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Assessment of Physicochemical Characteristics of Soils and its Correlation with Bulk Density

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Abstract: The crops production is main objective in agriculture field and it depends on fertility status of soils. The chemical analysis of soils is important tools to determine fertility status of soils. The present work deals with study of characterization of physical parameters, availability macronutrients, micronutrients and their correlation with bulk density of soil samples. Total nine samples were collected from Chandrapur city and analyzed for temperature, moisture content, bulk density, water holding capacity, electrical conductivity, PH, organic carbon, organic matter, available nitrogen, phosphorous, potassium, manganese, zinc, copper and iron. The result shows fluctuation in soil parameters. Some parameters were in sufficient level and some parameters were either deficient or above reference range.

Keyword: Physicochemical analysis of soil, soil quality, correlation study and bulk density

1. INTRODUCTION

The soil is store house of nutrients which provides nutrients to the plant for their normal growth and good crop yield[1-4]. Now a day's farmer overused chemical fertilizers in farming to get maximum production and good economic benefits. The continuous use of field for production and excessive use of chemical fertilizers fluctuates available nutrients level. Such activities gives improper plant growth, cell elongation, alteration in physiological process in plant that reduces quality of food grains and even production[5].Therefore evaluation of available micro and macro nutrients is important aspect in agricultural field before crop production and after crop production. In order to understand sufficiency or deficiency of soil nutrients, physicochemical analysis of soil samples and their correlation with almost dependent parameter is required[6-7]. The bulk density influences fertility and productivity of soil by affecting infiltration, root penetration, moisture content, water holding capacity, soil porosity, nutrient availability and microbial activity[8]. In view of this, present work deals with study of status of available micro and macro nutrients and their relation with bulk density in north Chandrapur city, Maharashtra (India).

2. MATERIALS AND METHODS

To characterize available nutrients status in soil, total nine samples were collected from different sites north Chandrapur city and named as site1, site 2, site 3, site 4, site 5, site 6, site 7, site 8 and site 9. The soils were collected at 0-10 cm depth, dried, crushed and grinded in ceramic mortar. They were screened by passing through a two mm sieve to remove stones and plant residue. They were then passed through a twenty mesh sieve to obtain fine powder. They were packed clean and pre dried polyethylene bottles and brought into laboratory for chemical analysis. The moisture content in soils were determined by drying samples in oven at 100^0C to constant weight. The WHC were measured by method given by P. K. Gupta. The 20% (w/v) aqueous solution of soils were prepared, filtered and measured PH and EC by PH meter and conductometer respectively. The OC were estimated by Wet digestion method given by Walkley and Black. The OM were determined by multiplying available OC by 1.72 factor. Nitrogen content in soils were determined by Kjeldahl method given by Jackson (1958) and Bremner (1982). Available phosphorus were determined by Bray's method. The macro nutrients Zn, Mn, Cu and Fe were determined by atomic absorption spectrophotometer. The soils were categorized as low, medium and high fertility status **(Table 1)** on the basis of availability of nutrients. The relationship between different soil parameters and bulk density were determined by using correlation coefficient formula

$$r = \frac{n\sum xy - \sum x\sum y}{\sqrt{n\sum x^2 - \left(\sum x\right)^2}\sqrt{n\sum y^2 - (y)^2}}$$

Where r= correlation coefficient and shows strength of relation between x and y of given samples, x and y are two pairs of data and n= number of pair of data

Table 1: Rating of soil fertility			
Remark of soil on the basis of PH			
Highly acidic	**Medium**	**Slightly acidic**	**Neutral**
<5.5	5.5-6.0	6.0-6.5	6.5-7.5
Remark of soil on the basis of EC			
<1*	1-2**	2-3#	>3##
Criteria	**Low**	**Medium**	**High**
OC (%)	< 0.5	0.50-0.75	> 0.75
N (Kg/Ha)	< 280	280-560	> 560
P (Kg/Ha)	< 10	10-24.6	> 24.6
K(Kg/Ha)	< 108	108-280	> 280
Cu (PPM)	< 0.2	0.2-0.4	> 0.4
Fe (PPM)	< 0.6	0.6-1.2	> 1.2
Mn (PPM)	< 4.5	4.5-9	> 9
Zn (PPM)	< 3.5	3.5-7	> 7
* No deleterious effect on soil, ** Critical for germination, # Critical for salt sensitive crops, ## Injurious to most of crops			

3. RESULT AND DISCUSSION

The analytical data of all soil samples for characterization of physicochemical parameters and availability of micro and macronutrients are presented in **Table 2**.

