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SOIL FERTILITY STATUS OF PUNJAB AGRICULTURAL UNIVERSITY SEED FARM, CHAK RULDU SINGH WALA, SANGAT, BATHINDA, PUNJAB

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ABSTRACT

Fertility status of soil and their correlation study was carried out for PAU seed farm located at Chak Ruldu Singh Wala, Sangat, Bathinda. In surface (0-15cm) soils, the value of pH ranged from 8.3 to 8.5 with a mean value of 8.3. The pH value increased in sub surface soil (15-30 cm) across the sites and varied from 8.2 to 8.6 with a mean value of 8.5. The EC varied from 0.16 to 0.26 and 0.11 to 0.25 dSm^{-1} with mean values of 0.19 and 0.17 dSm^{-1} in surface and sub-surface soils, respectively. Organic carbon content in surface soils ranged form 3.2 to 8.7 g kg^{-1} with an average value of 4.9 g kg^{-1} and decreased with increase in soil depth. Available P content varied from 17.5 to 21.5 kg ha^{-1} in surface and 12.5 to 14.5 kg ha^{-1} in sub-surface soils with average values of 19.9 and 13.9 kg ha^{-1}, respectively. Status of available K in the soils ranged from 220 to 610 kg ha^{-1} with an average of 404 kg ha^{-1} in upper layer; however, it varies from 195 to 510 kg ha^{-1} with an average of 326 kg ha^{-1} in lower layers. The DTPA –extractable Fe, Cu, Zn and Mn concentration varied from 10.55 to 13.02, 0.58 to 1.34, 2.44 to 3.45 and 6.42 to 8.75 mg kg^{-1} with mean values of 11.9, 0.99, 3.10 and 7.78 mg kg^{-1} in upper layer. DTPA-extractable Fe, Cu, Zn and Mn showed decreasing trends with increase in soil depth and ranged from 5.25 to 6.25, 0.25 to 0.95, 1.11 to 1.88 and 3.56 to 4.66 mg kg^{-1} with mean value of 5.8, 0.44, 1.51 and 4.09 mg kg^{-1} in lower layers. The available P had significantly negative correlation ($r = -0.466$, $P< 0.05$), ($r = -0.461$, $P< 0.05$) with pH and EC respectively. A significantly and positive correlation ($r = 0.468$, $P< 0.05$) of available P was recorded with organic carbon. A significant and positive correlation of available K was reported between organic carbon ($r = 0.573$, $P< 0.05$) and EC ($r = 0.487$, $P< 0.05$). The available K showed negative and non-significant correlation with pH ($r = -0.218$, $P< 0.05$). The DTPA – extractable Fe, Cu, Zn and Mn did not reveal any significant relationship with soil pH and electrical conductivity (EC), however significantly positive correlation ($r= 0.487$, $P< 0.05$), ($r= 0.545$, $P< 0.05$), ($r=0.578$, $P< 0.05$) and ($r= 0.593$, $P< 0.05$) was recorded with organic carbon for Fe, Cu, Zn and Mn respectively.

Key Words: Soil fertility, phosphorus, potassium, iron, copper, zinc, manganese.

INTRODUCTION

Role of balanced plant nutrition is well-established for sustainable agricultural production. Present agricultural systems are exploitive of nutrients through intensive tillage, mono-cropping year after year, use of high yielding varieties, imbalanced use of nutrients coupled with limited use of organic manures, less recycling and burning of crop residues, soil erosion, undulating topography and indiscriminate use of irrigation water. Balanced use of organics, fertilizers and bio-fertilizers plays an important role to maintain soil fertility in long run. The availability of macro and micronutrients to plants is influenced by several soil characteristics. Similarly, different cropping systems are suitable for different soil groups as regards to production and productivity. For understanding the reasons of deficiency of available nutrients in soils, correlation of physic-chemical properties with available macro and micronutrients were needed. Also, detailed study on status of macro and micronutrients of Chak Ruldu Singh Wala Seed Farm of Punjab Agricultural University, Regional Station, Bathinda had not been undertaken so far. Hence, present investigation was undertaken to study the status of macro, micronutrients and their relationship with important soil characteristics.

