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Impact of Different Altitudes on Distribution of Macro-nutrients under Different Land Use Systems of District Kupwara

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ABSTRACT: As the soil properties change among all land use systems at different altitudes which in turn leads to change in type of vegetation and productivity among different land use systems, therefore it is not possible to develop a single short list of soil properties which is suitable for all purposes. In this back drop, the present study was undertaken to investigate the distribution of Macro-nutrients at different altitudes under different land use systems in district Kupwara. Soil samples from four land uses of high, mid and low altitude areas of Kupwara were collected up to a depth of 0-20 cm. The soil samples were studied for various physico-chemical properties and macro-nutrient status. The study revealed that texture of soils ranged between clay loam, silty clay loam to sandy loam. The soils were slightly acidic to slightly alkaline in reaction with normal electrical conductivity. Bulk density and Particle density were decreasing with increase in altitude. The pH, electrical conductivity, calcium carbonate, cation exchange capacity and organic carbon varied significantly with altitude. The available nitrogen varied from 243.96-506.43 kg ha^{-1} and soils were low to medium in available nitrogen. The available phosphorus and potassium ranged from 12.21-36.63 and 123.4-242.37 kg ha^{-1}, respectively and were found medium to high. The correlation studies revealed that organic carbon showed positive and significant relationship with available nitrogen, phosphorus and potassium. The pH and EC exhibited significant and negative relationship with available nitrogen, phosphorus and potassium. The calcium carbonate showed significant and negative correlation with available nutrients. The OC and CEC content revealed significant and positive relationship with available nutrients. These properties affect the availability of nutrients in the soil.

Keywords: Land Use Systems (LUS), Altitude, Available nutrients, organic matter.

INTRODUCTION

Characterizing the variability of soil nutrients concerning site properties, including land use, and altitude (topography), is vital for a comprehensive understanding of how the ecosystems work and assessing the effects of future land use change on soil nutrients (Fang *et al.*, 2012). Understanding topography effects and assessing the soil properties in different land use is an essential step for sustainable soil management. The soils vary greatly due to altitude and land use as they have pronounced effect on soil properties and nutrient availability. The spatial extent of soil fertility is influenced by land management, as well as by topographic factors such as altitude. In particular, soils at a higher altitude have generally higher slopes that trigger soil erosion, with consequent translocation and deposition of the eroded materials down slope and a change in soil parameters, including texture, along the altitudinal gradient (Mishra and Francaviglia, 2021).

In addition, land use in Kupwara is driven by the socio-economic needs of local people, that can either grow crops for family consumption or choose more market-oriented and profitable systems such as plantations. Thus, land use in Kupwara can be different among districts, considering that local farmers also adapt the land use to the prominent site factors, particularly soil abiotic factors that govern soil fertility, morphology and altitude, and their activity is spread throughout the village boundaries while keeping in mind the proximity to the village where they live. Consequently, land use also depends on local and site-specific factors. Considering the multiplicity of the factors driving agriculture in Kupwara, our main objective was to assess their effects on specific soil properties related to soil fertility, and resulting from the complex interactions among land use and altitude gradient. Therefore, the present study was undertaken in district Kupwara to study the variations in soil properties, in different land uses at different altitudes with the following specific objectives:

(1) To evaluate the status of macro-nutrients under different land use systems at different altitudes.

(2) To work out the relationship of different macro-nutrients with soil physico-chemical properties.

MATERIALS AND METHODS

The present study area (Kupwara) is a notified area committee carved out from Srinagar in the state of Jammu and Kashmir, India and has been recognized as separate district, which is situated at a distance of ninety km away from Srinagar and located in the farthest northwest of Kashmir valley. It falls between 34°15′25″ and 34°49′30″N latitudes and 73°46′05″ and 74°36′48″E longitude. The average elevation is 1,741 amsl, with an average annual temperature of 18.8 °C and average annual rainfall of 990 mm. The soil samples collected thereof were investigated for mechanical components, physico-chemical properties and the available macro-nutrient status. Available nitrogen was estimated by alkaline per magnate method as given by Subbiah *et al.*, (1956), available phosphorus by Olsen *et al.*, (1982) and available potassium was analysed by extraction with 1N ammonium acetate at pH 7 as given by Jackson (1973).