3.1 Assessment of physicochemical properties of soil: The temp of soils is recorded at collection site and found to have normal range. The bulk density of soil samples were ranged from 1.18-1.36 g/cm^3***Fig. 1.1***. The water holding capacity of soil is measure of quantity of water retained by soils. In the present study, WHC of soil samples were ranged from 38.9-48.6 % ***Fig. 1.2***. The texture of soils were varied from 0.32-0.46 mm **Fig. 1.3**.The moisture content in soil is measure of water present in soil samples. It nourishes nutrients to plant through water present in soil found to vary from 6.72 to 8.62 % ***Fig. 1.4***.The PH measures hydrogen ion concentration in soil and used to predict acidic, basic or neutral behavior of soil. It affect availability of nutrients in the soil[9]. The PH values of soil in present work were varied from7.26 to 7.84 ***Fig. 1.5***. All the soils were alkaline in nature. The electrical conductivity of soil measures salinity of soil. The electrical conductivity of soil water suspension were ranged from 1.20 to 5.28 msm^{-1}***Fig. 1.6***. It was observed that all soils were found to have high electrical conductivity. Sample collected from site 3 have unexpected high conductivity. The OC and OM affects soil fertility, water holding capacity, water infiltration, root penetration and decreases soil erosion and influence power of holding CO_2 in atmosphere[10]. The organic carbon in soil is related with organic matter. Thus more is organic carbon more is organic matter. The organic carbon in soils in present work were varied from 0.140 to 0.478 % ***Fig. 1.7***. All soils were severely deficient in organic carbon. The organic matters in soils behaving as storehouse of nutrients for plant. All soils were found to have poor organic matter having 0.240 to 0.822 % range ***Fig. 1.8***.

3.2 Available macronutrients of soils: The macronutrients are needed for plant growth. Most of Indian soil are nitrogen deficient. The nitrogen is basic nutrient and it forms amino acids, proteins, chlorophyll, alkaloid and protoplasm of plants[11]. The deficiency of nitrogen turns leaves of plant to small yellow color which declines photosynthesis resulting low production. The available nitrogen in present study were varied from 78 to 334 kg/hector ***Fig. 1.9***. The phosphorous is key nutrient for plant and required for cell division, root growth, fruit formation and ripening of fruit[12]. The phosphorus present in soils were ranged from 12.3 to 28.2 kg/hector ***Fig.1.10***. The potassium is important for plant growth. It catalyzes enzymes in physiological process. It controls water economy and provides immunity from pests, disorders and environmental stresses[13]. The potassium level in soils under study were higher than reference value. It may be due to overuse of chemical fertilizers. The range of potassium in soils were varied from 217 to 403 kg/hector ***Fig.1.11***.

3.3 Available micronutrients of soils. From chemical analysis, all soils were rich in copper content and observed in range of0.26-0.92 ppm ***Fig. 1.12***. The manganese and zinc in all soils were sufficient and their range were varied from 2.11-2.84 ppm (***Fig. 1.13*** and 0.21 to 0.47 ppm ***Fig. 1.14***) respectively. The iron content in soil sample were sufficient and occurs in the range of 3.92 to 4.82 PPM (***Fig. 1.15***).

