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# Distribution Studies Of Micronutrients In Soil Of Left Side Of The Ganga Canal Flowing Through Muzaffarnagar, Meerut And Ghaziabad Districts, Uttar Pradesh, India

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**ABSTRACT**
*Soil is the most important natural resources which need to be properly and scientifically utilized for improving the productivity and economic condition of the rural area.The present study was conducted on soils of left side of Ganga canal flowing through Muzaffarnagar, Meerut and Ghaziabad district of Uttar Pradesh .Soil samples were collected and analyzed for their chemical properties like cationic micronutrient (Zn, Cu, Fe&Mn).The availability of these micronutrient decreases with increasing soil depth.Copper content ranged between 0.020 to 6.164, Iron 6.276 to 113.30, Manganese and zinc 0.36 to 5.80 mg kg soil$^{-1}$. Correlation was also worked out between different parameters.Organic matter was significantly correlated with cationic micronutrient. Copper was strongly correlated followed by iron, zinc and manganese. Whereas the soil pH was significantly and negatively correlated with Zn (r= - 0.293), Fe (r = - 0.503) and Mn (r= -0.301) but available Cu was not correlated with soil pH at any significance level.*
*Key word:Soil fertility, Organic Matter, Micronutrients, Surface soil and Class*

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## INTRODUCTION

Soil is the most important natural resources which need to be properly and scientifically utilized for improving the productivity and economic condition of the rural area. The National Commission on Agriculture recommended that land use policy should be such that land is utilized in accordance with the ecology, capability and the need of the land in different region and area. This is especially true for coarse texture soil area where irrigation facilities are meager.Micronutrient (Zn, Fe, Cu, Mn) are important soil elements that control its fertility. Soil fertility is one of the important factors controlling yield 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. Because of imbalanceand inadequate fertilizer use coupled with low efficiency of their inputs, the response (Production) efficiency of chemical fertilizer nutrients has declined tremendously under intensive agriculture in recent years **Meena et al., (2006)**. The results of numerous field experiments in different part of India have, therefore indicated "fertilizer – induced sustainability of crop productivity"**(Yadav 2003)**. Variation in nutrient supply is a natural phenomenon and some of them may be sufficient where other deficient

The stagnation in crop productivity cannot be boosted without judicious use of micronutrient fertilizers to overcome existing deficiencies/ imbalances. A widespread micronutrient deficiency has been observed in the soils of Rajasthan, especially zinc (46%) and iron (51.5%)**( Sharma*et al.*, 2003 )**.

**Location of study area:** The study area falls in three district of Western Uttar Pradesh i.e. Muzaffarnagar, Meerut and Ghaziabad. Ganga canal was considered as base line and on the left hand side (LHS) of Ganga canal from Purkaji to Muradnagar was taken as the study area. Each bridge on the canal between these two end points (Purkaji to Muradnagar) was selected for sampling location. Samples were taken from the distance of 1000, 2000, 3000, 4000, and 5000 meter

**Geographical outline of study area**

Muzaffarnagar is located at northern part of Uttar Pradesh. It is roughly rectangular in shape, lying between north latitude 29$^0$ 11' 30'' and 29$^0$ 45' 15'' and east longitude 77$^0$ 3' 45'' and 78$^0$ 7'. Meerut district is located from 29$^o$04' N latitude and 77$^0$42' E longitude at an altitude of 237 meter above the

mean sea level (MSL). Ghaziabad district is located from $25^0$ N latitude and $28^0$ 40'00' E longitudes at an altitude of $77^0$ 26' meter above the mean sea level (MSL)

**Sampling and analyses**

Soilsamples from two depths (0-15 and 15-30 cm) from eighteen locations ofMuzaffarnagar, Meerut and Ghaziabad district under different cropping pattern were collected with thehelp of auger and stored in polythene bags. Collected soil sampleswere air dried in shade, crushed gently with a wooden roller andthen pass through 2.0 mm sieve to obtain a uniform representativesample. Samples were properly labeled with the aluminum tag andstored in polythene bags for analysis. The processed soil sampleswere analyzed by standard methods for cationic micronutrients (Fe, Mn , Cu and Zn) .The Class of cationic micronutrients of study area soilswas calculated using the formula suggested by Parker *et al* ,(1951) .The concentration of micronutrients was determined by atomicabsorption spectrophotometer (GBC Avanta PM). All the analysis ofsoil samples was carried out in the laboratory of Department of SoilScience, S.V.P.U.A&Tech, Meerut (U.P), India.

