Assessment Of Soil Quality Using Physiochemical Parameter Of Soil In Dehradun District Of Uttarakhand

Bahukhandi Kanchan Deoli, Arora Shefali, Sharma Madhuben, Siddiqui Nihal Anwar

Abstract: Soil is one of the important component of environment which affect growth and development of plant. The soil testing is one of the chemical process in which the suitability of essential nutrients are determined before sowing the crops so that the demand of remaining nutrient can be fulfilled artificially though applying fertilizer in the field. The objective of this research is to analyze macro-nutrient (P, K, S) micro nutrient (Mn, Fe, Cu, Zn) in order to understand the suitability of soil for cultivation of medicinal plant species in the study area. In the present study the physiochemical analysis were carried out by analyzing the parameter i.e. pH, Organic carbon, Phosphorous, Potassium, Sulphur, Zinc, Iron, Manganese and Copper. Total 24 soil sample were collected in 2017 during winter season (November-December) in selected villages of Saheshpur block of Dehradun and compared with the Standard value of soil quality. The micronutrient Fe, Cu, Mn and Zn were determined by using Atomic Absorption Spectrophotometer. The organic carbon in the study area were ranged from 0.34 % to 0.94 %, the mean value of pH was 7.1 indicating alkaline nature of soil. In order to depict the spatial variation one way ANOVA is carried out and it was found that in few sampling locations the soil quality parameter i.e. Sulphur, Zinc and moisture content were highly variable as compare to other location. Correlation analysis were carried out among various parameter of soil quality, Mn shown good correlation between Fe, S, Zn and Cu. All the parameter were under permissible limit of soil quality standard except potash which was found to less than minimum (> 140 kg/hectare) requirement of soil quality standard.

key words: Soil quality; physiochemical parameter; soil fertility, micronutrient, macronutrient

1. INTRODUCTION

Soil, water, air and plants are the three major components for maintaining the ecosystems on which all life on earth depends. By the end of the 20th century, scientist changed their views about the importance of the soil as an environmental component and took a step forward to maintain or improve the soil quality for the better performance. Soil quality is defined as “Soil quality is an account of the soil’s ability to provide ecosystem and social services through its capacities to perform its functions under changing conditions” (Toth et al. 2007). The soil quality is the most integral part of environment component apart from than the quality of air and water as it control many ecological processes that ultimately effect water and air quality which aid in promoting plant growth. In the other words soil quality is made up of two words i) soil functional ability ii) soil response properties. Functional ability of soil is defined in particular conditions. This prerequisite is very important for the assessment of the soil. Functional ability of soil is govern by the number and the internal dynamics of soil properties. Although the external conditions also influence the soil quality and can be considered.

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Sojka and Upchurch (1999) associated the concept of soil quality and the sustainability that causes confusion in the area of soil quality. The environmental perspective of multi-functionality of soil given be the National Research Council, 1993 by (Sim et al.1997) is “The capacity of the soil to promote the growth of plants, protect watersheds by regulating the infiltration and partitioning of precipitation and prevent water and air pollution by buffering potential pollutants such as agricultural chemicals, organic wastes and industrial chemical”. Degradation of soils can occur due to depletion of organic matter (OM), extensive use of chemical fertilizers and pesticides and reduction of biodiversity (Tilman et al. 2001). In many developing countries, agronomic recommendation are mainly based on the soil types and agricultural zones and do not embrace the gradients (Gachimbi et al. 2004; Groenenboom et al. 1991). So soil testing is one of the good diagnostic tools to evaluate soil quality. Organic matter content and physiochemical parameter determine the soil quality which ultimately affected by changes in soil condition (Haynes, 2005, Undurraga et al. 2009, Wang et. al. 2011, Doran et.al. 1994). For the better characterization of soil quality two or more parameters of soil quality index may be investigated (Bastida et al. 2008). For the soil quality investigation a combination of chemical, physical and biological properties and indicator values can be combined with the quantifiable soil quality index (SQI) (Herrick et al. 2002; Aparicio et al. 2007). Several methods have been used for the soil assessment in which the mathematically methods were used (Brejda et al. 2000; Li; Lindstrom 2001; Sun et al. 2003; Shukla et al. 2006; Velasquez et al. 2007)

