

Impact of Biotic Stress on Physiochemical Properties of Soil at Doodhpathri of Kashmir Valley

ABSTRACT:

~~The study was carried out on~~ We studied the forest soil of Doodhpathri which is a famous tourist place ~~of in~~ Kashmir in the spring and summer seasons at three sites (forest, meadow, and deforested sites) in 2019. Soil samples were collected ~~from at~~ 15-30 cm depth. ~~The following soil characteristics were~~ We examined; determined soil texture, pH, electrical conductivity (EC), moisture, organic carbon (OC), available macronutrients (Nitrogen, Potassium, Phosphorus, Calcium, and Magnesium), and heavy metals (Copper; Cu, Nickel; Ni, Cadmium; Cd, Manganese; Mn, Lead; Pb, and Zinc; Zn). Soil texture analysis revealed the soils at all the study sites with a major proportion being comprised by the silt fraction and having a silty clay loam character. pH and electrical conductivity ~~was were~~ found to be high at the deforested site in the summer ~~season~~. Organic carbon and moisture content ~~was were~~ found higher at the forest site in summer ~~season~~ and spring ~~season~~ respectively. Nitrogen, potassium, and total bacterial count follow the same trend as higher concentration was found at the forest site in the summer ~~season~~ while Phosphorus, magnesium, and calcium follow the same trend as their high concentration was found at the meadow site in the summer ~~season~~. Significantly higher values of heavy metals (Cu, Ni, Cd, Mn, Pb, and Zn) were found at the meadow site in the summer ~~season~~. The results could ~~be helpful in formulating~~ help to formulate conservation strategies ~~of for the~~ soil at Doodhpathri that ~~are is~~ affected by anthropogenic activities.

I. INTRODUCTION:

Forest soils are critical in influencing the long-term productivity of forest ecosystems. Forest lands with good physical and chemical properties are critical for supporting terrestrial ecosystem production and driving processes that maintain environmental quality (Moussa *et al.*, 2008). Without an understanding of soil, it is impossible to comprehend the growth and reproduction of forests. Because they grow together over a long length of time, the soil and vegetation have a complex relationship. Soil characteristics are composed of two properties: physical and chemical, and a soil's behavior is usually determined by the proportion and ~~organisation~~ ~~organization~~ of both features. Minerals, air, water, and organic matter are the four basic components of soil. Minerals make up ~~around~~ 45% of the total volume in most soils, water, and air ~~about~~ 25% each, and organic matter 2% to 5%. (Retallack 2008).

Terrestrial ecosystems' soil characteristics depend on ~~a number of some~~ abiotic (Total ion content, acidity, carbon, nitrogen, and total phosphorous) and biotic (Climate, landform, topography, soil texture, soil moisture, and the makeup of the plant community) elements that change both seasonally and geographically (Peverill 1999). ~~Total ion content, acidity, carbon, nitrogen, and total phosphorous are abiotic variables that differ spatially in the topsoil. Climate,~~

landform, topography, soil texture, soil moisture, and the makeup of the plant community are some additional elements that also affect soil composition (Maria *et al.*, 2004), (Takata *et al.*, 2008). Forest lands with good physical and chemical properties are critical for supporting terrestrial ecosystem production and driving processes that maintain environmental quality (Moussa *et al.* 2008). Because soil and vegetation develop together throughout time, they have a complex interrelationship (Retallack 2008).

II. Materials and methods:

Study area: The present study was carried out in the Doodhpathri area of Kashmir. Doodhpathri lies within the geo-coordinates of 33° 54' 23 N latitude and 74° 36' 15 E at an elevation of 2544m above sea level, in the Budgam district of Kashmir. Two seasons (Spring and Summer) and three study sites were selected; viz. Site I (Forest), Site II (Meadow), and Site III (Deforested) in order to study the physico-chemical properties of soil. The study sites were selected on the basis of anthropogenic activities for the purpose of comparison. Soil sampling was performed during the spring and summer seasons (from June to November). At each site, six soil samples were obtained randomly from 15-30cm depth with the help of a soil auger and then mixed to form the composite sample. Three replicates from the composite soil sample were sealed and labeled in the thick polythene bags and used for further analysis. The standard methods used for analyzing different parameters in soil samples viz. were examined for soil texture (Piper, 1966); Ph, EC, available potassium (Jackson, 1973); organic carbon (Walkley and Black, 1947); moisture (Prihar and Sandhu, 1968); available nitrogen (Subbiah and Asija, 1956); available phosphorus (Olsen *et al.*, 1954); calcium and magnesium (EDTA method), and heavy metals (Lindsay and Norwell, 1978).