**RESULTS AND DISCUSSION**

Micronutrients distribution in soil samples collected from eighteen different locations of Muzaffarnagar, Meerut and Ghaziabad district from the left hand side of Ganga canal from 0 -15 and 15 -30 cm depth are described in this chapter

**Available Cationic Micronutrients**

**Available Copper**

DTPA-extractable available copper in the soil at various depths viz 0-15 and 15-30 cm of eighteen different locations was found to be sufficient 0.20 mg $kg^{-1}$soil. The data presented in Table-3 indicates that the DTPA-extractable Cu (mg $kg^{-1}$ soil) in surface (0-15) and sub surface (15-30cm) soils varied from 0.952 to 6.164 and 0.620 to 4.370 mg $kg^{-1}$soil, respectively. The maximum available Cu 6.164 mg $kg^{-1}$ soil in surface soil (0- 15 cm) was found in Belda location and minimum 0.952 mg $kg^{-1}$ soil in Milak (Sardhana) location. Similarly in sub surface (15- 30cm)soil maximum available Cu 4.370 mg $kg^{-1}$ soil was found in Belda location and minimum 0.482 mg $kg^{-1}$ soil in Milak (Sardhana), respectively. All the soil samples of eighteen different location were found to be sufficient in available Cu by considering the critical limit 0.20 mg $kg^{-1}$soil as suggested by Lindsay and Norvell (1978)( Table 5). A decreasing trend in available Cu content with increasing depth was noticed in all eighteen different locationswhich might be due to its association with organic carbon.The variation in the availability of Cu at surface (0-15) and subsurface (15-30) in various locations may be attributedto presence of Cu containing soils minerals. Similar results were reported by Meena*et al*., (2006), Leelavathi*et al.,* (2009) and Rajeswar*et al.,* (2009).

**Available Zinc**

The DTPA extractable available Zn estimated in soil of various depth viz. 0-15 and 15-30cm of eighteen different locations is shown in Table-3. The minimum and maximum value of available Zn in surface soil (0 – 15 cm) and sub surface soil (15 – 30 cm) ranged from 0.73 to 5.80 and 0.36 to 2.65 mg $kg^{-1}$ soil, respectively.

The maximum DTPA extractable available Zn5.80 mg $kg^{-1}$ soil in surface soil (0-15cm) was found in Jansath location and minimum 0.310 mg $kg^{-1}$ soil in Purkaji location. In case of sub surface soil (15-30cm) maximum DTPA extractable zinc 2.65 mg $kg^{-1}$ and minimum 0.36 mg $kg^{-1}$ soil was found in Jansath location. Considering critical levels suggested by Lindsay and Norvell (1978**)**24.00% samples were deficient ( < 0.6 mg $kg^{-1}$soil), 36.00% marginal (0.6 – 1.2 mg $kg^{-1}$ soil) and 40 % were sufficient (> 1.2 mg $kg^{-1}$soil )( Table 5). Similar results werealso reported by **Leelavathi*et al.,* (2009)**. The DTPA extractable Zn ranged from 0.86 to 1.30 mg $kg^{-1}$ soil in surface and 0.20 to 1.21 mg $kg^{-1}$ soil in sub surface horizons. The vertical distribution of Zn exhibited little variation with depth. Relatively high content of available Zn in surface horizons may be attributed to more complexion with organic carbon which resulted in chelation of Zn. Similar views were also expressed by Vankatesu*et al.,* (2002) and Rao*et al.,*(2008) in soils of Nellore district, Andhra Pradesh.

**Available Iron**

The DTPA- extractable Fe in soil at various depth viz. 0-15 and 15-30cm of eighteen different locations was found high. The data presented in Table-4 revealed that the DTPA extractable Fe in surface (0-15cm) as well as subsurface (15-30cm) varied from 8.24 to 113.30, 6.27 to 79.33 mg $kg^{-1}$ soil, respectively.

The highest available Fe content 113.30 mg $kg^{-1}$soil was found in Jouli location and minimum 8.24 mg $kg^{-1}$ soil at Aboopur location for surface soil (0-15cm) while maximum 7.93 mg $kg^{-1}$ soil at Jouli location and minimum 6.27 mg $kg^{-1}$ soil in Aboopur location for subsurface soil. According to the critical limit purposed by Lindsay and Norvell (1978) 96 percent surface soil sample (0-15cm) were sufficient in available Fe ((> 9.0 mg $kg^{-1}$soil) whereas 4.00 % samples were medium (4.5 – 9.0 mg $kg^{-1}$soil) .The amount of available Fe decreased with increasing soil depth( Table 5).The poor availability of iron in soils

may be attributed to slightly higher pH and lower organic carbon in the soils. The variability in the Fe containing minerals in soils may be another reason for the variable availability in soils.The surface soil contained more available Fe than these of the lower depth, which may partly be attributed to the higher organic carbon content of the surface soils as compared to subsurface soils. This finding also given by **Gupta *et al.,* (2003)** and similar observation were recorded by Rejeswar*et al.,* (2009).

**Available Manganese**

The data presented in Table -4 reveal that the DTPA extractable Mn in soil at various depths viz 0-15 and 15-30 cm in eighteen different locations was found sufficient to high because these values are well above the critical limit (1.0mg/kg) proposed by Lindsay and Norvell (1978). The maximum and minimum DTPA extractable Mn in surface (0-15 cm) and sub surface (15-30cm) varied from 8.42 to 90.82 and 6.27 to 57.82 mg $kg^{-1}$ soil. In surface soil (0-15cm) the maximum available Mn content 90.82 mg $kg^{-1}$ soil was found in BholaJhal location and minimum 8.92 mg $kg^{-1}$ soil in Aboopur. Maximum extractable Mn content 57.82 mg $kg^{-1}$ was found in sub surface soil of Nanglai location and minimum 6.27 mg $kg^{-1}$ in Aboopur.