and the use of a soil quality index (Hussain et al.1997; Glover et al. 2000, Andrews et al. 2002a; Andrews et al. 2002b; Masto et al. 2007; Xu et. al. 2006; Andrews et al. 2004; Erkossa et al. 2007; Qi et. al. 2009) are main. The objective of the present paper is to analyze physical and chemical parameters of soil quality in order to assess suitability of soil for sustainable farming practices, to understand ion-chemistry of the soil and assess various factors which affect soil quality and to generate base line data of soil quality parameter in the study area.

2. MATERIAL AND METHOD

2.1. Location of the Study area

The district Dehradun is situated in NW corner of Uttarakhand state and extends from N Latitude 29°58' to 31°02' 30" and E Longitude 77°34' 45" to 78°18' 30". It falls in Survey of India Toposheets Nos. 53E, F, G, Jammu and Kashmir (Fig.1). The district is bounded by Uttarkashi district on the north, Tehri Garhwal and Pauri Garhwal districts on the east and Saharnpur district (UP) on the south. Its western boundary adjoins Sirmour district of Himachal Pradesh separated by Rivers Tons and Yamuna. The total area of Dehradun district is 3088 km^2 with an average altitude of 640 m above mean sea level. The district comprises of six tehsils, namely Dehradun, Chakrata, Vikasnagar, Kalsi, Tiuni and Rishikesh. Further, it is divided into six developmental blocks, viz: Chakrata, Kalsi, Vikasnagar, Sahaspur, Raipur and Doiwala. The present study is confined to Masraj Patti Gramsabha of Sahaspur block of Dehradun district of Uttarakhand, comprises of 8 villages It is a part of Shivalik range of lower west Himalaya and situated on 1000 m -1050 m altitude. Dehradun comprises of both plain as well as hilly areas.

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2.2 Soil Types

Due to wide variation in topography, intensity of erosion, parent material and other factors, the soils show wide variation in many characteristics specially textures, depth, stoniness, colour, drainage, moisture status, organic matter contents and cation exchange capacity. In fact soil are the products of original geological formations hence three geological zones exhibit difference. On the basis of geological belts soil types of Doon valley has been categorized in three main categories i.e Lesser Himalaya Belt, Shiwalik Belt and the Boulder Belt of the valley geological belt.

2.3. Sampling and Soil Testing

The methodology consists of field survey, collection of the samples and analysis of physical and chemical parameter of soil quality. Total thirty soil samples had been collected from six different villages (Bidholi, Retiwala, Jagatpur, Dunga, Masrajpatti and Birsani) of Saheshpur Block of Dehradun during winter season. The soil sample samples were collected by using auger. The composite samples were kept in suitable plastic bag. These samples were air dried in sun light and then sieved in the lab to < 2 mm though stainless steel sieve and homogenized preserved. The parameter like pH, electrical conductivity (EC), organic carbon (OC), available phosphorous (P), potassium (K), sulphur (S), magnesium (Mg), calcium (Ca), zinc (Zn) and manganese (Mn) were analyzed in the lab. Soil samples were prepared 1: 10 (solid to liquid ratio) i.e 10 gram soil dissolved with 100 ml of distill water and shake in mechanical shaker for 18 hrs. (Kanmani and Gandhimathi, 2013).Water extract had been prepared as per standard test method for shake extraction of soil with water (ASTM D 3987 2006). The water extract of this samples have been taken after filtering it though Wattman filter paper and this water extract has been analyzed for various physical and chemical parameter i.e. pH, EC (electric conductivity) OC, P, K, S, Mg, Ca, Zn, Mn and Ca. The pH of the soil sample was determined by making suspension of (1:2:5) as per (Jackson, 1967). The organic carbon was determined by titrimetric method, Walkey and Black (1934), Bulk density was measured by core sampling method The soil moisture content was determined by oven drying method (Jackson 1967). The formula given by (Joel and Amajuoyi 2009) were used. The micronutrient (Zn, Mn, Cu, Fe) was determined by using Atomic Absorption Spectrophotometer