MATERIALS AND METHODS

General characteristics of the study area

The Bathinda district is situated at 30.2° North latitude and 74.95° East longitude and 202 m elevation above the mean sea level. The study area is located at 30.0° North latitude and74.78° East longitude in Sangat block (Latitude 30.2 ° North and Longitude 74.94 ° East). The farm is mainly used to seed

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production in both the cropping seasons. Cotton, moong and guar is grown in *Kharif* whereas wheat, barley and raya are produced during *Rabi* season since last ten years. Recommended doses of fertilizers were applied for each crop according to recommendations made in package of practices for crops of Punjab (*Kharif* and *Rabi*) with respect of the year.

Soil sampling and analysis

Geo-referenced twenty eight soil samples of the farm were collected at 0-15 cm and 15-30 cm depth with the help of an augur during *Kharif* 2015, and latitude and longitude of the sampling sites were recorded using global positioning system (GPS).The samples were air-dried, ground ,passed through 2-mm sieve and stored in properly labelled plastic bags for analysis. The pH and EC of the soils were determined in 1:2 soil-water suspensions using a glass electrode pH meter and conductivity meter respectively (Jackson, 1973). The organic carbon was determined by wet digestion method (Walkley and Black, 1934). The available P in the soil was extracted by employing Olsen extractant (0.5M $NaHCO_3$, pH 8.5) as described by Olsen *et al.* (1954) and the available K was extracted by using neutral ammonium acetate and the content was determined by aspirating the extract into flame photometer (Jackson, 1973). The plant available Fe, Cu, Zn and mn in soil samples were extracted with DTPA (0.005 M DTPA + 0.01 M $CaCl_2$ + 0.1 M triethanolamine, pH 7.3) as per method described by Lindsay and Norvell (1978) and concentration of Fe, Cu, Zn and Mn in the DTPA extract was determined using atomic absorption spectrophotometer (AAS). The correlation analysis of data was computed in relation to available nutrient with different properties of soils as suggested by Panse and Sukhatme (1961).

RESULTS AND DISCUSSION

The soil properties of the sites exhibited variation with respect to different sampling sites and soil depths. In surface (0-15cm) soil layers, the value of pH ranged from 8.27 to 8.52 with mean value of 8.31. However pH value increased with increase in soil depth across the sites and varies from 8.24 to 8.57 with mean value of 8.46 (Figure 1). The higher pH in lower layers could be due to increase in accumulation of exchangeable of cations. Electrical conductivity values of the soil layers indicated that non salinity character of the soil profiles. The EC varies from 0.16 to 0.26 dSm^{-1} in surface (0-15 cm) with mean value of 0.19 dSm^{-1} and 0.11 to 0.25 dSm^{-1} in sub-surface layer (15-30 cm) with mean value of 0.17 dSm^{-1} (Figure 1). Similar findings were also reported by Behera and Shukla (2013)