According to critical limit purposed by Lindsay and Novell (1978) 99 percent soils were sufficient in available Mn((>7.0 mg $kg^{-1}$soil)whereas 1.0 % samples were marginal (3.5 -7.0 mg $kg^{-1}$soil) ( Table 5). The presence of higher organic carbon will increase microbial activity which is responsible for reduction of Mn and thereby increase availability. Organic compound released during the decomposition of organic matter may chelaet the Mn and thereby increasing the availability of Mn. Similar results were alsoreported by Verma*et al.,* (2008) and Gupta *et al.,* (2003).The available Mn in the soils varied from 0.80 to 14.5 mg $kg^{-1}$ with a mean value of 6.01 mg $kg^{-1}$ soil .The surface soils contained higher amount of available Mn which decreased with depth.

**Correlation Studies**

**1. Correlation among the Organic Matter and Different micronutrients in soils of different locations**

Correlation among the Organic Matter and Different micronutrientsof eighteen different locations i.e. Muzaffarnagar, Meerut and Ghaziabad district from two soil depthsviz 0-15 and 15-30 cm were also worked out and presented in Table-6 .Data presented in table shows that organic matter was positively and significantly related with available cationic micronutrients .

Among the cationic micronutrients copper was related much strongly with organic matter (r= +0.745) followed by iron (r= +0.653), Zinc (r= +0.459) and manganese (r= +0.266).These association showed that available copper, iron, zinc and manganese in these soil are largely influenced by organic carbon.

**2. Correlation among the pH and Different micronutrients in soils of different locations**

The statistical relationship between available micronutrients and soil pH was also worked out and presented in table 7. Data presented in table indicates that the soil pH was significantly and negatively correlated with Zn (r= - 0.293), Fe (r = - 0.503) and Mn (r= -0.301) whereas available Cu was not correlated with soil pH at any significance level. The soil pH is negatively correlated with availability of Cu ,Fe and Zn it is well documented that the availability of cationic micronutrient increased with increasing soil acidity therefore this relationship is well accept. A positive correlation between soil pH and available micronutrient may be related with increased biological activity with increasing soil pH thereby more reduction of different micronutrient and consequently more availability. Similar results were reported by Verma*et al.,* (2008), Sharma *et al.,* (2006), Meena*et al.,* (2006).

**CONCLUSION**

Distribution studies of Micronutrients in soil of left side of the Ganga canal, Uttar Pradesh, India flowing through Muzaffarnagar, Meerut and Ghaziabad districtindicates thatexcept Zn ,100% samples for Cu ,96 % for Fe and 99% for Mnwere sufficient while in case of Zn 24 % samples were found deficient ,36.00 % marginal and 40 % samples were found sufficient . A decreasing trend in availability of micronutrientswith increasing depth was noticed in all eighteen different locations.

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**Table: 1. The variability in pH and EC in soil profile at different location of study area .**