RESULT AND DISCUSSION

Among available macro-nutrients, the available nitrogen presented in (Table 1) revealed that lower zone had overall available nitrogen 301.53 kg ha^{-1}. Confidence interval (95% CI) in LUS (land use systems) ranged between 247.4 to 307.0 kg ha^{-1}. In agriculture with mean value of 275.9 kg ha^{-1}. In horticulture it ranged between 262.1 to 313.8 kg ha^{-1} with mean value of 288.54 kg ha^{-1}. In pasture 269.4 to 316.2 kg ha^{-1} with mean value of 293.68 kg ha^{-1}. In forest 307.6 to 404.6 kg ha^{-1} with mean value of 347.94 kg ha^{-1}. Middle zone had overall available nitrogen 319.03 kg ha^{-1}. Confidence interval (95% CI) in LUS (land use systems) ranged between 284.99 to 305.05 kg ha^{-1}. In agriculture with mean value of 293.67 kg ha^{-1}. In horticulture 277.80 to 314.64 kg ha^{-1} with mean value of 295.62 kg ha^{-1}. In pasture 289.19 to 316.72 kg ha^{-1} with mean value of 300.42 kg ha^{-1}. In forest 310.1 to 455.8 kg ha^{-1} with mean value of 386.41 kg ha^{-1}. Similarly upper zone had overall nitrogen mean value of 349.22 kg ha^{-1}. Confidence interval (95% CI) in LUS (land use systems) ranged between 290.50 to 342.10 kg ha^{-1}. In agriculture with mean value of 316.50 kg ha^{-1}. In horticulture 281.7 to 380.3 kg ha^{-1} with mean value of 325.00 kg ha^{-1}. In pasture 301.6 to 415.2 kg ha^{-1} with mean value of 348.38 kg ha^{-1}. In forest 311.8 to 486.8 kg ha^{-1} with mean value of 407.02 kg ha^{-1}.

Among available macro-nutrients the nitrogen availability of soil in all the three zones was found to be medium in status with higher mean value recorded in high altitude 349.23 kg ha^{-1} fallowed by mid altitude 319.03 kg ha^{-1}. The lowest mean value 301.53 kg ha^{-1} of nitrogen was recorded at low altitude. This variation in available nitrogen content in three zones might be attributed to the climatic and altitude condition favourable for the accumulation of higher organic matter content at higher altitude. Similar results were reported by Ganai *et al.*, (2014); Najar, (2002); Singh *et al.*, (2012).

In different land use systems the highest available nitrogen was found in forest followed by pasture, horticulture, than agriculture. It is attributed due to high organic matter and overall high turnout of nitrogen during decomposition in forests as compared to other land use systems. Similar findings was reported by Maqbool *et al*., (2017).

The data presented in (Table 1) revealed that lower zone has overall mean value of 19.51 kg ha^{-1} available phosphorus. Confidence interval (95% CI) in LUS (land use systems) ranged between 13.86 to 21.62 kg ha^{-1}. In agriculture with mean value of 17.29 kg ha^{-1}. In horticulture 14.76-23.97 kg ha^{-1} with mean value of 19.39 kg ha^{-1}. In pasture 12.39 to 21.68 kg ha^{-1} with mean value of 16.82 kg ha^{-1}. In forest 19.56 to 29.80 kg ha^{-1} with mean value of 24.55 kg ha^{-1}. Middle zone had overall phosphorus mean value of 21.54 kg ha^{-1}. Confidence interval (95% CI) in LUS (land use systems) ranged between 14.27 to 24.91 kg ha^{-1}. In agriculture with mean value of 19.75 kg ha^{-1}. In horticulture 15.72 to 27.72 kg ha^{-1} with mean value of 21.12 kg ha^{-1}. In pasture 14.38 to 22.09 kg ha^{-1} with mean value of 17.99 kg ha^{-1}. In forest 19.20 to 37.57 kg ha^{-1} with mean value of 27.32 kg ha^{-1}. Similarly upper zone had overall phosphorus mean values of 22.91 kg ha^{-1}. Confidence interval (95% CI) in LUS (land use systems) ranged between 15.25 to 26.53 kg ha^{-1}. In agriculture with mean value of 21.32 kg ha^{-1}. In horticulture 16.58 to 29.01 kg ha^{-1} with mean value of 22.35 kg ha^{-1}. In pasture 18.69 to 26.78 kg ha^{-1} with mean value of 22.52 kg ha^{-1}. In forest 23.57 to 34.83 kg ha^{-1} with mean value of 29.47 kg ha^{-1}.