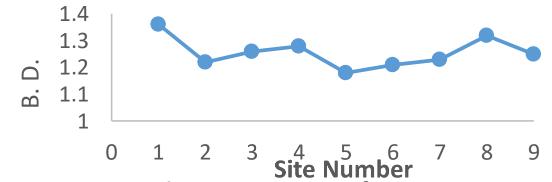

Fig. 1.1 *Variation of B. D.*

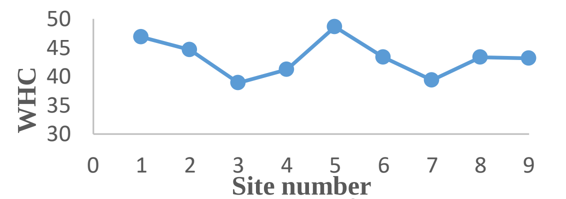

Fig. 1.2 *Variation of WHC*

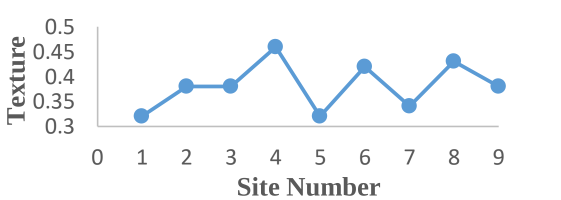

Fig. 1.3 *Variation of texture*

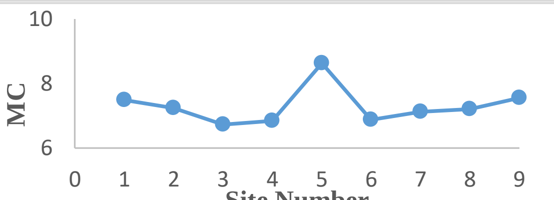

Fig. 1.4 *Variation of Moisture*

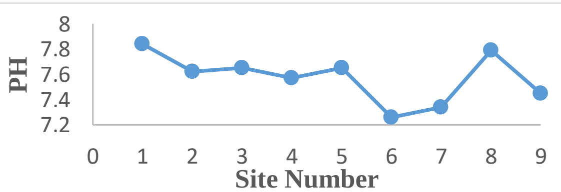

Fig. 1.5 *Variation of PH*

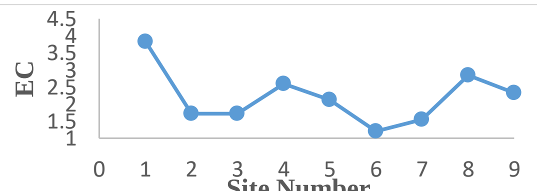

Fig. 1.6 *Variation of EC*

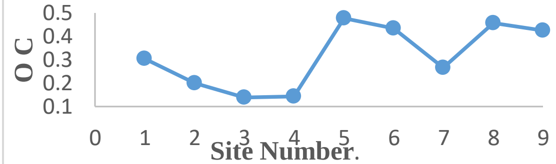

Fig. 1.7 *Variation of OC*

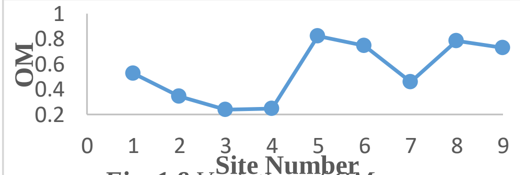

Fig. 1.8 *Variation of OM*

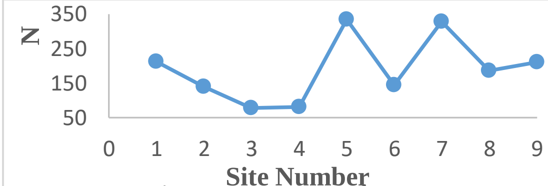

Fig. 1.9 *Variation of Nitrogen*

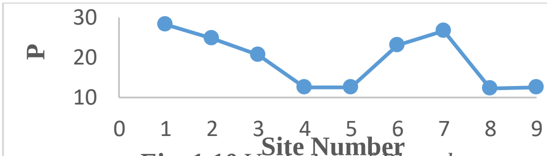

Fig. 1.10 *Variation of Phosphorus*

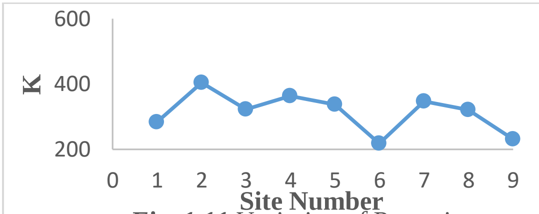

Fig. 1.11 *Variation of Potassium*

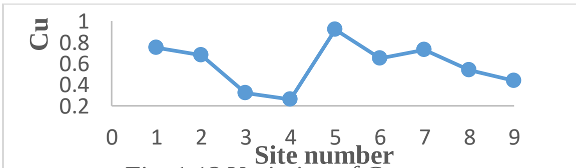

Fig. 1.12 Variation of Copper

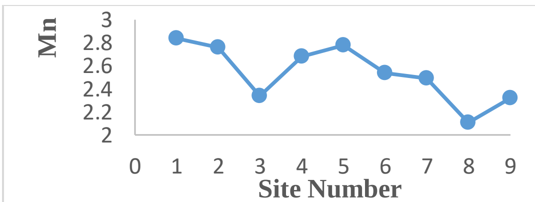

Fig. 1.13 *Variation of Mangnese*

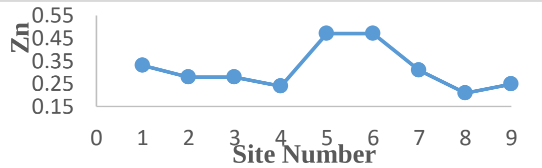

Fig. 1.14 *Variation of Zinc*

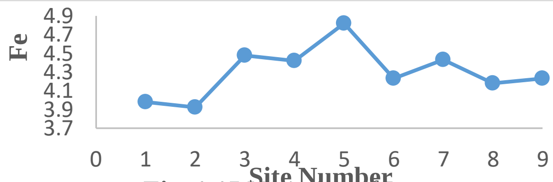

Fig. 1.15 *Variation of Iron*

4. CORRELATION STUDY

The correlation coefficient (r) between bulk density (x) and soil parameters (y) is discussed as follows. Positive r values indicates both (x) and (y) shows positive relation and negative r values indicates that one parameter increases and other decreases and vice versa.