| S. No | Locations | Depth (cm) | pH of Soil at distance (m) from canal | | | | | EC ($dSm^{-1}$)of Soil at distance (m) from canal | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1000 | 2000 | 3000 | 4000 | 5000 | 1000 | 2000 | 3000 | 4000 | 5000 |
| 1 | Purkaji | 0-15 | 7.45 | 7.62 | 7.25 | 7.35 | 8.15 | 0.126 | 0.191 | 0.132 | 0.133 | 0.189 |
| | | 15-30 | 7.64 | 7.74 | 7.44 | 8.33 | 8.46 | 0.101 | 0.095 | 0.573 | 0.230 | 0.190 |
| 2 | Kamheda (TP) | 0-15 | 7.56 | 7.56 | 7.65 | 7.35 | 7.40 | 0.284 | 0.128 | 0.193 | 0.135 | 0.190 |
| | | 15-30 | 7.98 | 7.48 | 7.84 | 7.45 | 8.50 | 0.189 | 0.110 | 0.092 | 0.575 | 0.193 |
| 3 | Balda | 0-15 | 7.35 | 6.90 | 7.36 | 7.09 | 7.33 | 0.254 | 0.108 | 0.145 | 0.093 | 0.190 |
| | | 15-30 | 7.87 | 7.94 | 8.11 | 7.43 | 7.88 | 0.132 | 0.187 | 0.203 | 0.086 | 0.083 |
| 4 | Bhopa | 0-15 | 7.20 | 7.75 | 6.55 | 7.20 | 8.05 | 0.1909 | 0.138 | 0.187 | 0.108 | 0.670 |
| | | 15-30 | 7.68 | 8.25 | 6.93 | 8.17 | 8.23 | 0.105 | 0.081 | 0.109 | 0.132 | 1.10 |
| 5 | Jouli | 0-15 | 7.55 | 6.02 | 6.20 | 6.23 | 7.74 | 0.282 | 0.118 | 0.200 | 0.190 | 0.135 |
| | | 15-30 | 7.92 | 6.85 | 7.07 | 6.35 | 7.70 | 0.189 | 0.084 | 0.095 | 0.089 | 0.096 |
| 6 | Janshath | 0-15 | 7.10 | 7.15 | 6.72 | 7.42 | 7.31 | 0.210 | 0.124 | 0.135 | 0.214 | 0.196 |
| | | 15-30 | 7.23 | 7.74 | 7.22 | 7.79 | 7.62 | 0.289 | 0.073 | 0.081 | 0.091 | 0.259 |
| 7 | Tajpur | 0-15 | 7.47 | 7.52 | 7.93 | 7.45 | 7.50 | 0.128 | 0.211 | 0.350 | 0.346 | 0.39 |
| | | 15-30 | 7.74 | 7.86 | 8.11 | 7.84 | 7.77 | 0.125 | 0.157 | 0.313 | 0.226 | 0.267 |
| 8 | Khatauli | 0-15 | 8.18 | 7.85 | 6.98 | 7.98 | 8.39 | 0.284 | 0.209 | 0.069 | 0.384 | 0.376 |
| | | 15-30 | 8.32 | 8.02 | 7.36 | 8.08 | 8.17 | 0.248 | 0.226 | 0.108 | 0.101 | 0.186 |
| 9 | Kaili (Sakoti) | 0-15 | 7.31 | 7.57 | 7.25 | 7.4 | 7.8 | 1.07 | 0.794 | 0.746 | 0.791 | 0.893 |
| | | 15-30 | 7.45 | 7.85 | 7.30 | 7.52 | 7.76 | 0.429 | 0.413 | 0.310 | 0.617 | 0.390 |
| 10 | Milak (Sardhana) | 0-15 | 7.85 | 7.40 | 7.75 | 7.51 | 7.74 | 1.59 | 1.03 | 0.210 | 0.380 | 0.485 |
| | | 15-30 | 7.95 | 7.83 | 7.88 | 7.76 | 7.97 | 0.670 | 0.620 | 0.347 | 0.212 | 0.254 |
| 11 | Nanu (SP) | 0-15 | 7.61 | 7.31 | 7.60 | 7.67 | 7.74 | 0.460 | 0.462 | 0.338 | 0.337 | 0.255 |
| | | 15-30 | 8.44 | 7.57 | 7.80 | 7.85 | 8.05 | 0.472 | 0.209 | 0.201 | 0.150 | 0.248 |
| 12 | Pooth (Rohata) | 0-15 | 7.12 | 7.64 | 7.34 | 7.1 | 7.66 | 0.282 | 0.254 | 0.416 | 4.90 | 0.334 |
| | | 15-30 | 7.80 | 7.70 | 8.28 | 7.60 | 8.46 | 0.207 | 0.184 | 0.427 | 0.221 | 0.129 |
| 13 | Bhola (Jhal) | 0-15 | 6.15 | 6.83 | 7.60 | 7.78 | 8.05 | 0.109 | 0.914 | 0.664 | 1.77 | 0.876 |
| | | 15-30 | 7.12 | 7.45 | 7.75 | 8.30 | 8.45 | 0.442 | 0.369 | 0.806 | 0.939 | 0.655 |
| 14 | Jani | 0-15 | 8.07 | 8.22 | 7.70 | 8.49 | 8.17 | 1.10 | 1.10 | 0.568 | 0.743 | 1.04 |
| | | 15-30 | 8.20 | 8.92 | 8.13 | 8.50 | 8.48 | 0.890 | 0.543 | 0.734 | 0.737 | 0.630 |
| 15 | Nanglai | 0-15 | 6.18 | 8.20 | 9.05 | 6.90 | 7.45 | 1.31 | 0.910 | 2.50 | 0.431 | 0.395 |
| | | 15-30 | 7.30 | 8.23 | 9.56 | 7.38 | 7.72 | 0.438 | 0.743 | 2.08 | 0.482 | 0.422 |
| 16 | Niwari | 0-15 | 7.50 | 7.64 | 7.52 | 7.51 | 7.60 | 0.517 | 0.760 | 1.02 | 0.870 | 0.745 |
| | | 15-30 | 7.81 | 7.71 | 7.82 | 7.80 | 7.72 | 0.293 | 0.576 | 0.631 | 0.550 | 0.555 |
| 17 | Sonda | 0-15 | 8.15 | 8.02 | 8.0 | 7.9 | 8.1 | 1.02 | 1.102 | 0.501 | 0.561 | 0.762 |
| | | 15-30 | 8.69 | 8.52 | 8.3 | 8.6 | 8.4 | 0.04 | 0.470 | 0.391 | 0.415 | 0.381 |
| 18 | Aboopur | 0-15 | 8.2 | 8.1 | 8.3 | 7.8 | 6.8 | 0.451 | 0.401 | 0.345 | 0.386 | 0.594 |
| | | 15-30 | 8.5 | 8.7 | 8.6 | 8.22 | 7.5 | 0.360 | 0.330 | 0.288 | 0.398 | 0.214 |