3. RESULT & DISCUSSION

The descriptive of soil quality parameter are given in Table 1. Shaipro Wilkis test has been conducted on the soil samples and it was found that data is normally distributed as the P>0.05 (Table 2).

3.1 Moisture Content and Density

The moisture is directly proportional to water holding capacity of the soil. The moisture content in the study area were ranged from 3.38 % to 8.87 % with a mean value of 4.29 % while the bulk density varied from 1.14 gm/cm^3 to 1.47 gm/cm^3 with a mean value of 1.23 gm/cm^3 in all sampling location (Table 1). The bulk density depend on compaction and consolidation of soil but it is negatively correlated with organic matter (Iram and Khan 2018)

3.2 pH and OC

The pH in the study area was ranged from 6.50 to 7.69 with a mean value of 7.2 and found under normal range as per Soil quality standard table (Table 2) (Fig. 1). It is estimated that alkaline nature of the soil decreases the solubility of minerals and create nutrient deficiency in the soil (Iram and Khan 2018). Organic matter play an important role in maintaining soil quality (Micheni. 2018). The organic matter in soil may be increase due to organic matter leaves falling on soil as well as due to application of chemical fertilizer or bio fertilizer in the soil. The organic carbon concentration was ranged from 0.37% to 0.94 % with the mean value of 0.65% (Table 1) and were under the normal range as Standard table of soil quality. (Table 2). The organic carbon is essential component of soil fertility as it add nutrient for plant growth by maintaining physical and biological health of the soil and also act as a buffer against harmful substance. The organic matter provide natural home for millions of bacteriological organism which aid biological and chemical reaction required for sustaining plant life. It aid moisture retention in the soil, enhance soil aggregation, aeration, aid in reduction of soil erosion and increase nutrient holding capacity of soil.

3.3 Potash and Phosphorous

The potash KA $(SO_4)_2$ in the soil varied from 67.5 Kg/ hectare to 405 kg/ hectare with a mean value of 100.58 Kg/ hectare (table 1) hectare which were found above maximum level (> 56) in all sampling location as per Soil Quality Standard (Table 2) (Fig 2). The phosphorous is one of the macro nutrients which is essential for plant growth and found in every living cell (Solanki, 2012). Inorganic phosphate supplied to the soil through fertilizer which is rapidly converted into unavailable form. Soluble phosphate converted into insoluble phosphate with the help of microorganism. Application of phosphorous is necessary for maintaining a balance between the other plant nutrients and ensuring the normal growth of crop (Wagh et al. 2013). P in the present soil vary from 8.96 Kg/hectare to 53 kg/ hectare with a mean value of 22.27 30.05 Kg/ hectare and found to be below the minimum requirement (<28) (Table 1) as per standard classification (Table 2), (Fig 2)

3.4 Sulphur and Zinc

The amount of S that became available to plant is largely depend upon the amount of organic matter and decomposition rate of organic matter by bacteria and other soil organism. S in plant utilized in the production of plant protein and is found several enzymes and vitamins used in plant metabolism and known to be important in formation of chlorophyll. The S concentration ranged from 9.55ppm to 81.6 ppm with a mean value of 24.58 ppm (table 1) and found to be above maximum (> 20) level in all sampling location when compared with soil quality standard (Table 2), (Figure 3). Zn is one of the important micronutrient and its availability in the soil decreases with increase in soil pH. Zn helps in promoting certain enzymes reaction in soil and is required for the production of chlorophyll 11 and formation of carbohydroxyl. The Zn concentration in the soil was ranged from 0.42 ppm to 5.18 ppm with a mean value of 2.42 ppm (table 1) in all sampling location and found above the maximum (> 1 ppm) level at few sampling location range as per Soil Quality Standard (Table 2) (Figure 3).The deficiency of Zn causes pathogenic fungal root disease (Graham and Webb 1991).

