

## Original Research Article

# Nutrient Status of Soil under Inceptisols from Paranda Tahsil of Osmanabad District of Maharashtra, India

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## ABSTRACT

The present investigation was carried out during (2012-2013) to study Nutrient Status of Soil under Inceptisols from Paranda Tahsil of Osmanabad District of Maharashtra. For this purpose total 60 soil samples were collected from thirty villages and two soil samples from each village of Paranda tahsil were collected according to their representative depth. From each village, 2 soil samples of Inceptisols (10-30 cm) were collected. These soil samples were analyzed for physical properties viz., bulk density, particle density, porosity, physico-chemical viz., pH, EC, organic carbon, free calcium carbonate and macronutrient viz., available N, P, K, exchangeable  $\text{Ca}^{++}$ ,  $\text{Mg}^{++}$ , available S and micronutrients viz., DTPA-Fe, Zn, Mn, Cu and available B. The bulk density, particle density and porosity were ranges from 1.13 to 1.99  $\text{g cm}^{-3}$ , 1.81 to 2.96  $\text{g cm}^{-3}$  and 13.81 to 51.50 per cent, with mean value 1.53  $\text{g cm}^{-3}$ , 2.39  $\text{g cm}^{-3}$  and 35.42 per cent, respectively. Available N, P and available K were varied from 62.76 to 464.46  $\text{kg ha}^{-1}$ , 5.98 to 32.79  $\text{kg ha}^{-1}$  and 106.4 to 1123.92  $\text{kg ha}^{-1}$  with an average value of 124.27  $\text{kg ha}^{-1}$ , 15.63  $\text{kg ha}^{-1}$  and 351.33  $\text{kg ha}^{-1}$ , respectively. Exchangeable  $\text{Ca}^{++}$  and exchangeable  $\text{Mg}^{++}$  content ranged from 14.1 to 56.4  $\text{cmol (P}^+) \text{ kg}^{-1}$  and 1.6 to 36.8  $\text{cmol (P}^+) \text{ kg}^{-1}$ , respectively and available S ranged from 11.87 to 58.5  $\text{mg kg}^{-1}$ . The DTPA- Fe, DTPA-Zn, DTPA-Mn and DTPA-Cu in soils varied from 0.92 to 4.34  $\text{mg kg}^{-1}$ , 0.10 to 1.85  $\text{mg kg}^{-1}$ , 0.24 to 12.71  $\text{mg kg}^{-1}$  and 1.11 to 9.56  $\text{mg kg}^{-1}$ , respectively.

### Keywords

Macro nutrients,  
Micro nutrient,  
physico-chemical properties

## Introduction

Osmanabad district is located between 18<sup>0</sup> 28' to 19<sup>0</sup> 28' North altitude and 76<sup>0</sup> 25' to 77<sup>0</sup> 25' East latitude. Osmanabad district is the South Western part of Marathwada region of Maharashtra state. Osmanabad district comprises of eight tahsils, out of these Paranda tahsil was considered for the study. Total cultivated area of Paranda tahsil is 37000 ha. In this tahsil, different crops are cultivated like jowar, wheat, maize (cereals), black gram (pulses), safflower, linseed, sunflower (oilseeds). Average annual rainfall was 615.5 mm.

In Marathwada region of Maharashtra, soils are poor in available N, medium to high in available P and sufficiently high in available K (Dhawan and Rekawar, 2002). The micronutrients like Zn and Fe are deficient while, Mn and Cu are in adequate quantities in the soils of Marathwada (Mali and Syed Ismail, 2002).

Essential nutrients to support healthy human life are acquired through diverse food sources, ultimately supplied from soil. Therefore, management of nutrients in the

soil is essential to ensure adequate nutrient supply to plants. Availability of nutrients is influenced by their distribution in soil other physico-chemical properties of the soil. Thus, knowledge of status of micronutrient and their interrelationship with soil characteristics is helpful in understanding the inherent capacity of soil to supply these nutrients to plants (Talukdar *et al.*, 2009).

The physico-chemical characteristics *viz.*, bulk density, particle density, porosity, pH, EC, organic carbon and free calcium carbonate are important as these affect on availability of nutrients in soil and thereby on crop growth and production. Macronutrients (N, P, K, Ca, Mg, S) and micronutrients (Fe, Zn, Mn, Cu, B) are important soil elements that control its fertility. Soil fertility is one of the important factors controlling yields of the crops. Soil characterization in relation to evaluation of fertility status of the soils of an area or region is an important aspect in context of sustainable agriculture production (Meena *et al.*, 2006). The present investigations were undertaken in Paranda tahsil of Osmanabad district (M.H.) with a view to study available macronutrient and identify important physico-chemical characteristics to understanding the soils ability to provide plant nutrients from Inceptisols.

### **Materials and Methods**

Sixty soil samples were collected from Inceptisols of 30 villages of Paranda tahsil. These soil samples were dried and processed. The samples were analysed for particle density and bulk density by Pycnometer and clod coating methods, respectively (Das and Agrawal, 1997). pH and Electrical conductivity (E.C.) in 1:2.5 soil water suspension (Jackson, 1978). Organic carbon estimated by modified method of Walkely and Black (Piper, 1966).

The free calcium carbonate was determined by rapid titration method as outlined by Piper (1966).

Available nitrogen was analyzed by using alkaline potassium permanganate method (Subbiah and Asija, 1956). Available phosphorus was determined by using 0.5 M sodium bicarbonate as an extractant by Olsen's method on spectrophotometer (Jackson, 1978). Available potassium was treated with normal ammonium acetate and potassium was determined from the extract by using flame photometer (Jackson, 1978). Exchangeable calcium and magnesium was analyzed by ammonium extracts of soils by titration with EDTA (Jackson, 1978). Available sulphur was determined by using 1:5 soil and extractant, 0.15 per cent CaCl<sub>2</sub> solution on spectrophotometer (Williams and Steinberg, 1969).