**Table, 2 The variability in organic matter in soil profile at different location of study area.**

| S. No | Locations | Depth (cm) | Organic matter (g $kg^{-1}$ Soil) at distance (m) from canal | | | | |
|---|---|---|---|---|---|---|---|
| | | | 1000 | 2000 | 3000 | 4000 | 5000 |
| 1 | Purkaji | 0-15 | 12.118 | 13.448 | 14.630 | 10.345 | 11.232 |
| | | 15-30 | 8.128 | 8.128 | 8.424 | 6.650 | 7.684 |
| 2 | Kamheda (TP) | 0-15 | 13.004 | 13.891 | 11.231 | 12.118 | 15.221 |
| | | 15-30 | 7.389 | 9.015 | 6.798 | 8.424 | 9.606 |
| 3 | Balda | 0-15 | 14.778 | 13.005 | 12.709 | 11.970 | 13.744 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 15-30 | 9.754 | 8.276 | 10.197 | 6.946 | 9.015 |
| 4 | Bhopa | 0-15 | 11.970 | 10.197 | 12.562 | 9.310 | 9.0148 |
| | | 15-30 | 7.980 | 8.424 | 7.241 | 6.059 | 5.468 |
| 5 | Jouli | 0-15 | 10.936 | 11.084 | 11.970 | 11.232 | 9.754 |
| | | 15-30 | 8.424 | 8.719 | 9.0148 | 7.833 | 6.502 |
| 6 | Janshath | 0-15 | 11.231 | 9.310 | 10.493 | 12.414 | 11.084 |
| | | 15-30 | 7.389 | 6.650 | 7.537 | 9.015 | 6.355 |
| 7 | Tajpur | 0-15 | 8.128 | 8.424 | 7.833 | 7.241 | 11.527 |
| | | 15-30 | 6.059 | 7.241 | 3.695 | 4.581 | 5.764 |
| 8 | Khatauli | 0-15 | 9.606 | 8.424 | 12.562 | 14.926 | 13.300 |
| | | 15-30 | 6.502 | 5.764 | 9.015 | 8.571 | 6.650 |
| 9 | Kaili (Sakoti) | 0-15 | 13.448 | 11.379 | 13.153 | 8.867 | 11.527 |
| | | 15-30 | 9.901 | 7.2413 | 8.128 | 6.059 | 7.537 |
| 10 | Milak (Sardhana) | 0-15 | 9.015 | 10.197 | 8.424 | 11.970 | 11.232 |
| | | 15-30 | 6.650 | 6.650 | 5.320 | 7.833 | 7.241 |
| 11 | Nanu (SP) | 0-15 | 10.788 | 10.197 | 11.379 | 7.537 | 8.276 |
| | | 15-30 | 5.6156 | 7.537 | 7.832 | 5.320 | 5.764 |
| 12 | Pooth (Rohata) | 0-15 | 9.754 | 7.537 | 10.197 | 9.310 | 7.833 |
| | | 15-30 | 6.059 | 4.286 | 6.207 | 5.320 | 3.547 |
| 13 | Bhola (Jhal) | 0-15 | 11.084 | 9.015 | 12.266 | 9.163 | 8.276 |
| | | 15-30 | 6.946 | 4.877 | 5.616 | 5.911 | 6.946 |
| 14 | Jani | 0-15 | 7.094 | 6.946 | 9.015 | 9.458 | 6.502 |
| | | 15-30 | 4.434 | 4.138 | 5.764 | 6.059 | 3.399 |
| 15 | Nanglai | 0-15 | 7.537 | 7.241 | 7.537 | 8.128 | 6.946 |
| | | 15-30 | 4.434 | 4.138 | 5.025 | 5.025 | 5.172 |
| 16 | Niwari | 0-15 | 10.640 | 8.424 | 5.616 | 6.650 | 4.138 |
| | | 15-30 | 8.128 | 5.616 | 2.808 | 4.877 | 2.217 |
| 17 | Sonda | 0-15 | 4.138 | 4.729 | 9.458 | 8.571 | 10.049 |
| | | 15-30 | 2.217 | 2.069 | 7.093 | 5.764 | 6.946 |
| 18 | Aboopur | 0-15 | 10.197 | 8.128 | 6.798 | 11.675 | 7.685 |
| | | 15-30 | 5.911 | 4.581 | 4.286 | 9.901 | 5.468 |