The available phosphorus status of soils under study was found to be medium to high (Table 1). At higher altitude mean value of phosphorus was 22.91 kg ha^{-1} while at mid and low altitude mean value was 21.54 and 19.51 kg ha^{-1} respectively. The available phosphorus content in soils of three altitudes varied significantly with higher content in high altitude soils followed by mid altitude and low altitude soils, which could be attributed to favourable soils reaction and high organic matter leading to the formation of organophosphate complexes and coating of iron and aluminium particles by humus at higher altitudes. This is supported by the research work of Tellen *et al*., (2018).

In different land use systems the highest available phosphorus was found in forest and lowest in agriculture. The variation in phosphorus content was due to adsorption and fixation of phosphorus with the calcium, magnesium, iron and aluminium, variation in application of fertilizers and agrochemicals, nature of vegetation, type of soil and climatic conditions. High content of organic matter in case of forests which releases organic anions on decomposition and form chelates with Fe and Al and make the P available then other land uses. The results were in conformity with the studies of Mishra *et al.*, (2019); Abreha *et al*., (2012)

Overall content of potassium presented in (Table 1) revealed that lower zone had overall mean value of 159.63 kg ha^{-1}. Confidence interval (95% CI) in LUS (land use systems) ranged between 133.48 to 162.08 kg ha^{-1}.

In agriculture with mean value of 147.38 kg ha^{-1}. In horticulture 135.45 to 169.47 kg ha^{-1} with mean value of 150.89 kg ha^{-1}. In pasture 144.03 to 168.70 kg ha^{-1} with mean value of 156.47 kg ha^{-1}. In forest 162.1 to 206.1 kg ha^{-1} with mean value of 183.76 kg ha^{-1}. Middle zone had overall potassium mean value 163.79 kg ha^{-1}. Confidence interval (95% CI) in LUS (land use systems) ranged between 142.93 to 163.78 kg ha^{-1}. In agriculture with mean value of 152.00 kg ha^{-1}. In horticulture 141.47 to 169.00 kg ha^{-1} with mean value of 155.33 kg ha^{-1}. In pasture 145.53 to 178.63 kg ha^{-1} with mean value of 160.87 kg ha^{-1}. In forest 167.92 to 205.09 kg ha^{-1} with mean value of 186.97 kg ha^{-1}. Similarly upper zone had overall potassium mean values of 169.73 kg ha^{-1}. Confidence interval (95% CI) in LUS (land use systems) ranged between 148.51 to 165.53 kg ha^{-1}. In agriculture with mean value of 156.31 kg ha^{-1}. In horticulture 144.2 to 180.6 kg ha^{-1} with mean value of 161.21 kg ha^{-1}. In pasture 143.6 to 190.2 kg ha^{-1} with mean value of 165.30 kg ha^{-1}. In forest 168.5-224.8 kg ha^{-1} with mean value of 196.08 kg ha^{-1}.

The mean value of available potassium at high altitude was 169.73 kg ha^{-1} while as at mid and low it was 163.80 and 159.63 kg ha^{-1} respectively. This shows that with increase in altitude increases the available potassium, it may be due to high organic matter at high altitudes. The results are in conformity with the findings of Ganai *et al.*, (2014).