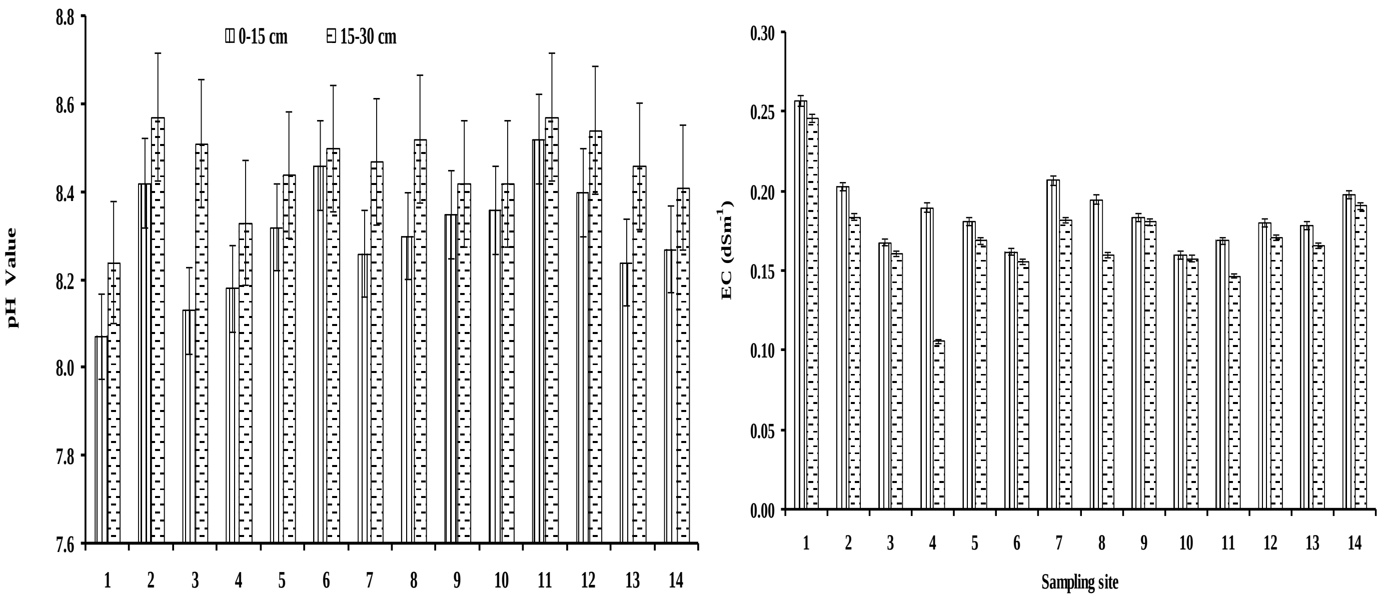

Fig.1: Soil reaction (pH) and electrical conductivity (EC) of the different soil profile

Organic carbon (OC) content in surface soil layer (0-15 cm) ranged form 3.2 to 8.7 g kg^{-1} with an average value of 4.9 g kg^{-1}. The value of organic carbon content in soil decreased with increase in soil depth across the sites. According to soil testing manual (2011) rating limit, on an average the surface soil contain low to medium organic carbon (<0.5 - 0.5%) and sub-surface soil layers contain low organic carbon (<0.5%) (Figure 2). The distribution of soil samples with respect to organic carbon content indicates that 21%, 71% and 8% soil samples had low, medium and high organic carbon in surface soils; however 92% and 8% samples were reported low and medium respectively, in sub-surface soils (Srivastava *et al.* 2016). The medium organic carbon content in surface soils may be attributed to the proper vegetation, growing of leguminous crops and incorporation of crop residues in soil.