**Table.3: Variability of DTPA-extractable copper and Zinc insoil profile at different location of study area.**

| S. No | Locations | Depth (cm) | DTPA-extractable copper (mg $kg^{-1}$) of Soil at distance (m) from canal | | | | | DTPA-extractable zinc (mg kg -1) of Soil at distance (m) from canal | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1000 | 2000 | 3000 | 4000 | 5000 | 1000 | 2000 | 3000 | 4000 | 5000 |
| 1 | Purkaji | 0-15 | 3.46 | 3.676 | 3.932 | 3.128 | 3.224 | 1.538 | 1.644 | 1.906 | 0.738 | 1.31 |
| | | 15-30 | 3.034 | 3.064 | 3.662 | 2.832 | 2.182 | 0.516 | 0.974 | 1.250 | 0.384 | 0.476 |
| 2 | Kamheda (TP) | 0-15 | 3.644 | 3.822 | 3.464 | 3.562 | 3.844 | 1.344 | 1.36 | 0.784 | 0.702 | 1.74 |
| | | 15-30 | 3.004 | 3.206 | 3.042 | 1.732 | 3.262 | 0.822 | 0.842 | 0.378 | 0.368 | 1.124 |
| 3 | Balda | 0-15 | 6.164 | 4.224 | 3.468 | 2.872 | 6.024 | 1.902 | 1.598 | 0.956 | 1.36 | 1.634 |
| | | 15-30 | 4.230 | 2.262 | 2.542 | 2.152 | 4.370 | 1.422 | 0.822 | 0.63 | 1.022 | 1.202 |
| 4 | Bhopa | 0-15 | 3.682 | 3.436 | 3.962 | 2.468 | 2.278 | 4.268 | 2.016 | 5.202 | 1.772 | 1.646 |
| | | 15-30 | 2.028 | 1.928 | 2.038 | 1.540 | 1.024 | 1.728 | 1.036 | 2.172 | 1.204 | 0.974 |
| 5 | Jouli | 0-15 | 3.072 | 3.748 | 5.104 | 4.644 | 2.184 | 0.768 | 1.648 | 2.248 | 1.876 | 0.73 |
| | | 15-30 | 2.256 | 2.794 | 4.282 | 3.544 | 1.904 | 0.526 | 0.732 | 1.652 | 0.972 | 0.454 |
| 6 | Janshath | 0-15 | 4.008 | 1.984 | 3.108 | 4.278 | 3.312 | 4.99 | 0.458 | 1.016 | 5.802 | 1.784 |
| | | 15-30 | 2.428 | 1.564 | 2.188 | 3.560 | 2.414 | 2.268 | 0.612 | 0.36 | 2.65 | 0.762 |
| 7 | Tajpur | 0-15 | 1.838 | 2.366 | 1.8 | 1.636 | 2.428 | 1.258 | 1.02 | 0.76 | 0.748 | 1.338 |
| | | 15-30 | 1.802 | 1.832 | 1.360 | 1.316 | 1.854 | 0.712 | 0.646 | 0.572 | 0.484 | 0.842 |
| 8 | Khatauli | 0-15 | 2.508 | 2.648 | 2.826 | 4.954 | 3.178 | 0.672 | 0.68 | 1.15 | 1.636 | 1.242 |
| | | 15-30 | 1.300 | 1.746 | 2.016 | 3.332 | 2.040 | 0.332 | 0.444 | 0.720 | 0.804 | 0.954 |
| 9 | Kaili (Sakoti) | 0-15 | 4.164 | 3.738 | 4.86 | 1.944 | 1.904 | 1.86 | 1.004 | 1.972 | 1.058 | 1.16 |
| | | 15-30 | 2.312 | 2.278 | 2.852 | 1.240 | 0.852 | 1.270 | 0.518 | 1.35 | 0.374 | 0.764 |
| 10 | Milak (Sardhana) | 0-15 | 1.248 | 1.674 | 0.952 | 1.842 | 4.56 | 1.082 | 1.374 | 0.79 | 1.766 | 1.188 |
| | | 15-30 | 0.694 | 1.246 | 0.482 | 1.346 | 3.112 | 0.408 | 0.516 | 0.360 | 0.756 | 0.460 |
| 11 | Nanu (SP) | 0-15 | 2.752 | 2.266 | 2.944 | 1.784 | 2.276 | 2.164 | 1.308 | 3.032 | 0.416 | 1.3 |
| | | 15-30 | 1.974 | 1.628 | 2.220 | 1.364 | 1.932 | 0.980 | 0.542 | 1.250 | 0.220 | 0.408 |
| 12 | Pooth (Rohata) | 0-15 | 1.92 | 1.308 | 2.242 | 1.508 | 1.43 | 1.72 | 0.656 | 2.1 | 1.524 | 1.442 |
| | | 15-30 | 1.286 | 1.214 | 1.892 | 1.282 | 0.620 | 0.904 | 0.520 | 1.314 | 0.818 | 0.788 |
| 13 | Bhola (Jhal) | 0-15 | 1.896 | 1.704 | 2.448 | 1.636 | 1.464 | 1.66 | 1.218 | 1.772 | 1.512 | 0.89 |
| | | 15-30 | 1.730 | 1.538 | 2.158 | 1.310 | 0.938 | 0.898 | 0.606 | 1.204 | 0.864 | 0.460 |
| 14 | Jani | 0-15 | 2.042 | 2.3 | 2.788 | 4.066 | 1.556 | 1.552 | 1.034 | 1.742 | 3.61 | 0.98 |
| | | 15-30 | 1.076 | 1.002 | 1.328 | 1.708 | 0.964 | 0.884 | 0.782 | 1.286 | 2.013 | 0.570 |
| 15 | Nanglai | 0-15 | 2.788 | 2.042 | 1.326 | 4.066 | 3.45 | 1.788 | 1.714 | 1.768 | 1.834 | 1.204 |
| | | 15-30 | 1.762 | 1.322 | 0.992 | 2.492 | 1.794 | 1.168 | 0.966 | 1.130 | 1.342 | 0.850 |
| 16 | Niwari | 0-15 | 4.292 | 2.68 | 1.914 | 2.008 | 2.078 | 1.814 | 1.77 | 1.644 | 1.612 | 1.17 |
| | | 15-30 | 1.996 | 1.786 | 1.376 | 1.402 | 1.368 | 1.200 | 1.016 | 0.980 | 0.648 | 0.378 |
| 17 | Sonda | 0-15 | 1.016 | 1.254 | 1.774 | 1.32 | 1.764 | 1.512 | 1.63 | 1.988 | 1.958 | 2.042 |
| | | 15-30 | 0.798 | 0.842 | 1.376 | 1.020 | 1.282 | 0.698 | 0.896 | 1.242 | 1.080 | 1.742 |
| 18 | Aboopur | 0-15 | 2.45 | 1.82 | 1.804 | 2.494 | 1.99 | 1.246 | 0.744 | 0.662 | 1.358 | 1.196 |
| | | 15-30 | 1.586 | 1.480 | 1.302 | 2.024 | 1.580 | 0.95 | 0.447 | 0.296 | 1.042 | 0.702 |

