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# Characterization of Rice Growing Soil of Nagara Block of Ballia District (U.P.), India

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**ABSTRACT**

An investigation was carried out for Characterization of rice growing soil of Nagara block of Ballia district, (U.P.) India. Depth wise soil samples were collected from two selected village and in this respect a soil profile was opened in each village. Soil samples were collected from 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105 and 105-130 soil depth. Standard method was followed for analysis of physico-chemical parameter of soil. Results revealed that pH of soil found to be slightly alkaline where EC was in normal range. Bulk density of soil found be (1.16 - 1.73 Mg $m^{-3}$) and water holding capacity contained (20.4 - 37.5 %). Organic carbon content varied from (0.07 - 0.59 %). The soil was slightly moderately calcareous (0.39 - 1.37 $CaCO_3$%). Available N, P, K, and S content in soil varied from (142.2 - 489.8 kg $ha^{-1}$), (9.76 - 15.28 kg $ha^{-1}$), (259.6 - 403.2 kg $ha^{-1}$) and (9.25 - 16.25 kg $ha^{-1}$). Micronutrients Fe, Cu, Zn and Mn content in soil from (2.37 - 9.02 mg $kg^{-1}$), (1.31- 9.07 mg $kg^{-1}$), (0.12 - 1.22 mg $kg^{-1}$) and (0.18 - 4.83 mg $kg^{-1}$) rang respectively.

## Introduction

Soil test-based fertility management is an effective tool for increasing productivity of agricultural soils that have a high degree of spatial variability resulting from the combined effects of physical, chemical or biological processes (Govaerts, 1998). However, major constraints impede wide scale adoption of soil testing in most developing countries. In India, these include the prevalence of small holding systems of farming as well as the lack of infrastructural facilities for extensive soil testing (Sen *et al.,* 2008). The importance of soil fertility and plant nutrition to the health and survival of all life cannot be understated. As human population continue to increase, human disturbance of the earth's ecosystem to produce food and fiber will place greater demand on soils to supply essential nutrients. Therefore, it is critical that we increase our understanding of the chemical, biological and physical properties and relationships in the soil plant atmosphere continuum that control nutrient availability. Soil is the most valuable natural resource. It is at the heart of terrestrial ecology, but is finite and non-renewable. To meet the challenges of this century, new understandings and new technologies will be needed to protect the environment and at the same time, produce food and biomass to support society (Brady and Weil, 2004). Systematic study of morphology and taxonomy of soils provides information on nature and type of soils, their constraints, potentials, capabilities and their suitability for various uses (Sehgal, 1999).

## Materials and Methods

Ballia district, the eastern part of the state of Uttar Pradesh is situated in central portion of the Ganges basin. The geographical extent of the district lies between latitude from 25°23" to 26°11" north and at longitudes from 83°38" to 84°39" east with elevation of about 27 to 115 meters above the sea level. The mean annual rainfall ranges from 950 to 1150 mm. The district has an area of 1,981 sq. km. Soil samples were air dried in shade and powdered gently with a wooden mallet and passed through 2 mm sieve. Soil pH was determined in 1:2.5 soil water suspension using glass electrode. Electrical conductivity (EC) was determined in 1:2.5 soil-water extract using Conductivity Bridge and expressed as $dSm^{-1}$ (Jackson, 1973). Calcium carbonate (CaCO3) was determined by rapid titration method (Puri, 1930). Bulk density method described by Kanwar and Chopra (1998). Organic carbon (OC) was determined by rapid titration method (Walkley and Black, 1934). Available nitrogen (N) was determined by alkali extractable nitrogen method (Subbiah and Asija, 1956), available phosphorus (P) by Olsen's *et al.*, (1954) and available potash (K) ammonium acetate extractable method described by Muhr *et al.,* (1965). Available sulphur (S) was extracted using 0.15 per cent calcium chloride solution (Williams and Steinbergs, 1969). Micronutrients namely Zn, Cu, Fe and Mn were determined on atomic absorption spectrophotometer as outlined by Lindsay and Norvell (1978).

## Results and Discussion

### Soil pH

The perusal of data in table 1 of soil pH of two pedon of Nagara Block soil was ranged from 7.4 to 8.1. A very small increasing range of pH towards alkaline from top soil (0-15 cm) to the lower (105-130 cm) depth were found in both pedons. Pedon 1 was showed 7.9 pH at 0-15 cm there after increasing 7.6 at 105-130 cm soil and pedon 2 was showed 8.1 pH at 0-15 cm there after decreasing 7.6 at 105-130 cm. The lower pH range was found at upper layer of pedon than the 105-130 cm depth due to presence of organic matter and their higher activity of hydroxyl aluminum at higher pH, eventually resulted in higher P adsorption (Mokwanye, 1975). The higher biological activities might be responsible for decreased pH range on surface soil, the pH value showed in increase with increasing in the depth of soil which is attributed to determine of neutral soluble salt (Abrol, 1998).

