70^0$ E to$83, 50^0$ E). The district is bounded by Sultanpur to its North, Azamgarh to North-East, Ghazipur to East, Varanasi to its south east, Sant Kabir Nagar to the south, Allahabad to the south-west and Pratapgarh to the west The topography consists mainly of hilly and plateau lands but has lot of local variations too. The soil of this region varies considerably but most of the area has red lateritic soils, experiences semi-arid and arid climate with an average annual minimum and maximum temperature 4 °C or 10 °C. Altogether 20 surface soil samples of the cultivated land of Jaunpur District were collected randomly to a depth of 0-15 cm in triangular shape by the help of Nolic from thirty different sites of different geomorphological locations *viz*, riverian tract, upland, middle and lowland. The soil samples were mixed thoroughly and about one kilogram of composite samples was drawn from each site. Collected surface soil sample (0-15 cm depth) were brought into laboratory and dried in shade at room temperature. Air dried soil samples were crushed with the help of wooden roller and passed through 2mm sieve. Finally processed soil samples were kept in a polythene bag for further physico-chemical analysis. The physico-chemical properties of different geomorphological locations of soils were determined in the laboratory by the standard procedure. Physical analysis, the bulk density and particle density was determined with the help of Pycnometer bottle in laboratory of disturbed soil samples (Black, 1965) [2].

**Table 1:** Procedure used for physico-chemical analysis of soil

| Properties | Method applied | Reference |
|---|---|---|
| **Physical properties** | | |
| Bulk density | Pycnometer | Black, (1965) [2] |
| Particle density | Water displacement | |
| WHC | Keen-Rackzowski box | (Black, 1965) [2] |
| Soil texture | Bouyoucos hydrometer method | (Bouyoucos, 1962) |
| **Chemical properties** | | |
| pH | By pH meter | Jackson (1973) |
| EC($dS/m^{-1}$) | EC pocket bridge | Jackson (1973) |
| Organic corbon (%) | Wet oxidation method | Walkey and Black (1934) [10] |
| Available Nitrogen (kg/ha) | Alkaline $KMnO_4$ method | Subbiah and Asija (1956) |
| Available Phosphorus (kg/ha) | Bray's method and Olsen method | Bray and Kurtz (1945) Olsen *et al*. (1952) |
| Available Potassium (kg/ha) | Ammonium Acetate method | Hanaway and Heidal (1952) |

## Result and Discussion

### Physical Properties of the Soils

The data on soil physico-chemical properties *viz*.bulk density, particle density of Jaunpur district was depicted in the table 2.

### 1. Bulk density

The data pertaining to the bulk density of Table No. (2). The bulk density of the collected soil samples of Jaunpur district ranged between 1.22 to1.38 Mg $m^{-3}$ with the mean value of 1.37 Mg $m^{-3}$ and standard deviation ±0.08. However, bulk density observed in most of the soils of district was medium to high. The soils were collected from cultivated areas. Thus, due to continuous tillage operation in rice, wheat, pulse and vegetables producing and low accumulation of organic matter resulted in high to medium range of bulk density.

### 2. Particle density

Particle density of different cultivated soils of Jaunpur district ranged between 2.44 to 2.82 Mg $m^{-3}$, with the mean value of 2.38 Mg $m^{-3}$ and standard deviation was ± 0.21 (Table No 2.). Highest particle density was observed 2.82 Mg $m^{-3}$ in the soils of Sample No.9 followed by 2.76, 2.66 and 2.64 Mg $m^{-3}$ in the soil samples of Sample No.1, Sample No.20 and Sample No.3 respectively. However, lowest value was observed in the soil samples of 2.44, 2.45 and 2.47 Mg $m^{-3}$ in the soils of sample no.6, sample no 10 and sample no. 7 respectively. Highest particle density in the soils of Jaunpur was observed from sample no.9 and lowest from sample no.6.Comparatively lower average value of particle density in the cultivated soils of Jaunpur district.

### 3. Water holding capacity

The water holding capacity of cultivated soils of Jaunpur district were comparatively higher with the mean value of 41.59% with ±6.01 standard deviation. Table No. (2).The highest water holding capacity among soil sample no. 3 was 49.3% in followed by 49.1- 48.7 and 48.6 in the soil samples of Sample No.20, Sample No.2 and Sample No.5 lowest (30.9%) in sample no.7 soil. Similarly in Jaunpur district highest water holding capacity was noticed (49.3%) and lowest (30.9%).Thus the major soil physical constraints may be in soils *i.e.* low water retention and high permeability, slow permeability, surface and subsurface mechanical impedance and shallow depth of the soils, which either restrict crop growth or reduce efficiency of basic inputs, such as water, fertilizers etc. The water retention or water holding capacity of soil is an important property of soil. Therefore, physical properties of the soils of Jaunpur district. The reported by Singh and Kashyap (2006).