Micronutrients were estimated as per the procedure described by Lindsay and Norvell (1978). For this 10 g finely sieved soil (0.5 mm) was taken in 20 ml of 0.005 M DTPA solution (Diethylene Triamine Penta Acetic Acid) containing 0.1 M triethanol amine and 0.01 M calcium chloride, adjusted to pH 7.3 with HCl for two hours and then filtered and filtrate was subjected to measurement on Atomic Absorption Spectrophotometer (AAS-200), at different wavelengths for Fe, Zn, Mn and Cu. Available boron was determined from soil samples by using Azomethine-H on spectrophotometer at 420 nm wavelength (Gupta, 1979).

### **Results and Discussion**

#### **Soil Characteristics**

The relevant soil characteristics of the representative 30 villages are described in Table 1. The bulk density of soils under Inceptisol order ranged from 1.13 to 1.99

$\text{gcm}^{-3}$  with the mean value  $1.53\text{gcm}^{-3}$ . Similar, results were also reported by Gupta *et al.*, (1995) analyzed the bulk density of 24 ha experimental farm of IARI, New Delhi and observed that it was varied from 1.32 to  $1.71\text{Mg m}^{-3}$  for 0.15 - 0.30 m layer. The particle density of soil ranged from 1.81 to  $2.96\text{gcm}^{-3}$  with mean value  $2.39\text{gcm}^{-3}$ . Whereas, porosity of these soils varied from 13.81 to 51.50 per cent with mean value 35.42 per cent. This result was confirmatory with results obtained by Cheke (2012) observed that the particle density of Inceptisol of Lohara tahsil of Osmanabad district was ranged between 2.09 to 2.97 with an average value  $2.48\text{mg m}^{-3}$ .

Further, the data (Table 2) showed that pH of these soils were ranged from 6.9 to 8.6 with an average value of 7.91. The Electrical conductivity of Inceptisols was varied from 0.11 to  $0.53\text{dSm}^{-1}$  with an average value of  $0.20\text{dSm}^{-1}$ . Organic carbon and organic matter content were ranged from 1.1 to 7.9 and 1.8 to  $13.6\text{g kg}^{-1}$  with a mean value of 4.32 and  $7.48\text{g kg}^{-1}$ , respectively. This result was confirmatory with results obtained by Chaudhary *et al.*, (1989) reported that soil pH, EC and organic carbon content in Inceptisol of Gorakhpur district were ranged from 6.55 to 8.45, 0.45 to  $0.74\text{dSm}^{-1}$  and 0.40 to 0.87 per cent, respectively. The data on  $\text{CaCO}_3$  content in Inceptisols of Paranda tahsil indicated that these soils were non-calcareous to calcareous in nature, ranged from 3.0 to  $163.0\text{g kg}^{-1}$  with an average value of  $62.11\text{g kg}^{-1}$ . Similar, results were also reported by Kulkarni (2012) studied the soils of Osmanabad tahsil of Osmanabad district and analyzed that the  $\text{CaCO}_3$  content were ranged from 1.10 to 11.0 per cent.

#### **Available Macronutrient Status of Soil**

The data regarding available N, P, K and S were presented in Table 3.

#### **Available Nitrogen**

Available N content ranged from 62.76 to  $464.46\text{kg ha}^{-1}$  with a mean value of  $124.27\text{kg ha}^{-1}$  in soils of Paranda tahsil. All the villages of Paranda tahsils were observed low in N content under Inceptisols.

Out of 60, 56 samples (93 %) were low ( $<250\text{kg ha}^{-1}$ ) and remaining 4 samples (7 %) were medium ( $250\text{ to }500\text{kg ha}^{-1}$ ) (Table 3). This result was confirmatory with results obtained by Basumatari *et al.*, (2010) observed that the available N content from Inceptisol of Assam was ranged from 104 to  $420\text{kg ha}^{-1}$ .

#### **Available Phosphorous**

Available P content in these soils was varied from 5.98 to  $32.79\text{kg ha}^{-1}$  with an average of  $15.63\text{kg ha}^{-1}$ . Among 60 soil samples collected from Paranda tahsil, 11 samples (18 per cent) were low, while 44 samples (73 %) were medium and 5 samples (8 %) were high in available P content. Similar, results were also reported by Basumatari *et al.*, (2010) observed that the available P content from Inceptisol of Assam was ranged from 3.67 to  $420\text{kg ha}^{-1}$ .

#### **Available Potassium**

Available K content in soils of Paranda tahsil was varied from 106.4 to  $1123.92\text{kg ha}^{-1}$  with a mean value of  $351.33\text{kg ha}^{-1}$ . Out of 60 soil samples, 28 samples (47 %) were high, 29 samples (48 %) were medium and only 3 samples (5 %) were low in available K content in Inceptisol.

This result was confirmatory with results obtained by Basumatari *et al.*, (2010) observed that the available K content from Inceptisol of Assam was ranged from 123 to  $583\text{kg ha}^{-1}$ .