4.1. The relation between bulk density and physicochemical parameter like Texture, Water holding capacity, Moisture content, PH, Electrical conductivity, Organic carbon and Organic matter: It was found positive correlation between bulk density and soil texture (r=0.119164; ***Fig. 2.1***). Water holding capacity and moisture content of soils were showed negative correlation with bulk density (***Fig. 2.2*** and ***Fig. 2.3***). The statistical study of bulk density with PH and electrical conductivity reveals strong positive correlation (r=0.636396; ***Fig. 2.4*** and r=0.55; ***Fig 2.5***). It was observed that poor positive correlation between bulk density and organic carbon (r=0.0262; ***Fig.2.6***) and organic matter (r=0.162173; ***Fig. 2.7***) of soils.

4.2. The relationship between bulk density and macronutrients

In the present study, we have studied linear relation between bulk density and available nitrogen, phosphorus and potassium. It was observed that available nitrogen and pottassium in soil decreases with bulk density(r=-0.276948; ***Fig. 2.8*** and ; r= -0.089443; ***Fig. 2.10***. However availability of phosphorus found to increases with bulk density (r=0.100995; ***Fig. 2.9***).

4.3. The relationship between bulk density and micronutrients

The correlation of bulk density with available micronutrients have been studied. We found strong negative correlation of bulk density with available micronutrients. (Manganese, r= -0.154919; ***Fig. 2.11***, Zinc, r= -0.568155; ***Fig. 2.12***, Copper, r=-0.301828; ***Fig. 2.13*** and iron,r= -0.507642; ***Fig. 2.14***).