III. EXPERIMENTAL FINDINGS RESULTS

3.1 Soil texture/particle distribution

Soil texture is a property of soil which does not change within a short time period. The average clay, silt, and sand contents of soil from deforested site were found as 24, 49, and 27% respectively at the deforested site. Similarly, the average clay, silt and sand content of soil at the forest site were found as 26, 50, and 24% respectively at the forest site, and while at meadow site the observed average values of clay, silt and sand content were 25, 50, and 25% respectively at the meadow site respectively. Using the USDA graph for the determination of soil textural classes, the soil under study from the experimental and control sites was found to fall in the silt clay loam class (Table 1).

Table 1: Soil texture of sampling sites

Site	Sand %	Silt %	Clay %	Class
Deforestrated	27	49	24	Silty clay loam

Forest	24	50	26	Silty clay loam
Meadow	25	50	25	Silty clay loam

3.2 Assessment of biotic stress on physico-chemical parameters of soil

(i) Moisture (°C)

It is clear from the data that the soil from forest sites have has higher values of moisture content followed by meadow and deforestrated sites. The observed values of moisture content of soil at forest site were were in the spring and summer 24.178 ± 0.789 in spring season and 14.151 ± 0.468 in summer at the forest site, season. Similarly, 21.368 ± 0.497 and 11.808 ± 0.440 at the meadow, and deforestrated sites the values recorded were 21.368 ± 0.497 , 11.808 ± 0.440 and 18.470 ± 0.573 , and 9.011 ± 0.540 deforested sites respectively. Moreover, it is evident from the data that the moisture content was significantly higher ($P < 0.05$) in the spring season as compared to summer at all the three sites. This may be attributed to the high rate of precipitation during spring and more vegetation cover in the particular area (Joshi *et al.*, 2010; Faruq *et al.*, 2013, and Shah and Jeelani, 2015).

(ii) pH and Electrical Conductivity (dS/m)

Data also showed that the soils at the forest site have lower values of pH in comparison to that of the meadow and deforestrated site compared to the other sites. The mean pH values of soil at the forest, meadow, and deforested sites was were recorded as 6.440, while at meadow and deforestrated site the mean values recorded were 6.546, and 6.970 respectively. Furthermore, the mean value of pH was significantly higher in the summer season at the deforested deforestrated site, while at meadow and forest sites the pH values were significantly higher in the spring season. Increase The increase in pH in the deforested area is attributed to the decrease in organic matter accumulation which directly depends upon the forest cover. The increase in pH can also be attributed to decrease in accumulation and subsequent slow decomposition of organic matter, which releases acids (de Hann, 1977). Electrical The electrical conductivity (EC) of soils was found significantly higher ($P < 0.05$) at the deforested deforestrated site as compared to the meadow and forest sites (Table 2). The observed values of EC in the spring and summer at deforestrated site were recorded as 0.217 ± 0.001 in spring season and 0.322 ± 0.002 in summer at the deforested site, 0.165 ± 0.003 and 0.284 ± 0.001 at the meadow site, and 0.147 ± 0.001 and 0.222 ± 0.001 at the season. Similarly, at meadow and forest site the observed values were recorded as 0.165 ± 0.003 , 0.284 ± 0.001 and 0.147 ± 0.001 , 0.222 ± 0.001 respectively. Highest pH and electrical conductivity near to the deforested and meadow sites could be due to decline of

forest flora (Grigalaviciene *et al.*, 2005; Joshi *et al.*, 2010; Das and Dkhar, 2011 and Shah and Jeelani, 2015).

(iii) Organic Carbon (%)

The % organic carbon in forest soils was significantly higher ($P < 0.05$) as compared to the other two sites. The mean value of 2.226 % organic carbon was observed at the forest site, 1.996% while at the meadow, and 1.496% at the deforested site. The observed values of % organic carbon were significantly higher ($P < 0.05$) in the summer season as compared to spring season at all the three sites. This may be due to the presence of dense vegetation and high temperature during the summer season, which leads to the more accumulation and decomposition of litter fall. Lesser contents of organic carbon in deforested area and higher in forest area may be the result of differential accumulation and decomposition of litter (Joshi *et al.*, 1993 and Joshi *et al.*, 2010).