**Table.1** Physical properties of soil from Paranda tahsil of Osmanabad district under Inceptisols

| Sr. No. | Village Sample No. | Bulk Density (g cm <sup>-3</sup> ) | Particle Density (g cm <sup>-3</sup> ) | Porosity (%) |
|---------|--------------------|------------------------------------|--|--------------|
| 1       | Kukkadgaon 1       | 1.99                               | 2.67                                   | 25.46        |
| 2       | Kukkadgaon 2       | 1.43                               | 2.02                                   | 29.20        |
| 3       | Malakapur 1        | 1.45                               | 2.67                                   | 45.69        |
| 4       | Malakapur 2        | 1.37                               | 2.56                                   | 46.48        |
| 5       | Ratnapur 1         | 1.67                               | 2.44                                   | 31.55        |
| 6       | Ratnapur 2         | 1.79                               | 2.40                                   | 25.41        |
| 7       | Shridharwadi 1     | 1.48                               | 2.38                                   | 37.81        |
| 8       | Shridharwadi 2     | 1.75                               | 2.78                                   | 37.05        |
| 9       | Vatephal 1         | 1.41                               | 2.50                                   | 43.60        |
| 10      | Vatephal 2         | 1.67                               | 2.78                                   | 39.92        |
| 11      | ChinchpurKhu. 1    | 1.70                               | 2.25                                   | 24.44        |
| 12      | ChinchpurKhu. 2    | 1.46                               | 2.67                                   | 45.31        |
| 13      | Udegaon 1          | 1.60                               | 2.51                                   | 36.25        |
| 14      | Udegaon 2          | 1.50                               | 2.33                                   | 35.62        |
| 15      | Takmodwadi 1       | 1.60                               | 2.41                                   | 33.60        |
| 16      | Takmodwadi 2       | 1.35                               | 2.48                                   | 45.56        |
| 17      | Jekatewadi 1       | 1.40                               | 2.35                                   | 40.42        |
| 18      | Jekatewadi 2       | 1.52                               | 2.74                                   | 44.52        |
| 19      | Chinchpur Bu. 1    | 1.44                               | 2.17                                   | 33.64        |
| 20      | Chinchpur Bu. 2    | 1.79                               | 2.74                                   | 34.67        |
| 21      | Pandharewadi 1     | 1.40                               | 2.26                                   | 38.05        |
| 22      | Pandharewadi 2     | 1.52                               | 2.94                                   | 48.29        |
| 23      | Shelgaon 1         | 1.51                               | 2.65                                   | 43.01        |
| 24      | Shelgaon 2         | 1.62                               | 2.34                                   | 30.76        |
| 25      | Lonarwadi 1        | 1.55                               | 2.04                                   | 24.01        |
| 26      | Lonarwadi 2        | 1.37                               | 2.25                                   | 39.11        |
| 27      | Ingonda 1          | 1.64                               | 2.64                                   | 37.87        |
| 28      | Ingonda 2          | 1.52                               | 2.10                                   | 27.61        |
| 29      | Anala 1            | 1.59                               | 2.20                                   | 27.72        |
| 30      | Anala 2            | 1.54                               | 2.65                                   | 41.88        |
| 31      | Karala 1           | 1.13                               | 2.33                                   | 51.50        |
| 32      | Karala 2           | 1.49                               | 2.48                                   | 39.91        |
| 33      | Mugaon 1           | 1.30                               | 2.10                                   | 38.09        |
| 34      | Mugaon 2           | 1.27                               | 2.56                                   | 50.39        |
| 35      | Donja 1            | 1.52                               | 2.48                                   | 38.70        |
| 36      | Donja 2            | 1.48                               | 2.44                                   | 39.34        |
| 37      | Parewadi 1         | 1.95                               | 2.27                                   | 14.09        |
| 38      | Parewadi 2         | 1.85                               | 2.96                                   | 37.50        |
| 39      | Kaudgaon 1         | 1.53                               | 2.10                                   | 27.14        |
| 40      | Kaudgaon 2         | 1.55                               | 2.45                                   | 36.73        |
| 41      | Sonari 1           | 1.63                               | 2.16                                   | 24.53        |
| 42      | Sonari 2           | 1.66                               | 2.29                                   | 27.51        |
| 43      | Domgaon 1          | 1.50                               | 2.23                                   | 32.73        |

|                |              |           |           |           |
|----------------|--------------|-----------|-----------|-----------|
| 44             | Domgaon 2    | 1.33      | 2.45      | 45.71     |
| 45             | Bhonja 1     | 1.43      | 2.24      | 36.16     |
| 46             | Bhonja 2     | 1.37      | 2.40      | 42.91     |
| 47             | Kumbhej 1    | 1.57      | 2.56      | 38.67     |
| 48             | Kumbhej 2    | 1.40      | 2.13      | 34.27     |
| 49             | Paranda 1    | 1.37      | 2.06      | 33.49     |
| 50             | Paranda 2    | 1.54      | 2.53      | 39.13     |
| 51             | Songiri 1    | 1.66      | 2.23      | 25.56     |
| 52             | Songiri 2    | 1.56      | 1.81      | 13.81     |
| 53             | Khasgaon 1   | 1.42      | 2.65      | 46.41     |
| 54             | Khasgaon 2   | 1.50      | 2.42      | 38.01     |
| 55             | Dhagpinpri 1 | 1.62      | 2.00      | 19.00     |
| 56             | Dhagpinpri 2 | 1.54      | 2.44      | 36.88     |
| 57             | Saranwadi 1  | 1.42      | 1.81      | 21.54     |
| 58             | Saranwadi 2  | 1.50      | 2.07      | 27.53     |
| 59             | Pinpalwadi 1 | 1.64      | 2.44      | 32.78     |
| 60             | Pinpalwadi 2 | 1.52      | 2.57      | 40.85     |
| <b>Range</b>   |              | 1.20-1.70 | 1.13-1.99 | 1.81-2.96 |
| <b>Mean</b>    |              | 1.49      | 1.53      | 2.39      |
| <b>SE ±</b>    |              | 0.01      | 0.02      | 0.03      |
| <b>C.V (%)</b> |              | 7.95      | 10.19     | 10.60     |

