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

ABSTRACT:

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

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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 Doodhpathri area of Kashmir. Doodhpathri lies within the geo-coordinates of 33o 54´ 23 N latitude and 74o 36´ 15 E at an elevation of 2544 mtrs 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 in spring and summer season basis from June to November. At each site, 6 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 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

3.1 Soil texture/particle distribution

Soil texture is a property of soil which does not change with short span of time. The average clay, silt and sand content of soil from deforestrated site were found as 24, 49 and 27 % respectively. Similarly, the average clay, silt and sand content of soil at the forest site were found as 26, 50 and 24 % respectively, while at meadow site the observed average values of clay, silt and sand content were 25, 50 and 25 % respectively. Using the USDA graph for the determination of soil textural classes, the soil under study from experimental and control site 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

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

(i) Moisture (°C)

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

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

Data also showed that soils at forest site have lower values of pH in comparison to that of the meadow and deforestrated site. The mean pH value of soil at forest site was 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 summer season at deforestrated site, while at meadow and forest site the pH values were significantly higher in spring season. Increase in pH in deforested area is attributed to 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 conductivity (EC) of soils was found significantly higher at deforestrated site as compared to meadow and forest site (Table2). The observed values of EC at deforestrated site were recorded as 0.217±0.001 in spring season and 0.322±0.002 in summer 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 site 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 as compared to other two sites. The mean value of 2.226 % organic carbon was observed at forest site while at meadow and deforestrated site the mean values recorded were 1.996 % and 1.496 % respectively. The observed values of % organic carbon were significantly higher in 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 summer season, which leads to the more accumulation and decomposition of litter fall. Lesser content of organic carbon in deforestrated 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).

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

The maximum mean value of available nitrogen and potassium was found at forest site with recorded values as 327.66 and 202.560 mg kg^{-1} respectively, while as available phosphorus, calcium and magnesium content showed a marked increase at 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 in summer season as compared to spring. Furthermore, the deforested site had minimum concentration of all the available nutrients as compared to forest and meadow site. The higher concentration of available nitrogen at forest area may be due to high concentration of organic matter in the form of leaf foliage. The decrease in available nitrogen in deforested area may be due to deforestation, grazing and tourism which is proportional to the decrease in organic matter and latter being the bank of soil nitrogen. Verma *et al.* (2005) and Zargar *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 significant decrease in available potassium was recorded at deforestrated area. The data revealed that forest area was having higher potassium content as compared to meadow and deforestrated areas. Furthermore, the soil potassium concentration was highest (187.770 mg/kg**)** in summer and lowest in spring (150.892 mg/kg), this may be due to the high temperature conditions during 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 disturbed area could be probably due to decrease in forest litter under degraded conditions. Basumatary and Bordoloi (1992) and Boruah and Nath (1992) found that layer of organic matter significantly improves the retention of potassium in the soils. Moreover, disturbed area (deforestrated conditions) enhances the rate of leaching of minerals (like K^+) and possibly decreases the concentration of available potassium in the soil. This may be the reason for less content of potassium at deforestrated area and high at forest area. These findings are in accordance with Singh (2004), Zargar *et al.* (2005), Chaudhari (2013), Shah and Jeelani (2015). Ghiri *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 essential nutrient classified as macronutrient because of 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 temperature conditions during summer season, which enhances the more availability of

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phosphorus in soil due to various chemical processes. The lower pH at forest area may be the reason for low availability of phosphorus at forest area. It has been reported that a large proportion of phosphorus is stored in the forms that are unavailable (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 pH of soil is 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 forest soil increases with increase in pH i.e. towards neutral (6-7).

In the present study significant increase in calcium and magnesium was recorded at meadow site. The data revealed that meadow site as having higher calcium and magnesium content as compared to forest and deforestrated areas. Calcium and magnesium content showed a marked increase at 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 highest (472.39 mg/kg and 66.244 mg/kg) in summer and lowest in 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 meadow site might be due to decomposition of litter while subsequent decrease at 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 depicts the impact of biotic stress on heavy metal status of soil at three sites viz., deforestrated, forest and meadow site. The average value for available copper content showed a remarkable increase at meadow site (7.67 mg kg^{-1}) followed by forest (7.17 mg kg^{-1}) and deforestrated site (4.57 mg kg-1). The average nickel, cadmium, manganese and lead content was also observed to reflect higher values at meadow site with recorded values as 1.53, 0.74, 6.47 and 0.86 mg kg^{-1} respectively followed by deforestrated 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 higher at meadow site with observed mean value as 4.45 mg kg^{-1} followed by forest site (4.02 mg kg^{-1}) and deforestrated site (2.38 mg kg^{-1}). The data also reveals that the heavy metal accumulation was significantly higher in summer as compared to spring season. The increased content of heavy metals accumulation may be due to increase in tourism and transport at 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 high degree of heavy metal contaminations to soil (Paggotto *et al.*, 2001). Weckwerth (2001) has reported that roadside soil contain high percentage of heavy metal contamination.