### Electrical conductivity of soil EC ($dSm^{-1}$)

The data of table 1 revealed that the EC of soil samples from two pedons of Nagara Blcok of soil depth. EC of soil under study ranged from 1.013 $dSm^{-1}$ indicated not wide variation between the two pedons, pedon-1 showed relative low EC 1.002 $dSm^{-1}$ values in surface layer as compared to sub surface (0--315cm) soil 1.003 $dSm^{-1}$ at (0-15 cm) were observed. Difference at pedon-2 which may be ascribed to the lateral movement of water from the construction of earthen band on ground (Mehta *etal*.1996).

### Bulk density (Mg m-3)

Bulk density of soil was measured by the depth wise soil taken two pedons, presented in table 1. Bulk density was varied between value 1.22to 1.55 Mg $m^{-3}$ between the pedon-1 and pedon-2 respectively. The increased bulk density was observed at pedon-1 with 105-130 cm depth, 1.55 Mg m-3, pedon-2 at with 0-15 cm depth, 1.73 Mg $m^{-3}$ and low value was at pedon 1 with 1.19 Mg $m^{-3}$ in 60-75 cm depth. Bulk density values varied from 1.19 to 1.73 Mg $m^{-3}$ with a small variation between both pedon and between the horizons. The increase in bulk density from upper to lower horizons of all pedon due to translocation of clay and other minerals develop the compaction (Mandal and Sharma, 2011).

## Water holding capacity (%)

Water holding capacity measured at pedon-1 and pedon-2 in table 1 which varied from 20.4 % on 105-130 cm depth to 37.5 % on surface horizon. WHC value decreased in horizon depth at both pedon. The pedon 1 was showed 19.1 % on 105-130 cm depth to 37.5% on 0-15 cm surface horizon and pedon 2 was showed 21.6 % on 105-130 cm to 35.8 % on lower surface horizon. There was great difference of water holding capacity in Nagara Block soil among the both pedon. The similar finding was given by Gupta *et al.*, (2019).

## Organic carbon (%)

Data on soil organic carbon table 1 revealed that organic carbon content at different depth of soil in two pedons showed decreasing with increasing soil depth. Nagara Block soil showed maximum organic carbon content 0.59 % at 15-30 cm depth of pedon-1 and 0.29 % at 0-15 cm depth of pedon-2. Pedon-2 was showed organic carbon content ranged between 0.29 to 0.11 % and pedon1 organic carbon ranged between 0.59 to 0.15 % with higher value in Nagara Block pedon. The similar finding was reported by Sahu and Bala (1995).

## Calcium carbonate (%)

Irrespective of the land use system the extent in profile horizons of calcium carbonate was measured at pedon-1 and pedon-2. The small variation was found in amount of CaCO3 (Table 1) in all pedons. The data of table 1 revealed that the calcium carbonate content in soil of all pedon depth was showed decreasing ranged from 1.37 to 0.39 % throughout the depth. However, $CaCO_3$ content was found maximum (1.37 %) in surface horizon (15-30 cm) and decreased regularly with soil depth at pedon-1.

The pedon-2 was showed 0.87% on 15-30 cm depth to 0.39 % on sub-surface layer. There was small difference of calcium carbonate in Nagara Block soil between the two pedon of Uraini and Malap village. The similar finding was reported by Gupta *et al.,* (2019).

## Available nitrogen (kg/ha)

The data in table 2 revealed that the available nitrogen content in soil of two pedons. The pedon-1 soil was ranged from 353.9 to 142.2 kg/ha, from surface (0-15 cm) horizons to lower depth (105-130 cm) horizons. Pedon-2 was showed for available nitrogen value 489.8 to 211.7 kg/ha from surface (0-15 cm) horizons to lower depth of (105-130 cm) horizons.

Its might be due to continuous application of imbalanced chemical fertilizer and cultural practices leads to extent of increased available N status at Nagara Block, a partial decomposition of crop residues build of available N and P with combined use of inorganic and organic sources of fertilizer have also been reported by Bhandari *et al.*(1992). Similarly, Singh et al (2011) also reported in a study from Darjeeling soil that the status of available N was higher in top soil compared to sub soil.