**Table.2** Physico-chemical properties of soil from Paranda tahsil of Osmanabad district under Inceptisols

| Sr. No. | Village Sample No. | pH  | EC (dSm <sup>-1</sup> ) | Organic carbon (g kg <sup>-1</sup> ) | Organic matter (g kg <sup>-1</sup> ) | CaCO <sub>3</sub> (g kg <sup>-1</sup> ) |
|---------|--------------------|-----|-------------------------|--------------------------------------|--------------------------------------|---|
| 1       | Kukkadgaon 1       | 7.8 | 0.19                    | 6.1                                  | 10.6                                 | 12.0                                    |
| 2       | Kukkadgaon 2       | 8.3 | 0.15                    | 5.6                                  | 9.7                                  | 4.0                                     |
| 3       | Malakapur 1        | 8.1 | 0.12                    | 4.6                                  | 8.0                                  | 45.0                                    |
| 4       | Malakapur 2        | 8.3 | 0.31                    | 2.8                                  | 4.8                                  | 79.0                                    |
| 5       | Ratnapur 1         | 8.1 | 0.15                    | 3.8                                  | 6.6                                  | 11.0                                    |
| 6       | Ratnapur 2         | 8.3 | 0.24                    | 2.5                                  | 4.3                                  | 95.0                                    |
| 7       | Shridharwadi 1     | 6.9 | 0.22                    | 4.8                                  | 8.3                                  | 3.0                                     |
| 8       | Shridharwadi 2     | 8.2 | 0.23                    | 6.3                                  | 10.9                                 | 60.0                                    |
| 9       | Vatephal 1         | 7.9 | 0.19                    | 5.2                                  | 9.0                                  | 67.0                                    |
| 10      | Vatephal 2         | 8.1 | 0.18                    | 4.6                                  | 7.9                                  | 119.0                                   |
| 11      | ChinchpurKhu. 1    | 8.1 | 0.36                    | 2.3                                  | 3.9                                  | 101.0                                   |
| 12      | ChinchpurKhu. 2    | 8.1 | 0.22                    | 5.9                                  | 10.3                                 | 17.0                                    |
| 13      | Udegaon 1          | 8.0 | 0.48                    | 2.1                                  | 3.6                                  | 124.0                                   |
| 14      | Udegaon 2          | 8.1 | 0.27                    | 5.4                                  | 9.3                                  | 38.0                                    |
| 15      | Takmodwadi 1       | 8.2 | 0.16                    | 1.1                                  | 1.8                                  | 134.0                                   |
| 16      | Takmodwadi 2       | 7.8 | 0.19                    | 7.4                                  | 12.7                                 | 88.0                                    |
| 17      | Jekatewadi 1       | 7.4 | 0.26                    | 7.5                                  | 13.0                                 | 16.0                                    |
| 18      | Jekatewadi 2       | 8.0 | 0.16                    | 1.5                                  | 2.6                                  | 25.0                                    |
| 19      | Chinchpur Bu. 1    | 7.9 | 0.17                    | 5.4                                  | 9.3                                  | 107.0                                   |

|                |                 |         |           |         |          |             |
|----------------|-----------------|---------|-----------|---------|----------|-------------|
| 20             | Chinchpur Bu. 2 | 8.1     | 0.53      | 5.9     | 10.3     | 103.0       |
| 21             | Pandharewadi 1  | 8.0     | 0.27      | 4.6     | 8.0      | 132.0       |
| 22             | Pandharewadi 2  | 8.3     | 0.24      | 6.5     | 11.2     | 39.0        |
| 23             | Shelgaon 1      | 7.5     | 0.18      | 2.5     | 4.3      | 135.0       |
| 24             | Shelgaon 2      | 7.8     | 0.18      | 3.8     | 6.6      | 39.0        |
| 25             | Lonarwadi 1     | 7.9     | 0.19      | 6.3     | 10.9     | 75.0        |
| 26             | Lonarwadi 2     | 7.6     | 0.22      | 5.0     | 8.6      | 80.0        |
| 27             | Ingonda 1       | 7.9     | 0.31      | 3.4     | 6.0      | 68.0        |
| 28             | Ingonda 2       | 7.4     | 0.16      | 2.3     | 4.0      | 26.0        |
| 29             | Anala 1         | 8.4     | 0.16      | 5.5     | 9.6      | 72.0        |
| 30             | Anala 2         | 8.3     | 0.14      | 5.9     | 10.3     | 45.0        |
| 31             | Karala 1        | 7.6     | 0.21      | 5.5     | 9.6      | 36.0        |
| 32             | Karala 2        | 8.0     | 0.30      | 3.8     | 6.6      | 28.0        |
| 33             | Mugaon 1        | 8.1     | 0.32      | 4.6     | 7.9      | 105.0       |
| 34             | Mugaon 2        | 8.2     | 0.23      | 4.2     | 7.3      | 108.0       |
| 35             | Donja 1         | 7.8     | 0.22      | 6.1     | 10.6     | 39.0        |
| 36             | Donja 2         | 7.7     | 0.21      | 2.3     | 4.0      | 22.0        |
| 37             | Parewadi 1      | 7.2     | 0.15      | 2.1     | 3.6      | 18.0        |
| 38             | Parewadi 2      | 8.6     | 0.15      | 3.6     | 6.3      | 90.0        |
| 39             | Kaudgaon 1      | 7.3     | 0.20      | 2.3     | 4.0      | 11.0        |
| 40             | Kaudgaon 2      | 8.2     | 0.22      | 1.1     | 1.8      | 75.0        |
| 41             | Sonari 1        | 7.7     | 0.13      | 2.3     | 4.0      | 28.0        |
| 42             | Sonari 2        | 7.8     | 0.16      | 6.1     | 10.6     | 29.0        |
| 43             | Domgaon 1       | 8.3     | 0.18      | 7.1     | 12.3     | 55.0        |
| 44             | Domgaon 2       | 7.9     | 0.13      | 6.9     | 11.9     | 53.0        |
| 45             | Bhonja 1        | 7.0     | 0.13      | 1.9     | 3.3      | 25.0        |
| 46             | Bhonja 2        | 7.4     | 0.11      | 2.7     | 4.6      | 26.0        |
| 47             | Kumbhej 1       | 7.8     | 0.17      | 3.6     | 6.3      | 64.0        |
| 48             | Kumbhej 2       | 7.6     | 0.26      | 7.9     | 13.6     | 40.0        |
| 49             | Paranda 1       | 7.8     | 0.12      | 1.2     | 2.0      | 28.0        |
| 50             | Paranda 2       | 7.4     | 0.11      | 1.1     | 1.8      | 27.0        |
| 51             | Songiri 1       | 8.1     | 0.16      | 4.6     | 7.9      | 163.0       |
| 52             | Songiri 2       | 8.4     | 0.18      | 4.2     | 7.3      | 75.0        |
| 53             | Khasgaon 1      | 7.9     | 0.23      | 6.7     | 11.6     | 35.0        |
| 54             | Khasgaon 2      | 8.0     | 0.13      | 3.6     | 6.3      | 29.0        |
| 55             | Dhagpinpri 1    | 7.5     | 0.15      | 6.9     | 11.9     | 18.0        |
| 56             | Dhagpinpri 2    | 7.5     | 0.33      | 4.0     | 7.0      | 35.0        |
| 57             | Saranwadi 1     | 8.2     | 0.22      | 3.0     | 5.3      | 94.0        |
| 58             | Saranwadi 2     | 8.4     | 0.24      | 5.9     | 10.3     | 92.0        |
| 59             | Pinpalwadi 1    | 8.5     | 0.13      | 3.4     | 5.9      | 160.0       |
| 60             | Pinpalwadi 2    | 8.3     | 0.14      | 4.2     | 7.3      | 160.0       |
| <b>Range</b>   |                 | 6.9-8.6 | 0.11-0.53 | 1.1-7.9 | 1.8-13.6 | 3.0 - 163.0 |
| <b>Mean</b>    |                 | 7.91    | 0.20      | 4.32    | 7.48     | 62.11       |
| <b>SE ±</b>    |                 | 0.04    | 0.01      | 0.23    | 0.41     | 5.54        |
| <b>C.V (%)</b> |                 | 4.68    | 39.13     | 42.80   | 42.93    | 69.10       |