**Table.4: Variability of DTPA-extractable iron and manganese in soil profile at different location of study area.**

| S. No | Locations | Depth (cm) | DTPA-extractable iron (mg kg$^{-1}$) of Soil at distance (m) from canal | | | | | DTPA-extractable manganese (mg kg -1) of Soil at distance (m) from canal | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **1000** | 2000 | 3000 | 4000 | 5000 | 1000 | **2000** | **3000** | **4000** | **5000** |
| 1 | Purkaji | 0-15 | 34.268 | 38.536 | 57.8 | 11.232 | 25.41 | 21.64 | 21.696 | 34.2 | 10.998 | 11.89 |
| | | 15-30 | 24.480 | 29.550 | 33.564 | 10.334 | 20.044 | 15.224 | 15.990 | 16.620 | 7.882 | 8.468 |
| 2 | Kamheda (TP) | 0-15 | 41.64 | 70.782 | 26.26 | 41.506 | 77.6 | 33.024 | 33.578 | 30.214 | 22.642 | 38.03 |
| | | 15-30 | 22.326 | 30.060 | 16.598 | 22.028 | 36.084 | 20.422 | 22.046 | 21.640 | 15.042 | 26.116 |
| 3 | Balda | 0-15 | 70.42 | 58.212 | 56.724 | 51.034 | 66.416 | 38.572 | 34.252 | 23.92 | 19.472 | 29.378 |
| | | 15-30 | 56.136 | 39.430 | 39.816 | 26.286 | 44.426 | 23.780 | 23.448 | 19.798 | 17.180 | 21.018 |
| 4 | Bhopa | 0-15 | 72.026 | 52.034 | 82.66 | 26.582 | 28.45 | 27.138 | 20.864 | 29.08 | 19.564 | 10.272 |
| | | 15-30 | 36.402 | 29.480 | 48.242 | 17.538 | 19.558 | 18.920 | 16.656 | 24.298 | 16.218 | 9.442 |
| 5 | Jouli | 0-15 | 39.44 | 91.9 | 113.13 | 72.824 | 16.074 | 22.530 | 35.812 | 24.380 | 26.432 | 24.492 |
| | | 15-30 | 24.750 | 66.430 | 79.326 | 49.082 | 11.350 | 13.052 | 29.578 | 14.560 | 18.512 | 17.244 |
| 6 | Janshath | 0-15 | 50.308 | 28.798 | 45.9 | 68.95 | 48.036 | 32.57 | 16.9 | 18.852 | 45.046 | 22.11 |
| | | 15-30 | 34.962 | 20.052 | 20.624 | 47.870 | 30.190 | 20.680 | 10.480 | 14.944 | 30.248 | 20.308 |
| 7 | Tajpur | 0-15 | 24.636 | 26.358 | 24.51 | 11.768 | 27.03 | 27.042 | 19.286 | 28.624 | 17.486 | 18.932 |
| | | 15-30 | 18.566 | 13.156 | 18.640 | 12.362 | 8.858 | 20.422 | 13.442 | 20.588 | 10.250 | 12.630 |
| 8 | Khatauli | 0-15 | 35.7 | 28.362 | 37.79 | 88.99 | 47.38 | 25.256 | 15.040 | 51.442 | 21.398 | 33.614 |
| | | 15-30 | 24.502 | 19.038 | 24.984 | 41.780 | 25.956 | 16.854 | 13.256 | 37.210 | 14.420 | 23.042 |
| 9 | Kaili (Sakoti) | 0-15 | 69.3 | 56.5 | 65.9 | 20.582 | 64.9 | 39.242 | 30.524 | 39.024 | 19.424 | 29.046 |
| | | 15-30 | 51.560 | 30.520 | 44.216 | 17.140 | 33.556 | 30.406 | 20.472 | 22.816 | 13.106 | 18.842 |
| 10 | Milak (Sardhana) | 0-15 | 15.772 | 16.242 | 14.072 | 37.5 | 18.622 | 16.24 | 16.938 | 24.514 | 10.438 | 12.420 |
| | | 15-30 | 10.682 | 13.432 | 8.502 | 24.636 | 14.626 | 11.938 | 12.42 | 18.514 | 7.24 | 10.438 |
| 11 | Nanu (SP) | 0-15 | 40.236 | 20.872 | 49.112 | 12.968 | 17.402 | 18.932 | 28.624 | 27.042 | 19.286 | 17.486 |
| | | 15-30 | 17.838 | 17.258 | 18.452 | 8.804 | 9.060 | 13.636 | 24.592 | 20.182 | 17.406 | 11.968 |
| 12 | Pooth (Rohata) | 0-15 | 20.958 | 12.802 | 81.824 | 19.826 | 17.922 | 23.112 | 14.852 | 24.38 | 23.456 | 20.15 |
| | | 15-30 | 14.050 | 8.642 | 43.622 | 13.024 | 12.392 | 17.086 | 11.694 | 20.51 | 18.108 | 12.426 |
| 13 | Bhola (Jhal) | 0-15 | 34.412 | 19.278 | 50.79 | 23.048 | 12.214 | 72.472 | 44.988 | 90.82 | 61.046 | 17.26 |
| | | 15-30 | 26.930 | 12.796 | 41.906 | 15.524 | 11.458 | 44.314 | 30.558 | 51.442 | 38.650 | 13.122 |
| 14 | Jani | 0-15 | 18.684 | 18.214 | 20.65 | 22.898 | 17.592 | 32.502 | 24.95 | 32.262 | 52.512 | 20.428 |
| | | 15-30 | 14.030 | 12.158 | 14.650 | 17.366 | 11.120 | 27.774 | 19.152 | 23.160 | 32.284 | 16.002 |
| 15 | Nanglai | 0-15 | 61.5 | 21.506 | 52.568 | 94.31 | 15.308 | 53.580 | 70.304 | 33.006 | 89.512 | 28.280 |
| | | 15-30 | 38.540 | 17.426 | 32.820 | 54.680 | 10.930 | 43.458 | 51.390 | 22.700 | 57.820 | 22.114 |
| 16 | Niwari | 0-15 | 109.86 | 38.72 | 19.332 | 25.446 | 14.896 | 71.602 | 33.762 | 21.158 | 32.82 | 16.312 |
| | | 15-30 | 64.700 | 19.382 | 12.464 | 14.578 | 11.850 | 34.95 | 22.728 | 14.058 | 23.930 | 11.994 |
| 17 | Sonda | 0-15 | 13.998 | 10.2 | 20.026 | 20.732 | 26.736 | 21.156 | 30.116 | 27.424 | 29.558 | 19.942 |
| | | 15-30 | 9.474 | 8.984 | 14.532 | 15.786 | 18.386 | 15.392 | 22.910 | 17.214 | 17.764 | 13.642 |
| 18 | Aboopur | 0-15 | 21.64 | 18.362 | 8.242 | 22.594 | 17.528 | 21.430 | 17.528 | 8.424 | 12.362 | 21.64 |
| | | 15-30 | 13.488 | 13.034 | 6.266 | 15.224 | 12.064 | 13.488 | 12.064 | 6.266 | 9.034 | 15.224 |