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Kord *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 the nearest point to high-way (Garcia and Millan, 1994). Heavy metals (Zn, Fe, Cu and Ni) showed an increasing trend in their content with increased urbanization and transportation (Aksoy and Ozturk, 1996). The present results were in agreement with findings of Asksoy and Ozturk (1996), Paggotto *et al.* (2001), Wreckwerth (2001), Petrova *et al.* (2014) and Panda and Dhal (2015).

(VI) Total bacterial count in soil

The most important role of soil microorganism in ecosystem is to cause decomposition of organic matters, synthesize and release them into inorganic forms that plant can use (Setiadi, 1989). Most microbes in 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 soil was significantly higher at forest site followed by meadow and deforestrated site. The observed values for total viable bacteria at forest site was 217±1.46 CFU $\times 10^6$ g^{-1} in summer while as in spring the observed value was 197±1.78 CFU $\times 10^6$ g^{-1}. Similarly, at meadow site the observed values were 169±0.94 and 152±0.79 CFU $\times 10^6$ g^{-1} in summer and spring season respectively, while as at deforestrated site the observed values were 109±0.74 CFU $\times 10^6$ g^{-1} in summer season and 98±0.67 CFU $\times 10^6$ g^{-1} in spring season. Moreover, the total mean microbial count was significantly higher in summer as compared to spring season (149 CFU ×106 g-1 and 165 CFU ×106 g-1) because of the higher amount of organic carbon present at the forest site followed by 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 of natural tropical forest 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 degradation of physicochemical parameters of soil among deforestrated and meadow (soil) due to deforestration and enhanced anthropogenic activities as compared to forest site. Poor soil health and the reduction in vegetation cover due to various factors makes the soils prone to erosion but also lead to loss of major plant nutrients due to leaching. High nutrient levels at the forest site is due to nutrient regeneration from fallen leaves, twigs, buds, flowers, animal excretal, decaying roots etc. Therefore, this study reveals that conservation of forest vegetation is crucial for maintaining of 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 Season (S): 0.364 Sites × Season (S × S): 0.81
	Forest	24.178±0.789	14.151±0.468	**19.165**	
	Meadow	21.368±0.497	11.808±0.440	**16.588**	
	Mean	**21.338**	**11.657**		
pH	Deforestrated	6.913±0.024	7.026±0.022	**6.970**	Sites (S): 0.014 Season (S): 0.011 Sites × Season (S × S): 0.025
	Forest	6.700±0.014	6.181±0.017	**6.440**	
	Meadow	6.813±0.013	6.280±0.014	**6.546**	
	Mean	**6.808**	**6.496**		
Electrical conductivity (dS/m)	Deforestrated	0.217±0.001	0.322±0.002	**0.269**	Sites (S): 0.001 Season (S): 0.001 Sites × Season (S × S): 0.002
	Forest	0.147±0.001	0.222±0.001	**0.185**	
	Meadow	0.165±0.003	0.284±0.001	**0.224**	
	Mean	**0.176**	**0.276**		
Organic carbon (%)	Deforestrated	1.426±0.060	1.566±0.055	**1.496**	Sites (S): 0.054 Season (S): 0.044 Sites × Season (S × S): 0.098
	Forest	1.855±0.041	2.598±0.099	**2.226**	
	Meadow	1.706±0.033	2.286±0.058	**1.996**	
	Mean	**1.662**	**2.150**		

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

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Table 3: Assessment of biotic stress on available nutrients (mg/kg) in 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 Season (S): 7.235 Sites × Season (S × S): 16.096
	Forest	295.18±1.82	360.15±25.63	**327.66**	
	Meadow	280.38±0.39	300.86±1.24	**290.62**	
	Mean	**245.25**	**285.25**		
Phosphorus (P)	Deforestrated	8.700±0.303	16.983±0.813	**12.841**	Sites (S): 0.664 Season (S): 0.542 Sites × Season (S × S): 1.206
	Forest	21.766±0.674	26.983±0.990	**19.875**	
	Meadow	14.883±0.617	29.950±1.122	**22.416**	
	Mean	**12.116**	**24.638**		
Potassium (K)	Deforestrated	94.865±1.802	132.125±0.928	**113.495**	Sites (S): 1.582 Season (S): 1.292 Sites × Season (S × S): 2.874
	Forest	183.783±2.411	221.033±0.997	**202.560**	
	Meadow	124.030±3.183	209.866±1.027	**191.948**	
	Mean	**150.892**	**187.770**		
Calcium (Ca)	Deforestrated	284.623±5.731	360.413±5.726	**322.51**	Sites (S): 14.366 Season (S): 11.73 Sites × Season (S × S): 26.096
	Forest	336.126±15.787	491.126±23.661	**413.65**	
	Meadow	465.700±24.389	565.646±11.951	**515.67**	
	Mean	**362.15**	**472.39**		
Magnesium (Mg)	Deforestrated	23.928±2.569	43.420±1.983	**33.674**	Sites (S): 2.080 Season (S): 1.698 Sites × Season (S × S): 3.778
	Forest	44.813±3.289	63.526±2.053	**54.170**	
	Meadow	57.476±1.903	85.786±2.070	**71.632**	
	Mean	**42.072**	**66.244**		