**Table.3** Status of available N, P, K, Ca, Mg and S in Inceptisols of Paranda tahsil of Osmanabad district

| Village Name    | Available N<br>(kg ha <sup>-1</sup> ) | Available P<br>(kg ha <sup>-1</sup> ) | Available K<br>(kg ha <sup>-1</sup> ) | Available S<br>(mg kg <sup>-1</sup> ) | Exch. Ca <sup>++</sup><br>(cmol(P <sup>+</sup> )kg <sup>-1</sup> ) | Exch.Mg <sup>++</sup><br>(cmol(P <sup>+</sup> )kg <sup>-1</sup> ) |
|-----------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|--|---|
| Kukkadgaon 1    | 125.53                                | 11.20                                 | 333.64                                | 58.50                                 | 27.2   | 12.8  |
| Kukkadgaon 2    | 90.84                                 | 15.67                                 | 385.72                                | 25.85                                 | 17.6   | 17.6  |
| Malakapur 1     | 351.48                                | 19.96                                 | 317.63                                | 16.39                                 | 24.0   | 10.4  |
| Malakapur 2     | 105.78                                | 15.84                                 | 405.21                                | 20.15                                 | 33.6   | 2.4   |
| Ratnapur 1      | 100.42                                | 9.08                                  | 165.31                                | 40.02                                 | 21.6   | 18.4  |
| Ratnapur 2      | 87.45                                 | 15.07                                 | 361.31                                | 38.54                                 | 45.6   | 4.0   |
| Shridharwadi 1  | 100.09                                | 10.01                                 | 263.08                                | 18.32                                 | 20.0   | 26.4  |
| Shridharwadi 2  | 112.98                                | 16.21                                 | 161.15                                | 45.35                                 | 49.6   | 4.0   |
| Vatephal 1      | 90.24                                 | 18.10                                 | 289.40                                | 12.48                                 | 21.0   | 25.3  |
| Vatephal 2      | 75.32                                 | 25.05                                 | 176.08                                | 19.91                                 | 22.4   | 19.2  |
| ChinchpurKhu.1  | 75.32                                 | 11.09                                 | 568.28                                | 12.32                                 | 36.0   | 14.4  |
| ChinchpurKhu. 2 | 125.34                                | 17.11                                 | 176.96                                | 16.15                                 | 42.5   | 9.7   |
| Udegaon 1       | 100.39                                | 16.27                                 | 306.54                                | 16.10                                 | 28.0   | 16.8  |
| Udegaon 2       | 87.87                                 | 28.92                                 | 219.63                                | 22.15                                 | 35.2   | 15.5  |
| Takmodwadi 1    | 112.55                                | 22.15                                 | 308.22                                | 28.10                                 | 24.0   | 18.4  |
| Takmodwadi 2    | 121.08                                | 32.79                                 | 1014.16                               | 19.61                                 | 28.9   | 15.2  |
| Jekatewadi 1    | 112.98                                | 8.40                                  | 628.99                                | 20.01                                 | 22.4   | 12.8  |
| Jekatewadi 2    | 97.52                                 | 14.66                                 | 175.50                                | 37.50                                 | 21.4   | 9.1   |
| Chinchpur Bu. 1 | 114.40                                | 14.27                                 | 174.44                                | 18.11                                 | 20.8   | 12.8  |
| Chinchpur Bu. 2 | 100.05                                | 24.02                                 | 293.66                                | 23.19                                 | 14.10  | 6.7   |
| Pandharewadi 1  | 112.98                                | 13.86                                 | 518.67                                | 16.15                                 | 40.8   | 2.4   |
| Pandharewadi 2  | 96.78                                 | 23.21                                 | 445.53                                | 22.21                                 | 30.1   | 16.9  |
| Shelgaon 1      | 125.09                                | 9.45                                  | 336.22                                | 12.48                                 | 16.8   | 11.2  |
| Shelgaon 2      | 138.08                                | 14.66                                 | 233.39                                | 22.91                                 | 28.7   | 15.3  |
| Lonarwadi 1     | 162.76                                | 8.29                                  | 371.05                                | 21.75                                 | 36.5   | 14.5  |
| Lonarwadi 2     | 100.25                                | 14.46                                 | 114.35                                | 19.73                                 | 26.4   | 4.8   |
| Ingonda 1       | 100.42                                | 14.75                                 | 1041.93                               | 15.75                                 | 25.6   | 9.6   |
| Ingonda 2       | 87.56                                 | 17.02                                 | 251.77                                | 20.07                                 | 24.0   | 19.5  |
| Anala 1         | 110.21                                | 15.15                                 | 346.64                                | 25.09                                 | 41.6   | 2.4   |
| Anala 2         | 94.25                                 | 27.28                                 | 187.37                                | 21.10                                 | 27.32  | 16.8  |
| Karala 1        | 187.87                                | 10.00                                 | 253.45                                | 20.10                                 | 32.8   | 9.6   |
| Karala 2        | 105.58                                | 22.81                                 | 413.05                                | 27.0                                  | 23.9   | 12.9  |
| Mugaon 1        | 125.53                                | 21.29                                 | 223.32                                | 20.0                                  | 39.5   | 9.6   |
| Mugaon 2        | 265.87                                | 31.97                                 | 335.82                                | 24.5                                  | 43.2   | 3.2   |
| Donja 1         | 104.10                                | 14.10                                 | 197.87                                | 18.77                                 | 30.1   | 8.7   |
| Donja 2         | 62.76                                 | 17.30                                 | 188.09                                | 23.65                                 | 42.4   | 4.8   |
| Parewadi 1      | 62.76                                 | 17.20                                 | 237.18                                | 13.45                                 | 48.8   | 7.2   |
| Parewadi 2      | 97.59                                 | 20.25                                 | 192.89                                | 27.84                                 | 25.1   | 5.7   |
| Kaudgaon 1      | 100.42                                | 10.00                                 | 404.76                                | 16.82                                 | 36.0   | 4.0   |
| Kaudgaon 2      | 214.05                                | 21.20                                 | 545.44                                | 43.82                                 | 27.2   | 4.3   |
| Sonari 1        | 150.21                                | 9.07                                  | 271.48                                | 16.10                                 | 38.4   | 12.0  |