3.5 Iron, Manganese and Copper

It is estimated that the quantity of Fe may present in abundant in soil, only a small fraction is available to the plant. Iron function as a catalyst in the formation of chlorophyll and is required many of the oxidation – reduction reaction occurring in the plant. It is one of the most common nutrient for plant growth and development because it exist in low soluble form that is hardly available for plant (Wagh et al. 2013). The Iron concentration ranged from 2.64 ppm to 20.78 ppm with a mean value of 11.5 ppm (Fig.3) and found under normal range Fe (10 ppm to 20 ppm) for agricultural production as per Soil Quality Standard (Table 2). Mn is known to play important role in many metabolic process in the plant and required for the formation of chlorophyll in plant (Lindsay and Norvess, 1978). The amount of manganese available to the plant dependent upon soil pH, the quantity of organic matter present and degree of aeration. In alkaline soil Mn deficiency may occur because it is less soluble at elevated pH level. The Mn concentration in soil range from 0.45 ppm to 19.52 ppm with a mean value of 5.03 ppm and found less than minimum requirement (5.03 ppm) at few sampling locations. The copper concentration was ranged from 0.18 ppm to 7.51 ppm with a mean value of 1.305 ppm in all sampling location and was above (maximum level > 0.4) as per Soil quality standard (table 2).

Correlation Analysis

The coefficient of correlation between different physiochemical parameter of soil were calculated and were presented in the (table 3). The high coefficient of correlation were indicated by (near + and -1) between two variables and around zero concentration indicated that no relationship exist between two variables. The value of r between two variable are ranged 0.5 to 0.7 that indicated two variable are strongly correlated (Rakesh and Raju, 2013). The Zn has shown strong correlation between the parameter S (r^2 = 0.4), Fe (r^2 = 0.4) and Mn(r^2 =4), Fe showed positive correlation between S(r^2 =), Mn (r^2 = 0.5) and with Cu (r^2 = 0.2). Similarly Mn indicated positive correlation between S (r^2 =0.6), pH (r^2 = 0.42), Zn (r^2 =0.41), and Fe (r^2 = 0.5) and with Cu (r^2 = 0.59). The pH also indicated positive correlation between S (r^2 = 0.4) and Mn (r^2 = 0.42) (Table 3).

In order to assess the spatial variation in the soil quality parameters at different sampling stations one way ANOVA has been performed at collected dataset. It was found that all soil quality parameters were statistical significant (P>0.05) except the parameter of S, Zn, Mn, Bulk density and moisture content. During field investigation it was found at few locations of Retiwala, Birsani and Bidholi the use of organic manure is more as compare to the other locations. All statistically significant parameters have shown higher values at some sampling while there were other sampling location also in the study area where statistically significant parameter have shown minimum values. No spatial variations are observed in the other insignificant parameters.

4. CONCLUSION

The physiochemical analysis of soil indicated that the parameter ie. pH, OC, and Fe were found under normal range of soil quality standard however the parameter i.e. Zn, Cu and Fe and potash concentration were found above maximum permissible limit of soil quality standard. The Mn and P concentrations were found below the minimum limit of Soil Quality Standard at few sampling locations. The parameter S, Zn and moisture content were found to be highly variable at few sampling locations. The soil quality is considered good source of essential nutrient for agricultural practices