### 4. Textural Classification of Soils

The data on textural classification presented in the Table 2, it is clear that most of the soils of Jaunpur district were loamy in texture. The range of sand content varied from 50.8% – 83.1% with an average value of 65.60% ±10.80%. Maximum sand content was found in sample no 13 (83.1%) and minimum was found in sample no 10 (50.8). The silt content was ranged between 8.7 – 37.4%with an average value 19.69% and±7.99 % standard deviation. Maximum silt content was found in sample no 10 (37.4%) and minimum in sample no 12 (8.7%). The clay content was observed between 4.6-20.8% with an average content of 14.73±4.29%. Maximum clay content was found in sample no 2 and minimum in sample no 13 soil. Kumar and Babel, (2011) [8] analyzed surface (0-30 cm) soil samples from wheat growing fields of Jaunpur district and reported that the sand, silt and clay content of the soil ranged from 76.70 to 90.40, 1.30 to 7.50 and 5.20 to 12.90 per cent, respectively and soils were categorized as sandy, loamy sand and sandy loam in texture. Similar result also found by Verma and Sharma, 2006.

**Chemical Characteristics of the Soils**

Soil samples collected from different cropping pattern from Jaunpur districts (Table.3) were characterized for chemical properties *viz.* pH, electrical conductivity, organic carbon, exchange capacity (EC).

**1. Soil reaction (pH)**

Soil reaction of the Jaunpur soil varied from 7.1 to 8.5 with the mean value of 7.79±0.38. Considering the wide variation in soil reaction under different cropping pattern were neutral to alkaline in nature. Majority of soils were slightly alkaline (70%) and rest was neutral in nature. The maximum pH was observed by soil sample no.4 (pH 8.5), followed by soil sample no.9 (pH 8.4) and soil sample no. 12 (pH 8.3) and minimum was soil sample no.2 and soil sample no.3 (pH 7.1). However, the soils of Jaunpur district were slightly acidic to light alkali and soil reaction was ranged between 7.2 to 8.5 pH. Among the 20 soil samples of the Jaunpur district, 16.7 % soil was neutral in reaction (pH ranges between7.1 to 7.5) and 66.7% soil sample was slightly alkaline in nature. The cropping systems in these locations are generally rice-wheat, pulse, sugarcane, vegetable, fruits and forage crop. This indicates that the cropping system have not significant effect on buffering capacity of the highly fertile soils of Jaunpur district.

**2. Electrical conductivity (E.C.)**

In Jaunpur district the electrical conductivity in surface soil was highest value in sample no.10 (2.10dS $m^{-1}$) and lowest value in soil sample no.6 (0.20dS $m^{-1}$). Since, EC value of soil less than 4 $dSm^{-1}$ is not so serious salt accumulation problem, the EC values of all the soils in different cropping system of the districts were comparatively of low to medium.

**3. Soil organic matter**

Organic matter content in cereal, sugarcane, pulse, vegetable, fruit and fodder cultivated soils of Jaunpur district varied from range 0.16 to 0.36%. In soils comparatively the content of organic matter was higher in sample no.4 due to incessant renewal through plant and animal residues in this soil. The organic matter content was lowest in soil sample no.2 in Rice and Vegetable growing area. In Jaunpur district, the highest organic matter content was obtained in soil sample no.4 lowest was noticed in soil sample no.2.

**4. Available nitrogen**

Available nitrogen of the farmer's field exhibited low range and varies from 186 to 269 kg $ha^{-1}$ with an average content of 255.6 ±28.03 kg $ha^{-1}$ (Table.3) in soils of Jaunpur district. Soil fertility status of available nitrogen is categorized on the basis as followed: low (< 270 kg $ha^{-1}$ N), medium (270-560 kg $ha^{-1}$ N) and high (> 560 kg $ha^{-1}$ N). However, Jaunpur district soils exhibited low to medium range of available nitrogen content in soils of the farmer's field and varies between 200 to 303 kg $ha^{-1}$ with an average content of 255.7 ±28.03 kg $ha^{-1}$. Results revealed that Jaunpur districts soil samples were found in the low category in soil in available nitrogen content in soils. None of the sample was found in the high content of available nitrogen in these soils sample of the districts. Continuous crop removal and leaching loss of nitrate contributes towards low nitrogen content in these farmers field achieving higher crop productivity. However, jaunpur soil was somewhat better condition due to presence of organic matter and also cropping intensity is lower than districts soil is undulate plateau and hills due to which moisture scarcity during most of the periods in the year remains dry in condition and is limit the crop removal of nitrogen. Kumar *et al*. (2009) [6] reported that available N content of soil in Jaunpur varied from 186-269 kg $ha^{-1}$ with a mean of 255.6 kg $ha^{-1}$.