|                |              |            |               |            |           |          |
|----------------|--------------|------------|---------------|------------|-----------|----------|
| Sonari 2       | 100.10       | 18.37      | 261.85        | 32.19      | 19.9      | 9.2      |
| Domgaon 1      | 62.76        | 7.25       | 294.11        | 14.76      | 32.0      | 8.8      |
| Domgaon 2      | 109.16       | 12.17      | 284.36        | 18.11      | 39.7      | 15.4     |
| Bhonja 1       | 250.21       | 6.29       | 106.40        | 15.66      | 25.6      | 18.4     |
| Bhonja 2       | 98.18        | 12.30      | 178.30        | 19.29      | 30.8      | 7.5      |
| Kumbhej 1      | 87.87        | 9.35       | 133.50        | 11.87      | 40.0      | 1.6      |
| Kumbhej 2      | 117.85       | 19.24      | 427.28        | 26.53      | 30.1      | 10.7     |
| Paranda 1      | 93.47        | 12.20      | 192.08        | 12.32      | 44.8      | 19.2     |
| Paranda 2      | 75.32        | 15.40      | 220.97        | 19.91      | 32.4      | 9.8      |
| Songiri 1      | 109.34       | 8.07       | 1123.92       | 22.81      | 23.2      | 16.8     |
| Songiri 2      | 125.53       | 16.17      | 1123.92       | 29.80      | 32.4      | 19.8     |
| Khasgaon 1     | 150.63       | 11.07      | 561.23        | 16.51      | 28.0      | 21.6     |
| Khasgaon 2     | 126.34       | 18.12      | 223.55        | 29.10      | 56.4      | 21.3     |
| Dhagpinpri 1   | 464.46       | 5.98       | 386.40        | 23.64      | 21.6      | 20.8     |
| Dhagpinpri 2   | 150.42       | 13.75      | 269.92        | 40.97      | 30.5      | 15.6     |
| Saranwadi 1    | 138.08       | 13.19      | 448.78        | 12.64      | 39.2      | 14.4     |
| Saranwadi 2    | 109.40       | 15.20      | 442.84        | 15.90      | 28.3      | 10.5     |
| Pinpalwadi 1   | 100.42       | 9.78       | 310.80        | 16.83      | 26.4      | 36.8     |
| Pinpalwadi 2   | 94.07        | 14.85      | 254.68        | 21.30      | 32.8      | 19.2     |
| <b>Range</b>   | 62.76-464.46 | 5.98-32.79 | 106.4-1123.92 | 11.87-58.5 | 14.1-56.4 | 1.6-36.8 |
| <b>Mean</b>    | 124.27       | 15.63      | 351.33        | 22.63      | 30.92     | 12.74    |
| <b>S.E±</b>    | 8.55         | 0.78       | 29.48         | 1.19       | 1.16      | 0.89     |
| <b>C.V (%)</b> | 53.30        | 38.66      | 65.01         | 40.88      | 29.18     | 54.24    |