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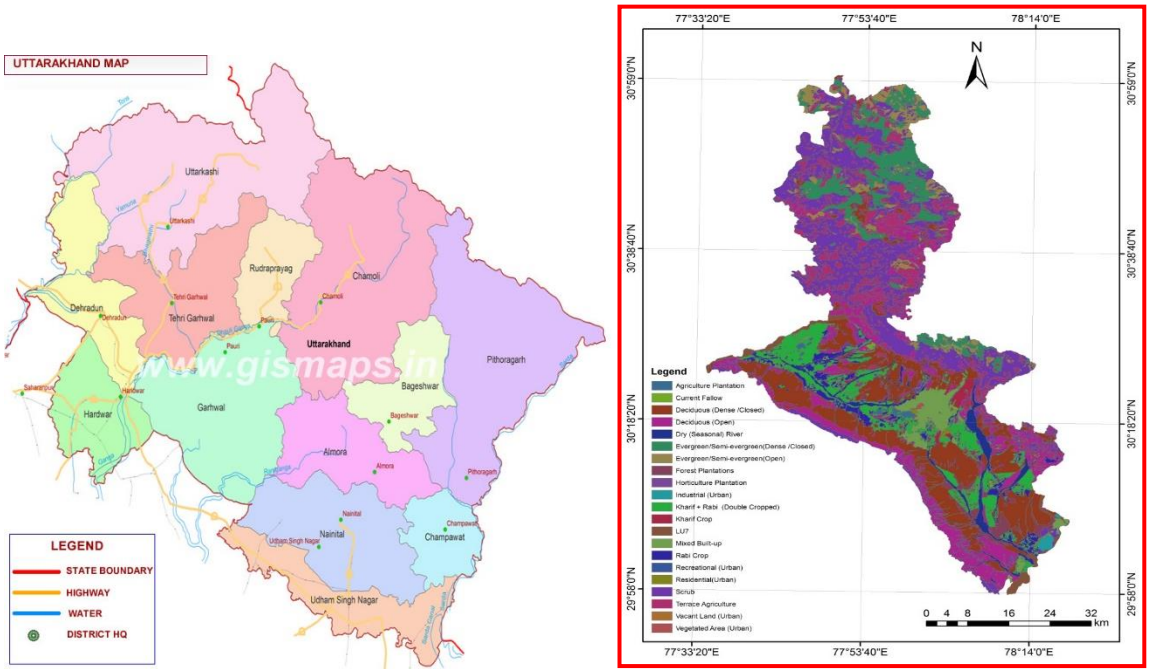
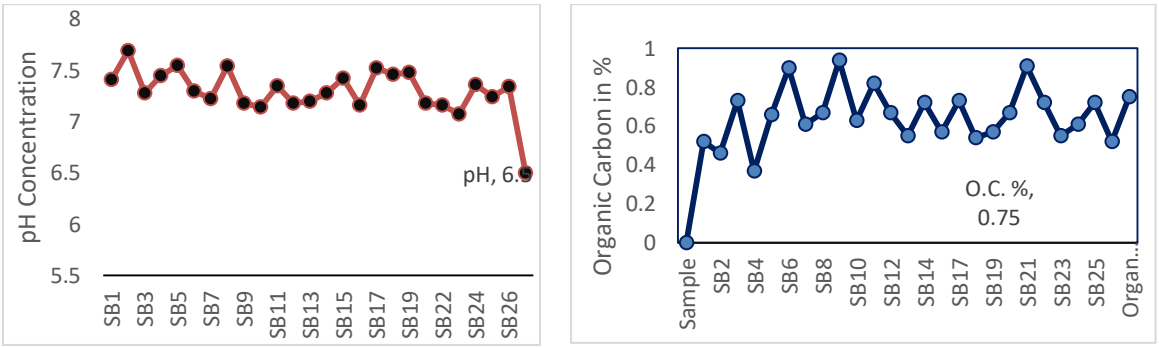


Sources: www.gismap, google.com Source : Bartarya & Bahukhandi 2012

Figure 1: *Location map of the study area*



(a) (b)

Fig.2*. Variation in Soil a) pH and b) Organic carbon concentration at different sampling location*