**5. Available phosphorus**

The available phosphorus content of the farmer's field (Table.3) of Jaunpur districts a soils ranges between 23.5 to 50.3 kg $ha^{-1}$ with an average content of 39.59±9.01 kg $ha^{-1}$and Jaunpur districts data clearly showed that the available phosphorus of the districts was higher in range. Its content in the soils is categorized in to different phosphorus fertility status as: low (< 10 kg $ha^{-1}$ P), medium (10-20 kg $ha^{-1}$ P) and high (> 20 kg $ha^{-1}$ P).This observation suggests that farmers are using continuously phosphatic fertilizer in their field for cultivating crops without testing the soils. High level of phosphorus in the soils indicated P build up with added water soluble phosphatic fertilizers. Phosphorus availability is not a problem because of having neutral soil reaction (Mandal and Chatterjee, 1972) [4].

**6. Available potassium**

The data on available potassium content in the soils of farmer's field of the soil sample were presented in the Table 3. Overall, an assessment of the soil samples revealed that Jaunpur district soils sample ranged from 325 to 489 kg $ha^{-1}$ with an average content of 355.9±32.64 kg $ha^{-1}$. The soils of the district exhibit availability medium to high potassium status in these soils may probably be due to presence of K bearing clay minerals. Based on soil testing K rating, sample is categorized in to low (< 108 kg $ha^{-1}$), medium (108-208 kg $ha^{-1}$) and high (> 208 kg $ha^{-1}$).Same result also find by Singh and Singh (2003) [3], Basumatary and Bordoloi (1992) [1], Patel *et al.* (2018) [5]

**Conclusion**

Thus it can concluded that soil of Jaunpur district good in physical properties with mean bulk density 1.3 Mg $m^{-3}$ and loamy in texture with 41.59% WHC and chemical properties such as soil pH varied neutral to slightly alkaline, EC ranged between 0.20 -2.10 dS $m^{-1}$, low in organic matter and nitrogen but higher in phosphorus and potassium.

**Table 2:** Physical properties of the soil samples of Jaunpur District.

| S.N. | Sample Number | Bulk Density (Mg $m^{-3}$) | Particle Density (Mg $m^{-3}$) | WHC (%) | Sand % | Silt % | Clay % | Texture |
|---|---|---|---|---|---|---|---|---|
| 1 | Sample No. 1 | 1.38 | 2.76 | 48.5 | 60.5 | 20.8 | 18.7 | Loam |
| 2 | Sample No. 2 | 1.30 | 2.61 | 48.7 | 57.9 | 21.3 | 20.8 | Clay loam |
| 3 | Sample No. 3 | 1.32 | 2.64 | 49.3 | 61.5 | 22.9 | 15.6 | Loam |
| 4 | Sample No. 4 | 1.30 | 2.61 | 40.2 | 63.3 | 20.5 | 16.5 | Loam |
| 5 | Sample No. 5 | 1.29 | 2.58 | 48.6 | 80.1 | 10.5 | 9.4 | Loamy sand |
| 6 | Sample No. 6 | 1.22 | 2.44 | 35.1 | 52.4 | 31.8 | 15.8 | Silty loam |
| 7 | Sample No. 7 | 1..23 | 2.47 | 30.9 | 78.5 | 9.2 | 12.3 | Sandy loam |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 8 | Sample No. 8 | 1.26 | 2.52 | 35.4 | 60.7 | 20.1 | 19.2 | Loam |
| 9 | Sample No. 9 | 1.41 | 2.82 | 43.6 | 78.1 | 11.8 | 10.1 | Loamy sand |
| 10 | Sample No. 10 | 1.22 | 2.45 | 41.2 | 50.8 | 37.4 | 11.8 | Silty loam |
| 11 | Sample No. 11 | 1.29 | 2.59 | 40.8 | 52.8 | 28.3 | 18.9 | Silty loam |
| 12 | Sample No. 12 | 1.30 | 2.61 | 33.6 | 77.1 | 8.7 | 14.2 | Sandy loam |
| 13 | Sample No. 13 | 1.28 | 2.56 | 45.3 | 83.1 | 12.3 | 4.6 | Loamy sand |
| 14 | Sample No. 14 | 1.26 | 2.52 | 32.8 | 75.2 | 11.1 | 13.7 | Sandy loam |
| 15 | Sample No.15 | 1.28 | 2.56 | 36.6 | 59.8 | 24.4 | 15.8 | Loam |
| 16 | Sample No. 16 | 1.22 | 2.44 | 39.2 | 57.7 | 23.4 | 18.9 | Loam |
| 17 | Sample No. 17 | 1.22 | 2.45 | 45.4 | 61.3 | 21.8 | 16.9 | Loam |
| 18 | Sample No. 18 | 1.30 | 2.61 | 46.6 | 64.9 | 20.9 | 14.2 | Loam |
| 19 | Sample No. 19 | 1.31 | 2.62 | 48.3 | 55.2 | 25.7 | 19.1 | Silty loam |
| 20 | Sample No. 20 | 1.33 | 2.66 | 49.1 | 81.1 | 10.8 | 8.1 | Loamy sand |
| | Rang | 1.22-1.38 | 2.44-2.82 | 30.9-49.3 | 50.8-83.1 | 8.7-37.4 | 4.6-20.8 | |
| | Mean | 1.37 | 2.38 | 41.59 | 65.60 | 19.69 | 14.73 | |
| | Standard Deviation(±) | 0.08 | 0.21 | 6.01 | 10.80 | 7.99 | 4.29 | |