**Table.4** Status of available micro nutrients in Inceptisols of Paranda tahsil of Osmanabad district

| <b>Village Name</b> | <b>DTPA-Fe<br/>(mg kg<sup>-1</sup>)</b> | <b>DTPA-Zn<br/>(mg kg<sup>-1</sup>)</b> | <b>DTPA-Mn<br/>(mg kg<sup>-1</sup>)</b> | <b>DTPA-Cu<br/>(mg kg<sup>-1</sup>)</b> | <b>Available B<br/>(mg kg<sup>-1</sup>)</b> |
|---------------------|---|---|---|---|---|
| Kukkadgaon 1        | 2.21                                    | 0.22                                    | 3.15                                    | 2.84                                    | 0.86  |
| Kukkadgaon 2        | 2.30                                    | 0.51                                    | 7.20                                    | 3.19                                    | 0.92  |
| Malakapur 1         | 2.91                                    | 0.14                                    | 9.40                                    | 5.27                                    | 0.48  |
| Malakapur 2         | 1.74                                    | 1.27                                    | 4.57                                    | 3.72                                    | 1.08  |
| Ratnapur 1          | 1.07                                    | 0.12                                    | 4.22                                    | 1.52                                    | 0.78  |
| Ratnapur 2          | 1.34                                    | 0.14                                    | 3.28                                    | 2.08                                    | 1.07  |
| Shridharwadi 1      | 1.87                                    | 1.58                                    | 2.72                                    | 1.11                                    | 0.23  |
| Shridharwadi 2      | 1.94                                    | 0.18                                    | 0.52                                    | 1.59                                    | 0.78  |
| Vatephal 1          | 2.94                                    | 0.11                                    | 5.23                                    | 2.70                                    | 0.81  |
| Vatephal 2          | 1.56                                    | 0.10                                    | 8.43                                    | 4.99                                    | 0.84  |
| ChinchpurKhu. 1     | 1.80                                    | 0.19                                    | 3.97                                    | 2.72                                    | 0.37  |
| ChinchpurKhu. 2     | 0.92                                    | 0.12                                    | 0.24                                    | 2.43                                    | 0.89  |
| Udegaon 1           | 1.43                                    | 0.16                                    | 4.53                                    | 2.57                                    | 0.92  |
| Udegaon 2           | 1.65                                    | 0.14                                    | 4.62                                    | 3.49                                    | 1.07  |
| Takmodwadi 1        | 3.07                                    | 0.89                                    | 5.10                                    | 2.84                                    | 0.04  |
| Takmodwadi 2        | 2.39                                    | 0.59                                    | 4.38                                    | 3.10                                    | 0.80  |
| Jekatewadi 1        | 2.47                                    | 1.24                                    | 4.76                                    | 3.49                                    | 1.02  |
| Jekatewadi 2        | 3.52                                    | 0.96                                    | 6.48                                    | 4.06                                    | 0.45  |



|                 |           |             |            |           |             |
|-----------------|-----------|-------------|------------|-----------|-------------|
| Chinchpur Bu. 1 | 2.71      | 0.89        | 3.04       | 4.33      | 0.92        |
| Chinchpur Bu. 2 | 1.95      | 1.23        | 4.55       | 6.74      | 0.82        |
| Pandharewadi 1  | 2.46      | 0.59        | 5.33       | 2.72      | 1.07        |
| Pandharewadi 2  | 1.37      | 0.19        | 3.89       | 3.71      | 1.23        |
| Shelgaon 1      | 3.02      | 0.14        | 2.57       | 1.18      | 0.35        |
| Shelgaon 2      | 1.40      | 0.16        | 2.60       | 2.44      | 0.94        |
| Lonarwadi 1     | 2.91      | 0.12        | 3.02       | 1.57      | 0.97        |
| Lonarwadi 2     | 3.06      | 0.68        | 3.31       | 1.11      | 0.84        |
| Ingonda 1       | 2.81      | 0.18        | 8.45       | 1.52      | 0.08        |
| Ingonda 2       | 1.34      | 0.21        | 4.46       | 4.71      | 0.82        |
| Anala 1         | 1.78      | 0.13        | 5.23       | 2.14      | 0.15        |
| Anala 2         | 2.88      | 1.15        | 3.59       | 2.94      | 0.79        |
| Karala 1        | 2.97      | 0.91        | 5.91       | 3.14      | 0.39        |
| Karala 2        | 2.34      | 0.69        | 4.56       | 2.78      | 0.72        |
| Mugaon 1        | 1.52      | 0.15        | 4.26       | 5.27      | 0.28        |
| Mugaon 2        | 3.72      | 0.65        | 9.30       | 3.71      | 0.88        |
| Donja 1         | 1.40      | 0.15        | 7.22       | 4.24      | 0.72        |
| Donja 2         | 4.33      | 0.17        | 12.06      | 8.74      | 0.92        |
| Parewadi 1      | 1.49      | 1.10        | 5.35       | 3.72      | 0.41        |
| Parewadi 2      | 1.39      | 0.25        | 9.87       | 4.32      | 0.90        |
| Kaudgaon 1      | 1.26      | 0.50        | 8.43       | 1.59      | 0.73        |
| Kaudgaon 2      | 1.97      | 0.13        | 9.54       | 2.70      | 0.25        |
| Sonari 1        | 2.02      | 1.10        | 3.28       | 3.71      | 0.39        |
| Sonari 2        | 2.50      | 0.12        | 10.98      | 4.72      | 0.98        |
| Domgaon 1       | 3.81      | 0.19        | 6.48       | 2.87      | 1.13        |
| Domgaon 2       | 2.25      | 1.85        | 5.23       | 3.62      | 1.25        |
| Bhonja 1        | 1.43      | 0.17        | 6.79       | 1.52      | 0.05        |
| Bhonja 2        | 2.51      | 0.11        | 7.74       | 2.66      | 0.25        |
| Kumbhej 1       | 1.90      | 0.10        | 4.01       | 2.95      | 0.92        |
| Kumbhej 2       | 1.92      | 0.18        | 12.05      | 5.49      | 0.82        |
| Paranda 1       | 2.61      | 0.12        | 3.72       | 3.72      | 1.10        |
| Paranda 2       | 1.31      | 0.15        | 4.79       | 4.11      | 0.77        |
| Songiri 1       | 1.40      | 0.25        | 7.38       | 3.52      | 0.48        |
| Songiri 2       | 2.25      | 0.16        | 5.22       | 3.19      | 0.91        |
| Khasgaon 1      | 1.96      | 0.12        | 10.67      | 3.18      | 1.20        |
| Khasgaon 2      | 3.72      | 0.15        | 9.12       | 2.65      | 0.91        |
| Dhagpinpri 1    | 4.34      | 0.12        | 10.84      | 9.56      | 0.24        |
| Dhagpinpri 2    | 2.57      | 0.96        | 12.71      | 5.11      | 0.82        |
| Saranwadi 1     | 1.61      | 0.32        | 8.77       | 4.04      | 0.92        |
| Saranwadi 2     | 1.98      | 0.10        | 10.71      | 3.71      | 1.01        |
| Pinpalwadi 1    | 1.92      | 0.12        | 4.74       | 2.18      | 0.43        |
| Pinpalwadi 2    | 4.08      | 0.18        | 6.89       | 3.31      | 0.91        |
| <b>Range</b>    | 0.92-4.34 | 0.10 - 1.85 | 0.24-12.71 | 1.11-9.56 | 0.04 - 1.25 |
| <b>Mean</b>     | 2.25      | 0.42        | 6.02       | 3.41      | 0.73        |
| <b>S.E±</b>     | 0.10      | 0.05        | 0.37       | 0.20      | 0.04        |
| <b>C.V (%)</b>  | 37.10     | 102.52      | 48.52      | 46.81     | 43.66       |