(iv) Assessment of biotic stress on nutrient status of soil

The maximum mean value of available nitrogen and potassium was found at the forest site with recorded values as (327.66 and 202.560 mg.kg⁻¹) respectively, while as available phosphorus, calcium, and magnesium contents showed a marked increase at the meadow site with mean values recorded as (22.416, 515.67, and 71.632 mg.kg⁻¹) respectively. Moreover, it is evident from data that the concentration of all the available nutrients was significantly higher ($P < 0.05$) in the summer season as compared to spring. Furthermore, the deforested site had a minimum concentration of all the available nutrients as compared to forest and meadow site. The higher concentration of available nitrogen at in the forest area may be due to the high concentration of organic matter in the form of leaf foliage. The decrease in available nitrogen in the deforested area may be due to deforestation, grazing, and tourism which is proportional to the decrease in organic matter and the latter being the bank of soil nitrogen. Verma *et al.* (2005) and Zargaret *et al.* (2005) also reported a significant decrease in available nitrogen in degraded forests while as, Singh (2004) reported medium to high available nitrogen content in forest soils of Kashmir Valley (Bogomolov *et al.*, 1996; Joshi *et al.*, 2010; Das and Dkhar, 2011 and Shah and Jeelani 2015).

In the present study, a significant decrease ($P < 0.05$) in available potassium was recorded at in the deforested deforested area. The data revealed that the forest area was having higher potassium contents as compared to the meadow and deforested deforested areas. Furthermore, the soil potassium concentration was highest (187.770mg/kg) in summer and lowest in spring (150.892mg/kg), this may be due to the high-high temperature conditions during the summer season, which enhances the more availability of potassium in soil due to various chemical processes in the soil which increase the availability of potassium during summer. The decrease in potassium content at in the disturbed areas could be probably due to the decrease in the forest litter under degraded conditions. Basumatary and Bordoloi (1992) and Boruah and Nath (1992) found that a layer of organic matter significantly improves the retention of potassium in the soils.

Moreover, disturbed area (deforested conditions) enhances the rate of leaching of minerals (like i.e. K^+) and possibly decreases the concentration of available potassium in the soil. This may be the reason for less content of potassium at-in the deforested deforestrated-area and high at-in the forest area. These findings are in accordance with following Singh (2004), Zargaret *et al.* (2005), Chaudhari (2013), and Shah and Jeelani (2015). Ghiriet *et al.* (2011) reported that the distribution of the different potassium forms in the soils varied considerably. This variation may be attributed to the differences in the chemical properties of the soils and possibly the extent to which potassium salts in the different soil series have leached.

Phosphorus is an essential nutrient classified as macronutrient because of the relatively large amount of phosphorus required by plants. Much of the phosphorus in the soil is not available to plants as it is influenced by soil reaction (pH) and a normal pH (between of 6-7) promotes the most availability of phosphorus to plants (Kimura *et al.*, 2009). Phosphorus availability was strongly influenced by soil pH. Furthermore, the soil phosphorus concentration was highest (24.638 mg/kg) in summer and lowest in spring (12.116 mg/kg), this may be due to the high-high-temperature conditions during the summer-season, which enhances the more availability of phosphorus in soil due to various chemical processes. The lower pH at-in the forest area may be the reason for the low availability of phosphorus at-in the forest area. It has been reported that a large proportion of phosphorus is stored in the forms that are unavailable/unavailable forms (Murphy and Riley 1958), for example, H_2PO_4 , which becomes available at low pH values and suffers from fixation by hydrous oxides and silicate minerals (Soromessa *et al.*, 2004). The soil pH of soil is an important factor for phosphorus availability and maximum availability was reported in the range of pH 6 to 7 (Tisdale *et al.*, 1997). Singh (2004), Chaudhari (2013), and Rasool *et al.* (2014) also observed that the available phosphorus in the forest soil increases with an increase in pH i.e. towards neutral (6-7).

In the present study significant ($P < 0.05$) increase in calcium and magnesium was recorded at the meadow site. The data revealed that the meadow site as having higher calcium and magnesium contents as compared to the forest and deforestrated areas. Calcium and magnesium contents showed a marked increase at the meadow site with mean values recorded as (515.67 and 71.632 mg/kg respectively) followed by forest and deforestrated sites. Furthermore, the soil calcium and magnesium concentration was-were highest (472.39 mg/kg and 66.244 mg/kg) in the summer and lowest in the spring (362.16 mg/kg and 42.072 mg/kg), this may be due to the high-temperature conditions during summer-season, which enhances the more availability of calcium and magnesium in soil due to various chemical processes and nutrient uptake by plants during summer. The increase in calcium and magnesium at the meadow site might be due to the decomposition of litter while the subsequent decrease at the forest and deforestrated sites may be due to leaching and uptake by plants (Richter and Markewitz, 2001).