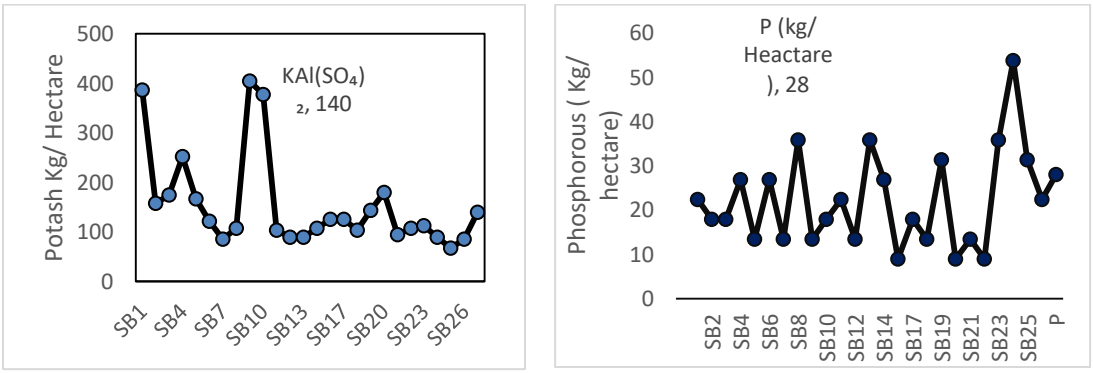


***Fig.3**. Variation in (a) Potassium and b) Phosphorus concentration in soil at different sampling location*

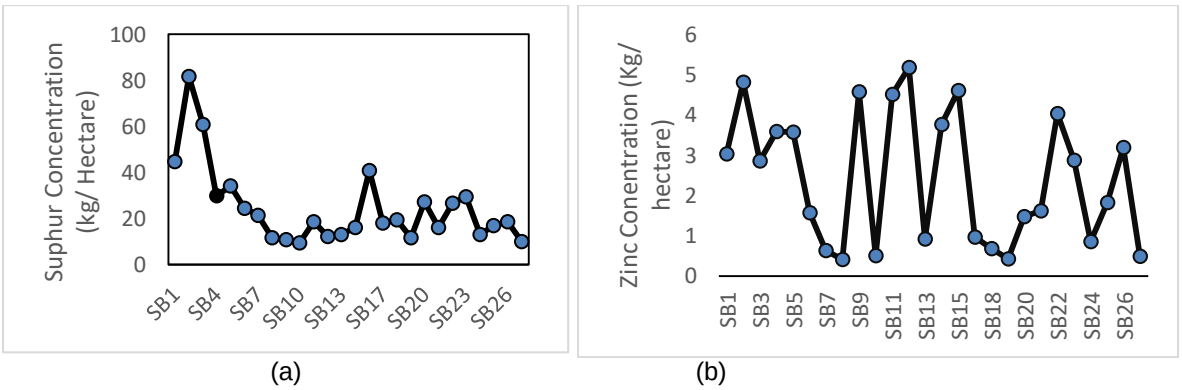


***Fig.4.** Variation in a) Sulphur and b) Zn concentration in soil at different sampling location*

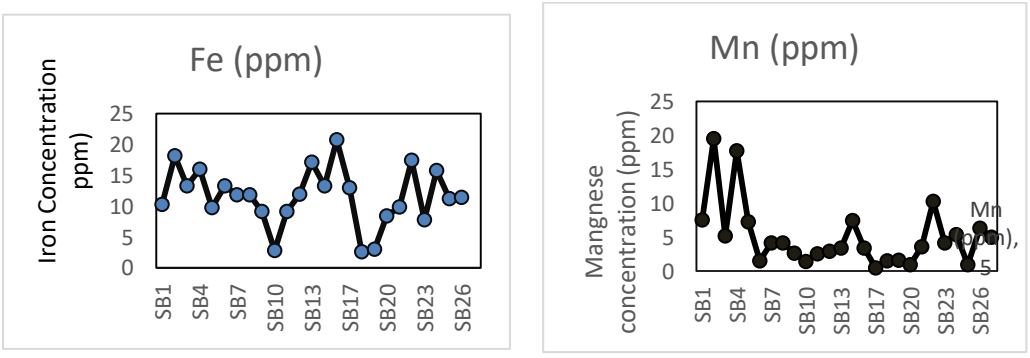


***Fig.5**. Variation in a) Iron b) Mn concentration in soil at different sampling location.*

***Table 1.** Descriptive Statistics of soil quality parameter*

Parameters	N	Minimum	Maximum	Mean	Std. Deviation
pH	26	6.50	7.69	7.2946	0.22416
Organic carbon (%)	26	0.37	0.94	0.6581	0.13813
Phosphorus(kg/Ha)	26	8.96	53.76	22.2708	10.73485
Potash (Kg/Ha)	26	67.50	405.00	154.0577	95.32317

Sulphur (ppm)	26	9.55	81.67	24.5815	16.85937
Zinc (ppm)	26	0.42	5.18	2.4235	1.63084
Iron(ppm)	25	2.64	20.78	11.5804	4.63093
Manganese (ppm)	26	0.45	19.52	5.0381	4.68341
Copper (ppm)	25	0.18	7.51	1.3052	1.51062
Bulk density (gm/cm^3)	26	0.95	1.47	1.2577	0.13453
Moisture Content (%)	26	2.09	8.87	5.2681	1.69890

Table 2 : *Soil Quality Standard Table*

Parameter	Range
pH	Acidic < 6.5
	Normal 6.5- 8.2
	Alkaline> 8.2
Electrical Conductivity	Normal < 1
	Medium 1-3
	Harmful > 3
Organic Carbon (in %)	minimum < 0.5
	Normal 0.5-0.75
	Maximum > 0.75