### Available Sulphur

The available S ranged from 11.87 to 58.5 mg kg<sup>-1</sup> with an average value of 22.63 mg kg<sup>-1</sup>. Out of 60 samples, none of the samples comes under low categorization (< 10 mg kg<sup>-1</sup>), 29 samples (48 %) were medium and 31 soil samples (52 %) were high in available S content. This result was confirmatory with results obtained by Sharma and Gangwar (1997) revealed that the available sulphur content in different soil series of Inceptisol of Moradabad district in Uttar Pradesh was varied from 15.0 to 56.2 mg kg<sup>-1</sup>.

### Exchangeable Ca<sup>++</sup> and Exchangeable Mg<sup>++</sup>

The exchangeable Ca<sup>++</sup> content ranged from 14.1 to 56.4 cmol (P<sup>+</sup>) kg<sup>-1</sup> with a mean value of 30.92 cmol (P<sup>+</sup>) kg<sup>-1</sup>. The result revealed that all the 60 soil samples collected from 30 villages from Paranda tahsil contained high exchangeable Ca<sup>++</sup> under Inceptisols. The amount of exchangeable Mg<sup>++</sup> was varied from 1.6 to 36.8 cmol (P<sup>+</sup>) Kg<sup>-1</sup> with a mean value of 12.74 cmol (P<sup>+</sup>) kg<sup>-1</sup>. The data further revealed that all the 60 soil samples collected from 30 villages of Paranda tahsil were rich in exchangeable Mg<sup>++</sup>.

### Available Micronutrient Status

The data regarding available micro nutrient status viz; DTPA Fe, Mn, Zn, Cu and available B were presented in Table 4. The DTPA-Fe content in soils varied from 0.92 to 4.34 mg kg<sup>-1</sup> with a mean value of 2.25 mg kg<sup>-1</sup>. Out of 60 soil samples, 39 samples (65 %) were deficient, 21 samples (35 %) were marginal in DTPA-Fe content. None of the sample was categorized as sufficient. DTPA-Zn in soils ranged from 0.10 to 1.85 mg kg<sup>-1</sup> with a mean value of 0.42 mg kg<sup>-1</sup>.

Among 60 soil samples, 44 (73 %), 11 (18 %) and remaining 5 (8 %) were categorized as deficient, marginal and sufficient, respectively in DTPA-Zn content.

The DTPA-Mn content in soils was varied from 0.24 to 12.71 mg kg<sup>-1</sup> with an average 6.02 mg kg<sup>-1</sup>. Among the 60 soil samples, only 2 samples (3 %) were deficient, 26 samples (44 %) were marginal and 32 samples (53 %) were sufficient in DTPA-Mn content. The DTPA-Cu content in the soils ranged from 1.11 to 9.56 mg kg<sup>-1</sup> with an average of 3.41 mg kg<sup>-1</sup>. All soil samples (60) collected from 30 villages of Paranda tahsil was rich in DTPA-Cu under Inceptisol. The available B in soils was ranged from 0.04 to 1.25 mg kg<sup>-1</sup> with a mean value of 0.73 mg kg<sup>-1</sup>. Among 60 soil samples, only 3 samples (5 %) were deficient (< 0.1 mg kg<sup>-1</sup>), 15 samples (25 %) were marginal (0.1 to 0.5 mg kg<sup>-1</sup>) and 42 samples (70 %) were sufficient (>0.5 mg kg<sup>-1</sup>) in available B content. Similar, results were also reported by Malewar (2005) reported that the DTPA Zn, Fe, Mn, Cu and HWS-B from the soils of Marathwada region were ranged from 0.20 to 6.84, 0.36 to 25.14, 1.20 to 72.84, 0.28 to 12.32 and 0.14 to 1.35 mg kg<sup>-1</sup>, respectively.

The study of physico-chemical and soil nutrients analysis of soil samples revealed that the Inceptisols of Paranda tahsil of Osmanabad district were neutral to alkaline in soil reaction, all soil samples were safe in electrical conductivity for growing crops, organic carbon content was low to medium and CaCO<sub>3</sub> content in soils were non-calcareous to calcareous in nature. Available primary macro nutrients viz., N was low, P content was low to medium and K content was medium to high in Inceptisols of Paranda tahsil. The secondary macro nutrient viz., exchangeable Ca<sup>++</sup>, Mg<sup>++</sup> were found to be high and available S was

medium to high in soils of Paranda tahsil. The lowest content of DTPA-Fe and Zn while, medium to high content of DTPA-Mn and higher content of DTPA-Cu were observed in soils of Paranda tahsil. However, available B was mostly sufficient in soils of Paranda.

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