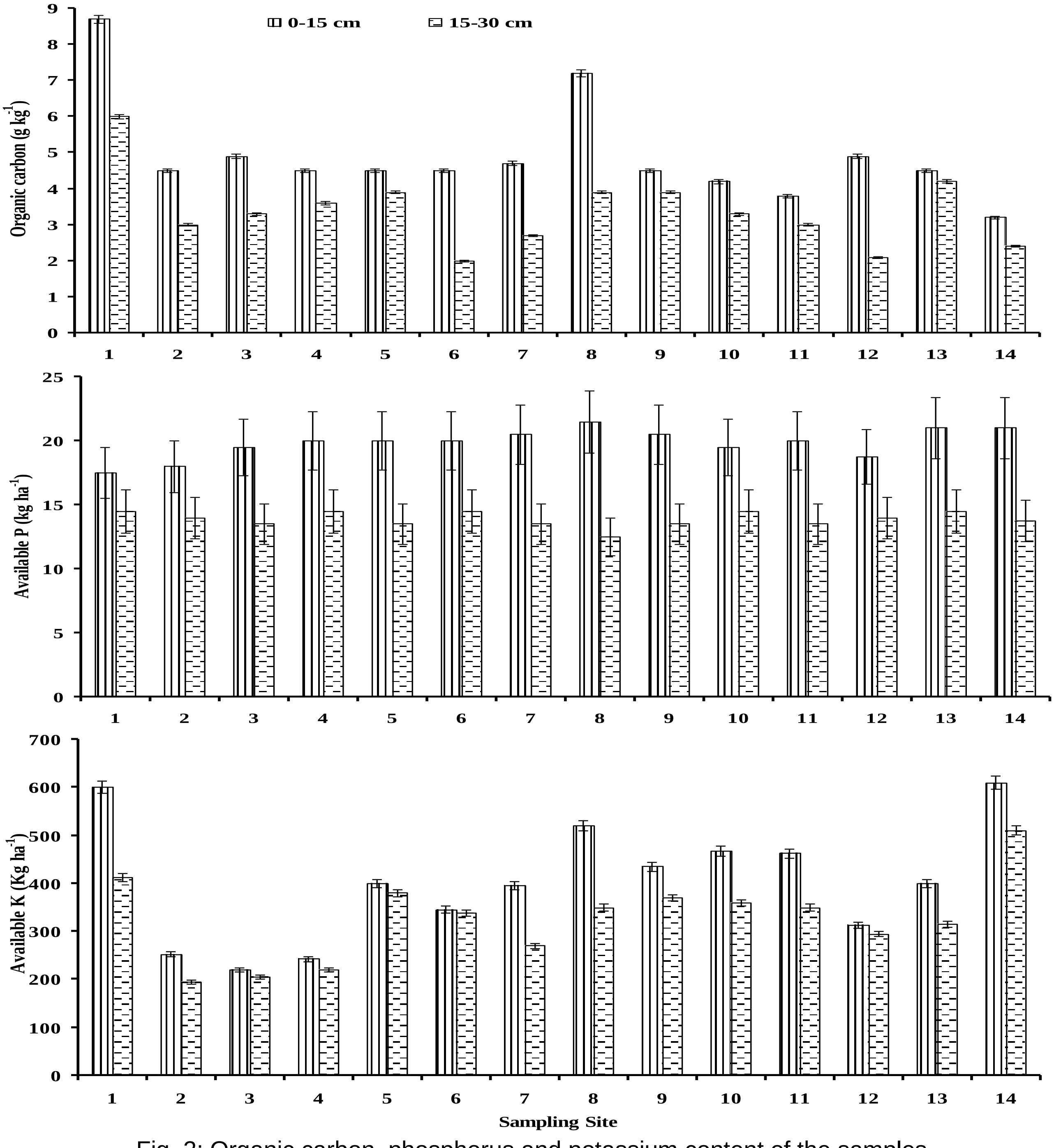

Fig. 2: Organic carbon, phosphorus and potassium content of the samples

Available P content varied from 17.5 to .21.5 kg ha^{-1} in surface layer (0-15cm) and 12.5 to 14.5 kg ha^{-1} in sub-surface layer (15-30cm) with an average value of 19.9 and 13.9 Kg ha^{-1} respectively (Figure 2). On the basis of the limits suggested by Govt. of India in soil testing manual (2011) all the soils samples (100%) of seed farm contain medium P (10-24.6 kg ha^{-1}). The high available P content is attributed to the regular application of phosphatic fertilizers and the immobile nature of phosphate ions in soils which must have resulted in accumulation of P in soils. Medium to high P content in soils of arid tract of Punjab has also been reported by Verma *et al.* (2005). Status of available K in the soils ranged from 220 to 610 kg ha^{-1} with an average of 404 kg ha^{-1} in upper layer (0-15 cm), whereas it varied from 195 to 510 kg ha^{-1} with an average of 326 kg ha^{-1} in lower layers (15-30 cm). According soil testing manual (2011) rating limit, all the samples (100%) showed high K content (Figure 2). The higher content of available K is attributed to the prevalence of Illite - a potassium rich mineral in these soils. Moreover, as the ground waters of south-western district have considerable amount of dissolved potassium, irrigation with such waters also results in higher amounts of available K in these soils (Patel *et al.,* 2000). These finding are also in line as reported by Verma *et al.* (2005).

Distribution of Fe, Cu, Zn and Mn in soil profile

Data regarding distribution of DTPA-extractable Fe, Cu, Zn and Mn in soil profiles of different sites have been given in Figure 3. The DTPA –Fe concentration varied from 10.55 to 13.02 (with mean value of 11.9 mg kg^{-1}) and 5.25 to 6.25 (with mean value of 5.8 mg kg^{-1}) in 0-15 and 15-30 cm depth, respectively. DTPA-Fe showed decreasing trends with increase in soil depth, which is in line of the findings of Shrama *et al.* (2000), Pati and Mukhopadhyay (2011) and Behera and Shukla (2013). It is also observed that the soil contains higher level of Fe as compared to critical level in soil as suggested by methods manual soil testing in India (2011).