**Table.1** Status of soil pH, EC, B.D. WHC, Organic Carbon and $CaCO_3$ of pedons of soil in different in two village of Nagara block soil

| Depth (cm) | Uraini (P1) | | | | | | Malap (P2) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | pH (1:2.5) | EC (dSm-1) (1:2.5) | Bd (Mgm-3) | WHC (%) | O.C. (%) | CaCO3 (%) | pH (1:2.5) | EC (dSm-1) (1:2.5) | Bd (Mgm-3) | WHC (%) | O.C. (%) | CaCO3 (%) |
| 0-15 | 7.8 | 1.003 | 1.22 | 37.5 | 0.31 | 0.45 | 8.1 | 1.001 | 1.73 | 35.8 | 0.29 | 0.62 |
| 15-30 | 7.9 | 1.002 | 1.24 | 34.7 | 0.59 | 1.37 | 7.9 | 1.003 | 1.65 | 34.2 | 0.24 | 0.87 |
| 30-45 | 7.6 | 1.002 | 1.29 | 31.9 | 0.31 | 0.97 | 7.8 | 1.003 | 1..29 | 32.8 | 0.11 | 0.69 |
| 45-60 | 7.6 | 1.003 | 1.33 | 28.6 | 0.27 | 0.77 | 7.8 | 1.003 | 1.34 | 29.6 | 0.07 | 0.77 |
| 60-75 | 7.4 | 1.002 | 1.26 | 24.8 | 0.45 | 0.65 | 7.8 | 1.001 | 1.19 | 27.4 | 0.27 | 0.39 |
| 75-90 | 7.4 | 1.003 | 1.25 | 22.6 | 0.22 | 0.69 | 7.7 | 1.003 | 1.29 | 26.9 | 0.22 | 0.49 |
| 90-105 | 7.4 | 1.003 | 1.31 | 21.9 | 0.15 | 0.87 | 7.7 | 1.003 | 1.25 | 23.4 | 0.18 | 0.79 |
| 105-130 | 7.6 | 1.003 | 1.55 | 20.4 | 0.15 | 0.79 | 7.6 | 1.001 | 1.16 | 22.2 | 0.16 | 0.92 |

**Table.2** Status of available NPK and S in pedons soils at different depth

| **Soil depth (cm)** | **Uraini (P1)** | | | | **Malap (P2)** | | | |
|---|---|---|---|---|---|---|---|---|
| | N | P | K | S | N | P | K | S |
| **0-15** | 353.9 | 13.65 | 336 | 16.25 | 489.8 | 15.28 | 403 | 13.59 |
| **15-30** | 341.2 | 12.24 | 280 | 16.20 | 442.4 | 14.64 | 313 | 12.46 |
| **30-45** | 268.6 | 12.08 | 302 | 12.82 | 426.6 | 14.25 | 313 | 11.84 |
| **45-60** | 230.6 | 11.97 | 291 | 12.46 | 395.0 | 13.87 | 302 | 11.32 |
| **60-75** | 183.2 | 11.78 | 280 | 11.75 | 385.5 | 13.38 | 336 | 10.68 |
| **75-90** | 164.3 | 11.24 | 259 | 11.28 | 268.6 | 12.97 | 336 | 10.18 |
| **90-105** | 158.0 | 10.98 | 280 | 10.96 | 252.8 | 12.49 | 291 | 9.76 |
| **105-130** | 142.2 | 9.76 | 313 | 9.84 | 211.7 | 11.93 | 262 | 9.76 |

**Table.3** Status of available (DTPA Extractable) Fe, Cu, Zn and Mn (mg $kg^{-1}$) in soil at different soils depth

| **Depth(cm)** | **Uraini (P1)** | | | | **Malap (P2)** | | | |
|---|---|---|---|---|---|---|---|---|
| | Fe | Cu | Zn | Mn | Fe | Cu | Zn | Mn |
| **0-15** | 3.10 | 7.85 | 0.62 | 2.55 | 5.23 | 9.07 | 0.50 | 4.83 |
| **15-30** | 9.02 | 3.74 | 0.27 | 0.35 | 5.39 | 8.70 | 0.44 | 2.28 |
| **30-45** | 7.69 | 6.99 | 0.38 | 1.76 | 7.69 | 9.02 | 0.40 | 2.96 |
| **45-60** | 3.20 | 6.30 | 0.34 | 3.98 | 8.97 | 7.74 | 0.49 | 1.41 |
| **60-75** | 2.88 | 4.43 | 0.27 | 0.99 | 3.84 | 8.06 | 0.53 | 0.18 |
| **75-90** | 2.72 | 4.54 | 1.19 | 2.55 | 4.06 | 0.97 | 0.18 | 0.48 |
| **90-105** | 3.15 | 7.42 | 0.17 | 1.16 | 5.82 | 1.54 | 0.55 | 0.20 |
| **105-130** | 2.37 | 5.12 | 1.22 | 0.64 | 7.85 | 1.31 | 0.12 | 0.26 |

## Available phosphorus (kg/ha)

Irrespective of the land use system the extent in horizons of available phosphorus was measured at pedon-1 and pedon-2. The small variation in amount of available phosphorus (Table 2) was found in both pedons. The pedon-2 showed greater amount of available phosphorus (15.28 kg/ha) in 0-15 cm depth and it was decreased with increasing horizon depth up to 105-130 cm of 9.76 kg/ha (Rajeswar and Khan, 2007) then pedon-1 soil. The greater amount of available phosphorus was found in pedon-1 of 13.65 kg/ha. So, that in 0-15 cm depth in no application of phosphorus might have increased the phosphorus fixation capacity of soil under mixed soil and current land use system (Das *et al*.1993).