(V) Assessment of biotic stress on heavy metal analysis of soil

~~Result~~ The result depicts the impact of biotic stress on the heavy metal status of soil at three sites viz., deforestrated, forest, and meadow sites. The average value for available-copper

content showed a remarkable increase at the meadow site (7.67 mg.kg⁻¹), the deforested site (7.17 mg.kg⁻¹), and the deforested site (4.57 mg.kg⁻¹). The average nickel, cadmium, manganese, and lead contents were also observed to reflect higher values at the meadow site with recorded values as (1.53, 0.74, 6.47, and 0.86 mg.kg⁻¹ respectively), followed by deforested site with mean values recorded as (1.17, 0.58, 5.00, and 0.69 mg.kg⁻¹ respectively), and forest site with mean values as (0.79, 0.43, 5.00, and 0.43 mg.kg⁻¹ respectively). The available zinc content was found significantly ($P < 0.05$) higher at the meadow site with observed mean value as (4.45 mg.kg⁻¹), followed by the forest site (4.02 mg.kg⁻¹), and the deforested site (2.38 mg.kg⁻¹). The data also reveals that the heavy metal accumulation was significantly ($P < 0.05$) higher in the summer as compared to spring season. The increased heavy metal contents of heavy metals accumulation may be due to an increase in tourism and transport at in the meadow area. The higher concentrations of heavy metals were found during summer and lowest during spring season, which may be due to the high tourist rush during the summer season. Furthermore, the high rate of exhausts, wear, and tear of motor vehicle tyres, and tourism pressure could have added a high degree of heavy metal contaminations to the soil (Paggotto *et al.*, 2001). Weckwerth (2001) has reported that roadside soil contains a high percentage of heavy metal contamination. Kordet *et al.* (2010) also reported that the highest and the lowest metal content were found in the heavy traffic zone and low traffic zone respectively. Remarkable high levels of heavy metals were found in at the nearest point to the high-way (Garcia and Millan, 1994). Heavy metals (Zn, Fe, Cu, and Ni) showed an increasing trend in their contents with increased urbanization and transportation (Aksoy and Ozturk, 1996). The present results were in agreement with findings those of Asksoy and Ozturk (1996), Paggotto *et al.* (2001), Weckwerth (2001), Petrova *et al.* (2014), and Panda and Dhal (2015).

(VI) Total bacterial count in soil

The most important role of soil microorganisms in the ecosystem is to cause the decomposition of organic matters, synthesize it, and release them into inorganic forms that plants can use (Setiadi, 1989). Most microbes in the terrestrial ecosystem are present in the soil. Bacteria are the most dominant group of soil microbes. It was observed that the total viable bacteria in the soil was significantly higher at the forest site followed by the meadow and deforested sites. The observed values for total viable bacteria at forest site in the summer and spring seasons were $217 \pm 1.46 \text{ CFU} \times 10^6 \text{ g}^{-1}$ in summer while as in spring the observed value was $197 \pm 1.78 \text{ CFU} \times 10^6 \text{ CFU.g}^{-1}$ at the forest site. 169 ± 0.94 and $152 \pm 0.79 \times 10^6 \text{ CFU.g}^{-1}$. Similarly, at the meadow site the observed values were 169 ± 0.94 and $152 \pm 0.79 \text{ CFU} \times 10^6 \text{ g}^{-1}$ in summer and spring season respectively, while as at deforested site the observed values were $109 \pm 0.74 \text{ CFU} \times 10^6 \text{ g}^{-1}$ in summer season and $98 \pm 0.67 \text{ CFU} \times 10^6 \text{ CFU.g}^{-1}$ in spring season the deforested site. Moreover, the total mean microbial count was significantly ($P < 0.05$) higher in summer as compared to the spring season ($149 \text{ CFU} \times 10^6 \text{ g}^{-1}$ and $165 \text{ CFU} \times 10^6 \text{ CFU.g}^{-1}$) because of the higher amount of organic carbon present at the forest site followed by the meadow site and also higher temperature favours decomposition of forest litter (Ogunmwonyi *et al.*, 2008). Also, low level of microbial population and activity due to the deforestation and degradation