**Table:5. Classification of soil of study area on the basis of cationic Micronutrients.**

| SN | Name of Nutrient | Percent sample | | | Critical Limit (mg kg$^{-1}$ soil ) | | |
|---|---|---|---|---|---|---|---|
| | | **Deficient** | **Marginal** | **Sufficient** | **Deficient** | **Marginal** | **Sufficient** |
| 1 | Copper | - | - | 100 | < 0.2 | 0.2 - 0.4 | > 0.4 |
| 2 | Zinc | 24.00 | 36.00 | 40 | < 0.6 | 0.6 –1.2 | > 1.2 |
| 3 | Fe | - | 4.00 | 96 | < 4.5 | 4.5 – 9.0 | > 9.0 |
| 4 | Mn | - | 1 | 99 | < 3.5 | 3.5 – 7.0 | > 7.0 |

**Table: 6. Correlation studies between OM to DTPA extractable micronutrients under differentlocation of study area.**

| Locations | OM to DTPA extractable micronutrients | | | |
|---|---|---|---|---|
| | **Zn** | **Cu** | **Fe** | **Mn** |
| OM | 0.459448 | 0.745 | 0.653 | 0.266 |

**Table: 7.Correlation study between pH to DTPA extractable micronutrients under different locations (all value of different locations)**

| Locations | pH to DTPA extractable micronutrients | | | |
|---|---|---|---|---|
| | **Zn** | **Cu** | **Fe** | **Mn** |
| pH | -0.293 | -0.108 | -0.503 | -0.301 |

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