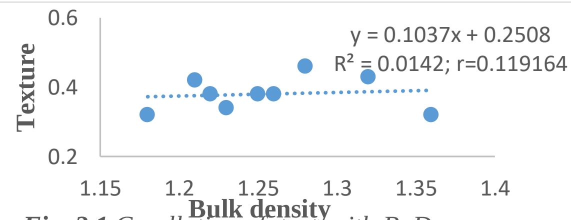

Fig. 2.1 *Corellation of text. with B. D.*

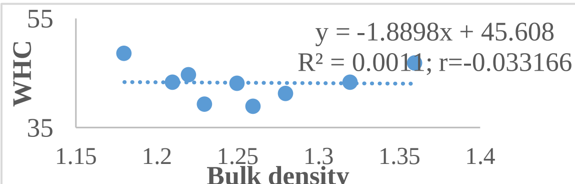

Fig. 2.2 *Corellation of WHC with B. D.*

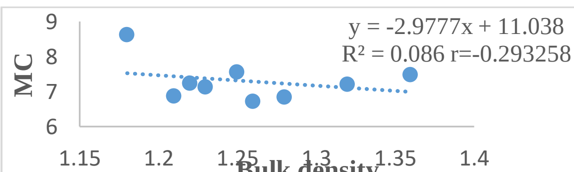

Fig. 2.3 *Corellation of M C with B. D.*

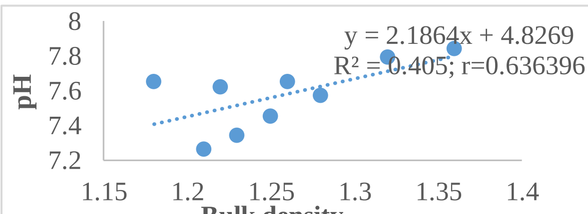

Fig. 2.4 *Corellation of PH with B. D.*

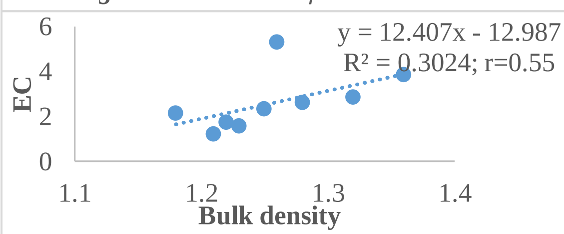

Fig. 2.5 *Corellation of E C with B. D.*

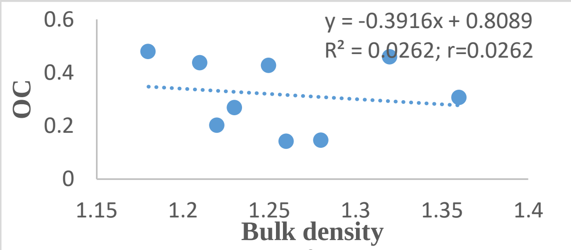

Fig. 2.6 *Corellation of O C with Bulk density*

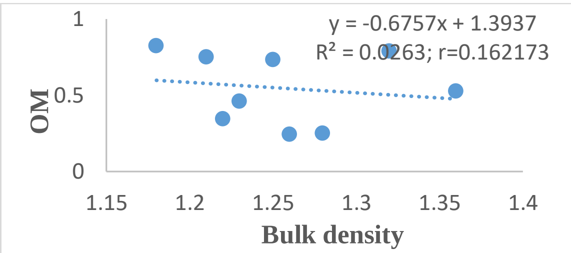

Fig. 2.7 *Corellation of E C with B. D.*

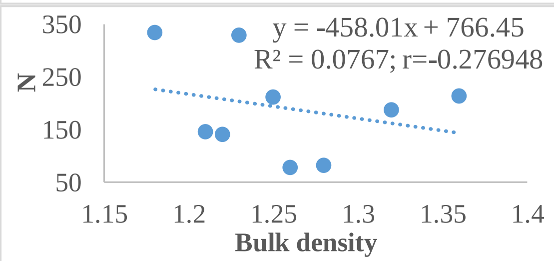

Fig. 2.8 *Corellation of N with B. D.*

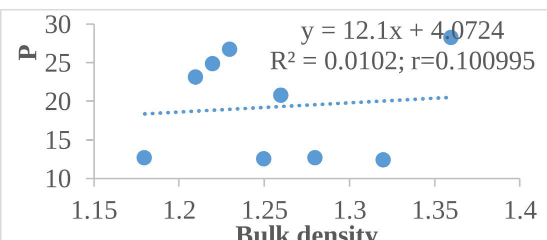

Fig. 2.9 *Corellation of P with B. D.*

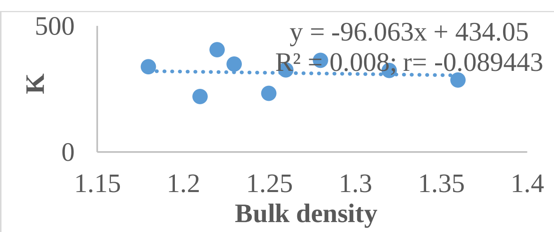

Fig. 2.10 *Corellation of K with B. D.*

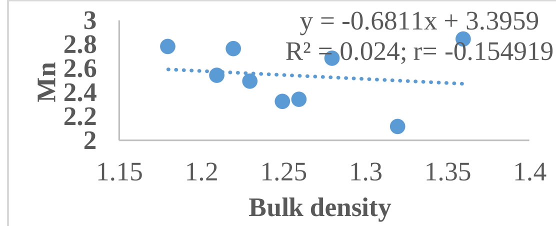

Fig. 2.11 *Corellation of Mn with B. D.*

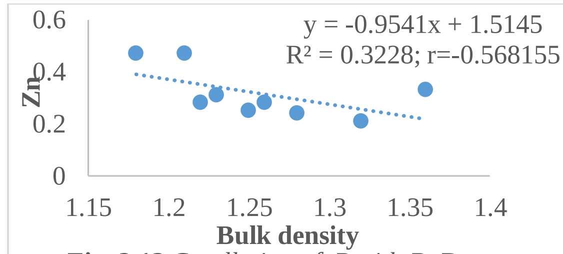

Fig. 2.12 *Corellation of P with B. D.*

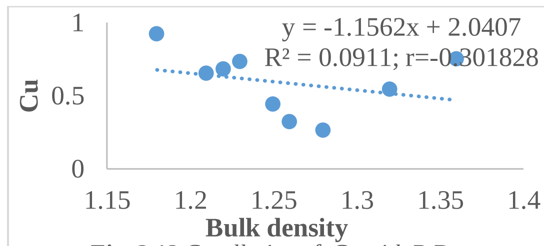

Fig. 2.13 *Corellation of Cu with B D.*

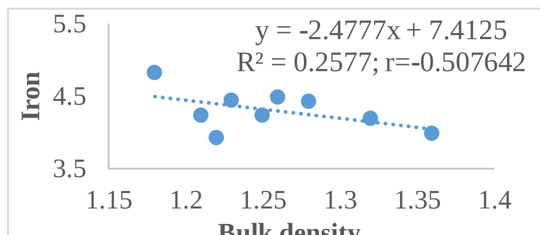

Fig. 2.14 *Corellation of Fe with B. D.*

5. CONCLUSION

The chemical study in present work reveals that soil criteria varies randomly. The PH of soil were alkaline in nature. The EC of soils were higher than reference range due to accumulation of salts and poor water drainage. The organic carbon and organic matter, available nitrogen and potassium were deficient in soil samples may be due to continuous use of field for agriculture and poor management of organic manure and chemical fertilizers application. All soils have