## Available potassium content (kg/ha)

The amount of available potassium measured at pedon 1 and pedon 2 (Table 2). Available potassium decreased with increasing in horizons depth at two pedons. Available potassium in pedon-1 was varied from 336 to 259.6 kg/ha and in pedon-2 was showed 403.2 kg/ha on surface horizon and 291.2 kg/ha on 90-105 cm depth. There was great different of available potassium content in Nagara Block soil between the both horizon of Uraini and Malap village. The maximum available potassium content was found in the surface horizons and showed decreasing trend with increasing horizons depths. It could be attributed to more intensive weathering and release of exchangeable K and decomposition from organic residues. However, Singh *et al*.(2017)

## Available sulphur content (kg/ha)

Data (Table 2) revealed that on available sulphur varied with the horizon depth depending upon soil pH and organic material of soil of both pedons of land use system. Available sulphur in pedon-1 was 16.25 to 9.84 kg/ha and soil pedon-2 of 13.59 to 9.25 kg/ha, respectively. Greater amount of available sulphur was found in surface soil than in sub surface soil resulted from its recycling over the years by plant and subsequent organic matter accumulation (Bhatnagar *et al*., 2003).

## Micronutrients

Available (DTPA extractable) Iron (Fe), Copper (Cu), Zink (Zn) and Manganese (Mn) content.

## DTPA extractable Fe (mg/kg)

Data (Table 3) revealed that on DTPA extractable Fe in different soil depth of pedons were showed decreasing ranged from upper to lower depth of 2.72 to 9.02 mg/kg throughout the all depth. However, available Fe content was found maximum 9.02 mg/kg in surface horizons 15-30 cm there after decreased regularly with soil depth at pedon-2. The greater amount of value has possible due to the accumulation of water and organic material, although the lowest Fe content was measured 2.72 mg/kg at pedon1 with 75-90 cm pedon depth. Iron (Fe) content was fairly greater in pedon-2 up to upper surface at 0-15 cm horizons depth due to greater Fe accumulation was observed on the surface of pedon-2 and it was gradual decreased with depth and elevation of pedon, the similar finding was given by Tiwari and Mishra (1990).

## DTPA extractable Cu (mg/kg)

The available (DTPA extractable) Cu at different soil depth was studies in two pedons of two village. The data showed decreasing range (Table-7) from 0.97 to 9.07 mg/kg throughout the depth, however, available Cu content was found maximum (9.07 mg/kg) in surface horizons (0-15 cm) and decreased regularly with soil depth at pedon-2, although the lowest Cu content was measured 0.97 mg/kg at pedon-2 with 75-90 cm. The pedon-1 was found 3.74 mg/kg on 15-30 cm depth to 7.85 mg/kg on upper horizon. There were greats different of available Cu content in Nagara Block soil among the two pedons of both villages. The Cu content in both profile have no proper variation according to the depth (Singh *et al.,* 2014).

**DTPA extractable Zn (mg/kg)**

The data (Table-7) revealed that on available Zn at different soil depth were showed decreasing range from 0.17 to 1.19 mg/kg throughout the depth.

The pedon-1 was showed 0.27 mg/kg on 60-75 cm depth to 1.19 mg/kg on 75-90 cm depth horizon and pedon-2 was showed 0.12 mg/kg on 105-130 cm depth to 0.55 mg/kg on 90-105 cm depth horizons. There was great difference of available Zn content in Nagara Block soil among the two pedons. Available Zn in both pedons varied from 0.27 to 1.19 mg/kg. The maximum available Zn was observed in the surface horizon and showed decreasing trend towards increasing horzon depth. Similar finding are given by gupta *et al* (2019).

**DTPA extractable Mn (mg/kg)**

The amount of available Mn measured at pedon-1and -2 in Table-7 showed that the available Mn decreased in horizon depth at all pedon from upper to lower depth.

The pedon-1 was showed 0.35 mg/kg on 15-30 cm depth to 2.55 mg/kg on 15-30 cm lower horizon and pedon-2 was showed 4.83 mg/kg on 0-15 cm to 0.18 mg/kg on lower surface horizon. There was great defence of available Mn in Nagara Block soil among the two pedons (Singh *et al.,* 2014).

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