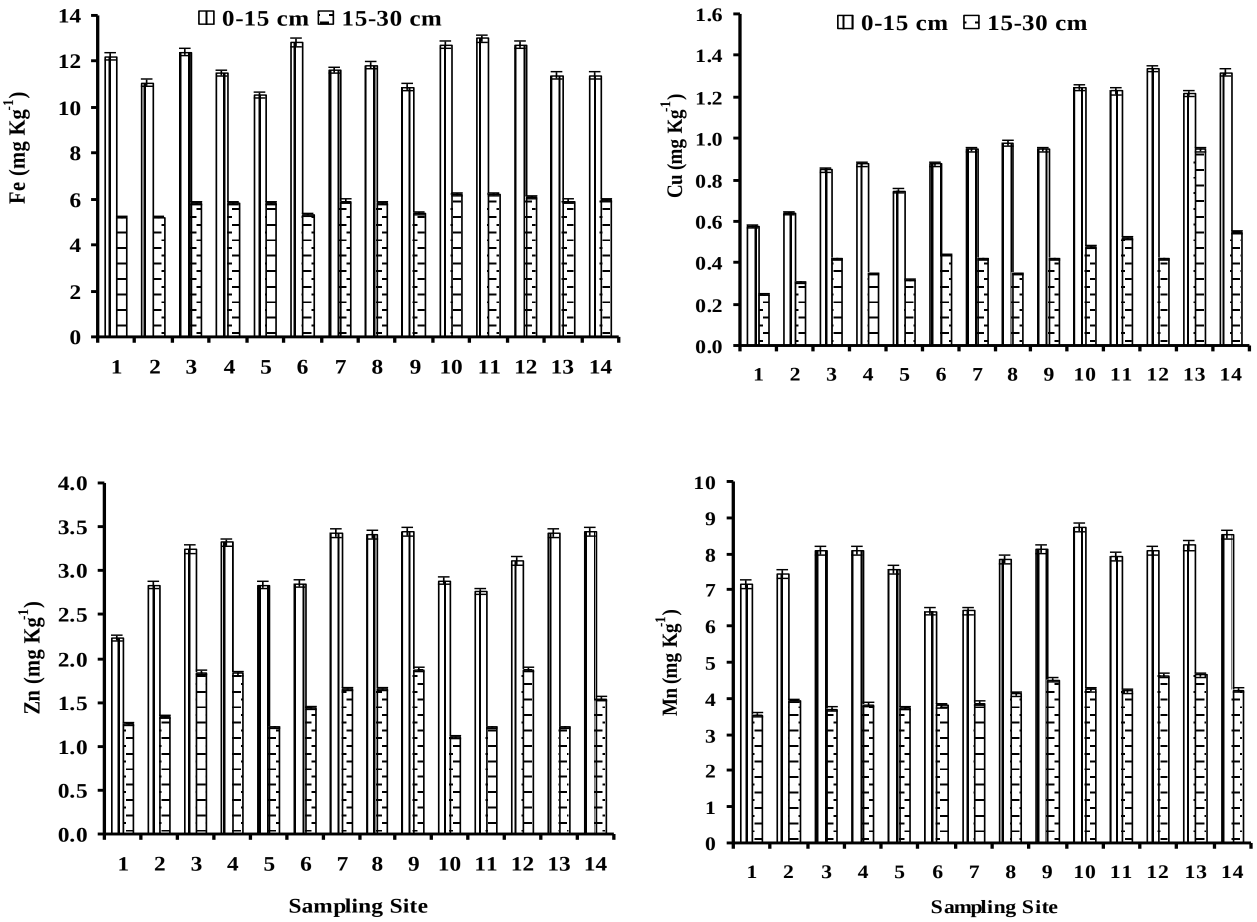

Fig. 3: Distribution of Fe, Cu, Zn and Mn in soil profile

Available Cu concentrations in different soil depth are given in figure 3. Copper concentration ranged from 0.58 to 1.34 (with mean value of 0.99 mg kg^{-1}) and 0.25 to 0.95 (with mean value of 0.44 mg kg^{-1}) in 0-15 and 15-30 cm soil depths, respectively across the sites. The lower depth (15-30 cm) had less mean DTPA extractable-Cu, which corroborates the observations made by Behera *et al.* (2009) in an Inceptisol. These results reveal that availability of Cu to the plants is more in surface soil layer (0-15 cm) than in sub soil layer (15-30 cm). The data also showed that the soils of the farm had higher Cu content compared to critical limit suggested by Govt. of India in soil testing manual (2011).The concentration of DTPA –Zn in surface soil layers spanned from 2.44 to 3.45 with an average of 3.10 mg kg^{-1} in upper layer (0-15 cm). However, it ranged from 1.11 to 1.88 with an average of 1.51 mg kg^{-1} in sub-surface layer (15-30 cm). The mean value of DTPA-Zn decreased with increase in soil depth across the sites. Similar results were also reported by Sharma *et al.* (2000). The decaline in DTPA-extractable Zn may be ascribed to decaline in soil organic C content down the soil profile as organic carbon content significantly correlated with DTPA-extractable Zn in surface soil as reported by Behera *et al.* (2011). Considering the critical limits for Zn (0.4-1.2 mg kg^{-1}) by Govt. of India as suggested in soil testing manual (2011), both the soil profile of all sites had sufficient available Zn concentration. The concentration of DTPA extractable- Mn ranged from 6.42 to 8.75 (with mean value of 7.78 mg kg^{-1}), 3.56 to 4.66 (with mean value of 4.09 mg kg^{-1}) in 0-15 cm and 15-30 cm respectively in soil profiles across the sampling sites. All the soil samples showed Higher Mn content in both the layers when we considered the limits as suggested in soil testing manual (2011).

Relationship between soil properties and available nutrients