sufficient available manganese, zinc, copper and iron. The positive correlation is observed between bulk density and texture, PH, electrical conductivity, organic carbon and organic matter, available phosphorous whereas water holding capacity, Moisture content, available nitrogen, potassium, manganese, zinc, copper and iron shows negative correlation.

6. ACKNOWLEDGEMENT

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Table 2: Physicochemical analysis of soil samples

Criteria	**Units**	**Soil collected from different site**								
		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Temp.	^0C	28	26	27	25	25	26	29	26	25
MC	%	7.48	7.24	6.72	6.84	8.62	6.87	7.12	7.21	7.56
BD	g/cm^3	1.36	1.22	1.26	1.28	1.18	1.21	1.23	1.32	1.25
Text.	mm	0.32	0.38	0.38	0.46	0.32	0.42	0.34	0.43	0.38
WHC	%	46.8	44.6	38.9	41.2	48.6	43.3	39.3	43.3	43.1
PH	--	7.84	7.62	7.65	7.57	7.65	7.26	7.34	7.79	7.45
EC	msm^{-1}	3.83	1.71	5.28	2.59	2.13	1.2	1.54	2.84	2.32
OC	%	0.305	0.200	0.140	0.144	0.478	0.435	0.267	0.457	0.425
OM	%	0.524	0.344	0.240	0.247	0.822	0.748	0.459	0.786	0.731
N	Kg/Ha	213	140	78	82	334	145	328	187	211
P	Kg/Ha	28.2	24.8	20.7	12.6	14.4	23.1	26.7	12.3	12.5
K	Kg/Ha	282	403	322	362	336	217	346	321	231
Mn	ppm	2.84	2.76	2.34	2.68	2.78	2.54	2.49	2.11	2.32
Zn	ppm	0.33	0.28	0.28	0.24	0.47	0.35	0.31	0.21	0.25
Cu	ppm	0.75	0.68	0.32	0.26	0.92	0.65	0.73	0.54	0.44
Fe	ppm	3.98	3.92	4.48	4.42	4.82	4.23	4.43	4.18	4.23

Abbreviations: WHC= Water holding capacity, MC= Moisture content, Text. = Texture, EC= Electrical conductivity, BD=bulk density, Temp.= Temperature, Kg/Ha=Kg/Hector, N=Nitrogen, P=Phosphorus, K=Potassium, Mg=Magnesium, Zn=Zinc, Cu=Copper, Fe=Iron