Available Phosphorus (kg/hec)	Minimum < 28
	Normal 28-56
	Maximum >56
Available Potassium (kg/hec)	Minimum < 140
	Normal 140-280
	Maximum > 280
Sulphur	Minimum < 10
	Normal 10-20
	Maximum >20
Magnesium	Minimum < 1
	Normal 1-2
	Maximum > 2
Calcium	Minimum < 1.5
	Normal 1.5-3.0
	Maximum > 3.0
Zinc	Minimum < 0.5
	Normal 0.5-1.0

3.6		Maximum > 1.0
	Mangnese	Minimum < 5
		Normal 5-10
		Maximum > 10
	Copper	Minimum < 0.2
		Normal 0.2-0.4
		Maximum > 0.4

Table 3: *Pearson's Coefficient of Correlation between soil physiological parameter*

	pH	O.C.	P	K	S	Zn	Fe	Mn
pH	1	-0.425	-0.008	-0.002	0.460	0.056	0.064	0.422
O.C.	-0.425	1	-0.200	-0.010	-0.325	0.023	-0.128	-0.515
P	-0.008	-0.200	1	-0.210	-0.253	-0.370	0.064	0.001
K	-0.002	-0.010	-0.210	1	0.117	0.135	-0.270	-0.270
S	0.460	-0.325	-0.253	0.117	1	0.423	0.405	0.619
Zn	0.056	0.0235	-0.370	0.135	0.423	1	0.411	0.477
Fe	0.064	-0.128	0.064	-0.270	0.405	0.411	1	0.503
Mn	0.422	-0.515	0.001	0.122	0.619	0.411	0.503	1
Cu	0.196	-0.443	0.083	0.214	0.100	0.1679	0.219	0.593

Table 4*. One way ANOVA test for soil quality parameter*

Soil quality parameter	Sig.
pH	0.142
Organic carbon	0.352
Phosphorus	0.436
Potash	0.087
Sulphur	0.001
Zinc	0.023
Iron	0.089
Manganese	0.004
Copper	0.052
Bulk density	0.006
Moisture Content	0.000