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of natural tropical forests was reported by several authors (Sahani and Behera, 2001; Hossain *et al.*, 2010;)

CONCLUSION:

~~It was concluded from the study that~~ The impact of biotic stress results ~~from the~~ degradation of physicochemical parameters of ~~the~~ soil among deforested and meadow (soil) due to deforestation and enhanced anthropogenic activities as compared to forest sites. Poor soil health and the reduction in vegetation cover due to various factors makes the soils prone to erosion but also lead to ~~the~~ loss of major plant nutrients ~~due to~~ leaching. High nutrient levels at the forest site ~~is~~ are due to nutrient regeneration from fallen leaves, twigs, buds, flowers, animal excretal, decaying roots, etc. Therefore, ~~this study reveals that the~~ conservation of forest vegetation is crucial for maintaining soil health in tourist destinations as it mitigates the damage caused by deforestation and anthropogenic activities.

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Table 2: Assessment of biotic stress on physicochemical parameters of soil at

Parameters	Site	Season		Mean	C.D (P≤0.05)
		Spring	Summer		
Moisture content (%)	Deforestrated	18.470±0.573	9.011±0.540	13.740	Sites (S): 0.446
	Forest	24.178±0.789	14.151±0.468	19.165	Season (S): 0.364
	Meadow	21.368±0.497	11.808±0.440	16.588	Sites × Season (S × S): 0.81
	Mean	21.338	11.657		
pH	Deforestrated	6.913±0.024	7.026±0.022	6.970	Sites (S): 0.014
	Forest	6.700±0.014	6.181±0.017	6.440	Season (S): 0.011
	Meadow	6.813±0.013	6.280±0.014	6.546	Sites × Season (S × S): 0.025
	Mean	6.808	6.496		
Electrical conductivity (dS/m)	Deforestrated	0.217±0.001	0.322±0.002	0.269	Sites (S): 0.001
	Forest	0.147±0.001	0.222±0.001	0.185	Season (S): 0.001
	Meadow	0.165±0.003	0.284±0.001	0.224	Sites × Season (S × S): 0.002
	Mean	0.176	0.276		
Organic carbon (%)	Deforestrated	1.426±0.060	1.566±0.055	1.496	Sites (S): 0.054
	Forest	1.855±0.041	2.598±0.099	2.226	Season (S): 0.044
	Meadow	1.706±0.033	2.286±0.058	1.996	Sites × Season (S × S): 0.098
	Mean	1.662	2.150		

The data are given in Mean±Standard Error of 6 replicates.

Table 3: Assessment of biotic stress on available nutrients (mg/kg) in the soil at different sites

Parameters	Site	Season		Mean	C.D (P≤0.05)
		Spring	Summer		
Nitrogen (N)	Deforestrated	160.19±4.13	194.76±1.12	177.47	Sites (S): 8.861
	Forest	295.18±1.82	360.15±25.63	327.66	Season (S): 7.235
	Meadow	280.38±0.39	300.86±1.24	290.62	Sites × Season (S × S): 16.096
	Mean	245.25	285.25		
Phosphorus (P)	Deforestrated	8.700±0.303	16.983±0.813	12.841	Sites (S): 0.664
	Forest	21.766±0.674	26.983±0.990	19.875	Season (S): 0.542
	Meadow	14.883±0.617	29.950±1.122	22.416	Sites × Season (S × S): 1.206
	Mean	12.116	24.638		
Potassium (K)	Deforestrated	94.865±1.802	132.125±0.928	113.495	Sites (S): 1.582
	Forest	183.783±2.411	221.033±0.997	202.560	Season (S): 1.292
	Meadow	124.030±3.183	209.866±1.027	191.948	Sites × Season (S × S): 2.874
	Mean	150.892	187.770		
Calcium (Ca)	Deforestrated	284.623±5.731	360.413±5.726	322.51	Sites (S): 14.366
	Forest	336.126±15.787	491.126±23.661	413.65	Season (S): 11.73
	Meadow	465.700±24.389	565.646±11.951	515.67	Sites × Season (S × S): 26.096
	Mean	362.15	472.39		
Magnesium (Mg)	Deforestrated	23.928±2.569	43.420±1.983	33.674	Sites (S): 2.080
	Forest	44.813±3.289	63.526±2.053	54.170	Season (S): 1.698
	Meadow	57.476±1.903	85.786±2.070	71.632	Sites × Season (S × S): 3.778
	Mean	42.072	66.244		