**Table 3:** Chemical properties of the soil samples of Jaunpur district.

| S.N. | Sample Number | pH | E.C. (dS $m^{-1}$) | O.C. (%) | Available Nitrogen (kg $ha^{-1}$) | Available Phosphorus (kg $ha^{-1}$) | Available Potassium (kg $ha^{-1}$) |
|---|---|---|---|---|---|---|---|
| 1 | Sample No. 1 | 7.3 | 0.60 | 0.18 | 189 | 25.6 | 325 |
| 2 | Sample No. 2 | 7.1 | 1.90 | 0.16 | 198 | 23.5 | 334 |
| 3 | Sample No.3 | 7.2 | 1.40 | 0.19 | 236 | 27.3 | 334 |
| 4 | Sample No. 4 | 8.5 | 0.70 | 0.36 | 266 | 50.3 | 382 |
| 5 | Sample No. 5 | 7.5 | 0.20 | 0.25 | 244 | 40.8 | 362 |
| 6 | Sample No. 6 | 7.1 | 0.20 | 0.16 | 212 | 24.7 | 362 |
| 7 | Sample No. 7 | 7.8 | 1.30 | 0.28 | 208 | 48.9 | 352 |
| 8 | Sample No. 8 | 7.6 | 0.50 | 0.18 | 265 | 26.1 | 391 |
| 9 | Sample No. 9 | 8.4 | 0.20 | 0.35 | 225 | 49.2 | 381 |
| 10 | Sample No. 10 | 7.5 | 2.10 | 0.25 | 242 | 41.3 | 362 |
| 11 | Sample No. 11 | 8.1 | 0.60 | 0.31 | 199 | 45.2 | 371 |
| 12 | Sample No. 12 | 8.3 | 1.50 | 0.32 | 200 | 43.9 | 290 |
| 13 | Sample No. 13 | 7.3 | 1.10 | 0.21 | 216 | 39.6 | 362 |
| 14 | Sample No. 14 | 7.8 | 1.50 | 0.25 | 195 | 42.1 | 280 |
| 15 | Sample No.15 | 7.8 | 1.00 | 0.22 | 186 | 38.0 | 427 |
| 16 | Sample No. 16 | 7.9 | 0.50 | 0.25 | 215 | 44.5 | 362 |
| 17 | Sample No. 17 | 7.8 | 1.30 | 0.24 | 225 | 43.9 | 352 |
| 18 | Sample No. 18 | 8.2 | 0.90 | 0.26 | 269 | 47.2 | 360 |
| 19 | Sample No. 19 | 7.4 | 0.30 | 0.21 | 256 | 41.6 | 367 |
| 20 | Sample No. 20 | 7.8 | 0.60 | 0.29 | 265 | 48.1 | 362 |
| | Range | 7.1-8.5 | 0.20-2.10 | 0.16-0.36 | 186-269 | 23.5-50.3 | 325-489 |
| | Mean | 7.79 | 0.92 | 0.25 | 255.6 | 39.59 | 355.9 |
| | Standard deviation (±) | 0.38 | 0.57 | 0.06 | 28.03 | 9.01 | 32.64 |

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