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

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Table 4: Assessment of biotic stress on heavy metal status (mg/kg) in 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 Season (S): 0.518 Sites × Season (S × S): 1.152
	Forest	6.49±0.34	7.85±1.21	**7.17**	
	Meadow	4.76±0.47	10.67±1.15	**7.67**	
	Mean	**4.84**	**8.19**		
Nickel (Ni)	Deforestrated	1.06±0.58	1.28±0.54	**1.17**	Sites (S): 0.515 Season (S): 0.420 Sites × Season (S × S): 0.935
	Forest	0.77±0.47	0.82±0.95	**0.79**	
	Meadow	1.43±0.32	1.64±0.87	**1.53**	
	Mean	**1.08**	**1.25**		
Cadmium (Cd)	Deforestrated	0.55±0.03	0.62±0.13	**0.58**	Sites (S): 0.085 Season (S): 0.070 Sites × Season (S × S): 0.155
	Forest	0.37±0.04	0.50±0.10	**0.43**	
	Meadow	0.71±0.06	0.77±0.16	**0.74**	
	Mean	**0.54**	**0.63**		
Manganese (Mn)	Deforestrated	4.76±04	5.25±10	**5.00**	Sites (S): 1.034 Season (S): 1.018 Sites × Season (S × S): 2.052
	Forest	5.61±05	6.30±09	**5.95**	
	Meadow	6.03±02	6.92±06	**6.47**	
	Mean	**5.45**	**6.16**		
Lead (Pb)	Deforestrated	0.55±0.03	0.83±0.13	**0.69**	Sites (S): 0.085 Season (S): 0.070 Sites × Season (S × S): 0.155
	Forest	0.37±0.04	0.50±0.10	**0.43**	
	Meadow	0.77±0.06	0.95±0.16	**0.86**	
	Mean	**0.56**	**0.76**		
Zinc (Zn)	Deforestrated	1.85±0.33	2.94±0.98	**2.38**	Sites (S): 0.952 Season (S): 0.777 Sites × Season (S × S): 1.729
	Forest	3.07±0.60	4.98±1.74	**4.02**	
	Meadow	3.60±0.26	5.30±1.63	**4.45**	
	Mean	**2.84**	**4.40**		

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

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

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

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

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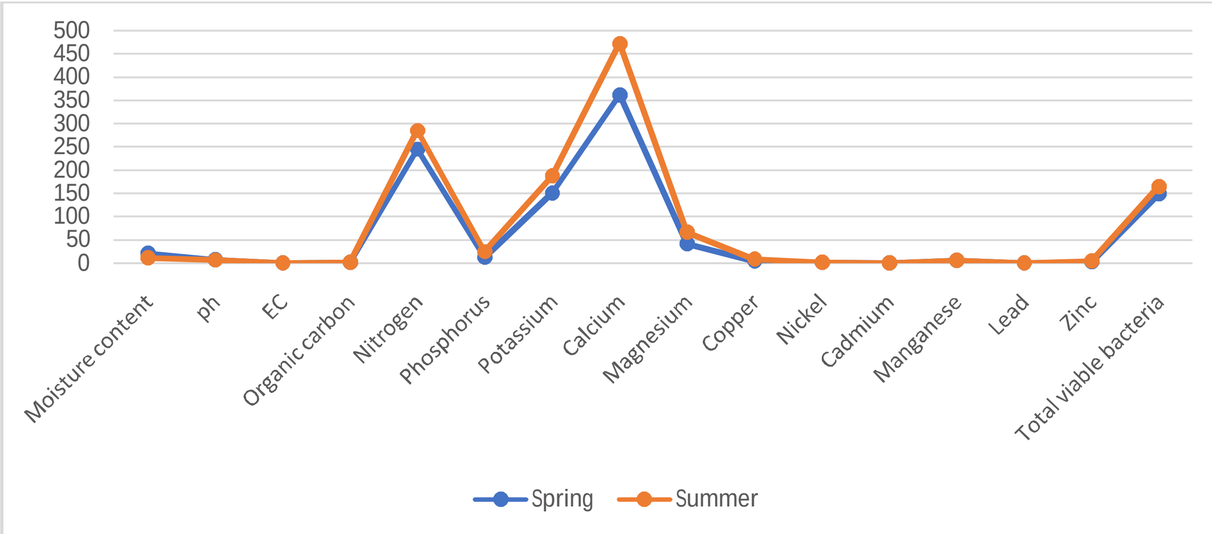

Fig. 1. Graphical representation of mean values of soil quality parameters at different seasons.

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