The data are given in Mean±Standard Error of 6 replicates

Table 4: Assessment of biotic stress on heavy metal status (mg/kg) in the soil at different sites

Parameters	Site	Season		Mean	C.D (P≤0.05)
		Spring	Summer		
Copper (Cu)	Deforestrated	3.25±0.49	5.88±0.52	4.57	Sites (S): 0.634
	Forest	6.49±0.34	7.85±1.21	7.17	Season (S): 0.518
	Meadow	4.76±0.47	10.67±1.15	7.67	Sites × Season (S × S): 1.152
	Mean	4.84	8.19		
Nickel (Ni)	Deforestrated	1.06±0.58	1.28±0.54	1.17	Sites (S): 0.515
	Forest	0.77±0.47	0.82±0.95	0.79	Season (S): 0.420
	Meadow	1.43±0.32	1.64±0.87	1.53	Sites × Season (S × S): 0.935
	Mean	1.08	1.25		
Cadmium (Cd)	Deforestrated	0.55±0.03	0.62±0.13	0.58	Sites (S): 0.085
	Forest	0.37±0.04	0.50±0.10	0.43	Season (S): 0.070
	Meadow	0.71±0.06	0.77±0.16	0.74	Sites × Season (S × S): 0.155
	Mean	0.54	0.63		
Manganese (Mn)	Deforestrated	4.76±04	5.25±10	5.00	Sites (S): 1.034
	Forest	5.61±05	6.30±09	5.95	Season (S): 1.018
	Meadow	6.03±02	6.92±06	6.47	Sites × Season (S × S): 2.052
	Mean	5.45	6.16		
Lead (Pb)	Deforestrated	0.55±0.03	0.83±0.13	0.69	Sites (S): 0.085
	Forest	0.37±0.04	0.50±0.10	0.43	Season (S): 0.070
	Meadow	0.77±0.06	0.95±0.16	0.86	Sites × Season (S × S): 0.155
	Mean	0.56	0.76		
Zinc (Zn)	Deforestrated	1.85±0.33	2.94±0.98	2.38	Sites (S): 0.952
	Forest	3.07±0.60	4.98±1.74	4.02	Season (S): 0.777
	Meadow	3.60±0.26	5.30±1.63	4.45	Sites × Season (S × S): 1.729
	Mean	2.84	4.40		

The data are given in Mean±Standard Error of 6 replicates

Table 5: Total viable bacteria CFU $\times 10^6$ g⁻¹ in soil

Sites	Season		Mean
	Spring	Summer	
Deforestrated	98 \pm 0.67	109 \pm 0.74	103.5
Forest	197 \pm 1.78	217 \pm 1.46	207
Meadow	152 \pm 0.79	169 \pm 0.94	160.5
Mean	149	165	

The data are given in Mean \pm Standard Error of 6 replicates

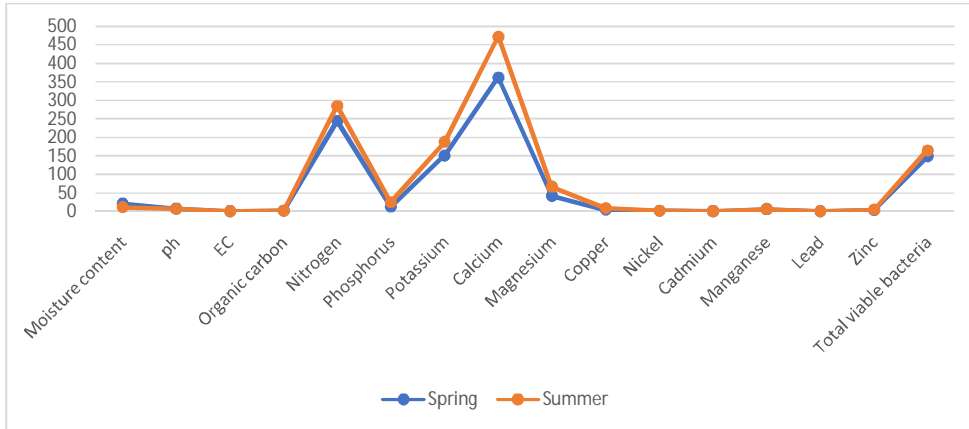


Fig. 1. Graphical representation of mean values of soil quality parameters at different seasons.

UNDER PEER REVIEW