Relationship between soil properties (0-30 cm) and available nutrients (0-30 cm) showed that the available P had significantly negative correlation (r = -0. 466*, $P< 0.05$), (r = -0.461*, $P< 0.05$) with pH and EC, respectively. This is because at higher pH, calcium precipitates with P as Ca-phosphate and reduced P availability A significant and positive correlation (r = 0.468*, $P< 0.05$) of available P was recorded with organic carbon. This relationship might be due to the presence of more P in organic forms and after the decomposition of organic matter as humus is formed which forms complex with Fe and Al and that is a protective cover for P fixation with Fe and Al, thus reduce P adsorption or fixation in soil. Similar results were also reported by Meena *et al.* (2006) and Singh *et al.* (2014). A significant and positive correlation of available K was reported between OC(r = 0. 573*, $P< 0.05$) and EC (r = 0. 487*, $P< 0.05$). This might be due to creation of favourable soil environment with presence of high organic matter. The available K showed negative and non-significant correlation with pH (r = -0. 218*, $P< 0.05$). Similar results were reported by Meena *et al.* (2006) and Singh *et al.* (2014). The DTPA – extractable Fe, Cu, Zn and Mn did not reveal any significant relationship with soil pH and electrical conductivity (EC). This indicates that distribution of available cationic micronutrients in the soil is not influenced by above soil properties. Bhera and Shukla (2013) studied the depth-wise distribution of zinc, copper, manganese and iron in acid soils of India and their relationship with some soil properties and observed no relationship between DTPA – extractable Fe, Cu, Zn and Mn with soil pH and EC. Pati and Mukhopadhyay (2011) also recorded no relationship of soil pH with DTPA – extractable Fe, Cu and Zn. The DTPA-extractable Fe, Cu, Zn and Mn increase significantly with increase in OC (r= 0.487*, $P<$ 0.05, for Fe), (r= 0.545*, $P< 0.05$, for Cu), (r= 0.578*, $P< 0.05$ for Zn) and (r=0.593*, $P< 0.05$ for Mn). The results confirm the observations of Sharma *et al.* (2006), Bhanwaria *et al.* (2011) and Singh *et al.* (2014).

The soils of the farm are non-saline and alkaline in reaction with medium to high organic carbon. The availability of P in soil was medium, whereas high in K content. Sufficient availability of micronutrients such as Fe, Cu, Zn and Mn were found in the soil. All the macro and micro-nutrients analysed decreased with increase in soil depth, however, no deficiency were observed in sub-surface layer. The soils of the farm has sufficient amount of nutrients for sustainable crop production.

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