In different land use systems the highest available potassium was found in forest followed by pasture, horticulture, than agriculture. It may be due to the formation of organic complexes with clay in forests and pastures, however in horticulture and agriculture due to intensive cultivation leads to removal of potassium from soil. Similar findings was reported by Gupta *et al.*, (2010); Mesfn *et al*., (2020).

Table 1: Status of available macro-nutrients of soil at different altitudes in different land use systems of district Kupwara.

Altitude	Land use systems	Location	Av.N (kg ha^{-1})	Av.P (kg ha^{-1})	Av.K (kg ha^{-1})
LOW	Agriculture	Braripora	243.96	20.11	143.55
		Turkpora	271.01	14.29	153.23
		Tulwara	250.74	15.5	123.4
		Buhama	303.93	13.42	145.8
		Batergam	310.08	23.13	170.93
		Mean ± SE	275.9 ± 13.5	17.29 ± 1.86	147.382±7.68
		95% C.I	247.4- 307.0	13.86-21.62	133.48 -162.08
	Horticulture	Chogal	290.93	21.45	135.5
		Butkoot	309.41	26.49	182
		Neelpora	255.5	19.47	144.65
		Aarampora	268.77	14.9	135.4
		Hayan	318.13	14.62	156.93
		Mean ± SE	288.55±11.8	19.39 ± 2.21	150.89 ± 8.72
		95% C.I	262.1-313.8	14.76 -23.97	135.45- 169.47
	Pasture	Neelpora	250.83	23.77	144
		Tikar	305	19.59	160.6
		Hiri bala	297.23	12.57	156.93
		Zachaldara	327.43	15.97	176.8
		Ashkenpora	287.94	12.21	144.06
		Mean ± SE	293.69±12.5	16.82±2.19	156.48±6.08
		95% C.I	269.4- 316.2	12.39-21.68	144.03-168.70
	Forest	Zachaldara	310.32	32.97	182.45
		Kupwara	407.43	26.63	151.96
		Tikar	304.86	18.18	172.33
		Turkpora	401.8	24.05	201.37
		Ashkenpora	315.3	20.93	210.73
		Mean ± SE	347.94 ± 23.2	24.55 ± 2.54	183.77 ± 10.4
		95% C.I	307.6- 404.6	19.56-29.80	162.1 - 206.1
Overall mean			**301.53**	**19.51**	**159.63**
MID	Agriculture	Sogam	282.15	20.41	139.53
		Laribal	310.03	13.77	146.32
		Chandigam	288.27	26.03	170.7
		Badibera	287.83	14.76	156.86
		Malpora	300.07	23.79	146.6
		Mean ± SE	293.67 ± 5.02	19.75 ± 2.42	152.00 ± 5.43
		95% C.I	284.99 -305.05	14.27 - 24.91	142.93 -163.78
	Horticulture	Chinjimula	293.24	16.09	169
		Hayan	268.38	30.47	136.4
		Trehgam	308.85	15.35	146.53
		Villgam	287.22	24.97	155.73
		Sogam	320.42	18.7	169
		Mean ± SE	295.62± 8.97	21.12 ± 2.89	155.33 ± 6.36
		95% C.I	277.80 - 314.64	15.72 -27.72	141.47 - 169.00
		Chandigam	322.44	13.17	156.06
		Guglusa	288.43	22.97	146.2

	Pasture	Tulwara	290.32	17	144.86
		Chandigam	311	15.59	163.26
		Lasipora	289.94	21.21	194
		Mean ± SE	300.43 ± 6.90	17.99 ± 1.80	160.88 ± 8.94
		95% C.I	289.19 -316.72	14.38 -22.09	145.53 - 178.63
	Forest	Gundmaschar	303.8	23.05	154.46
		Gund gushi	400.32	39.2	215.73
		Chandigam	403.24	18.78	188.86
		Gundmaschar	316.3	35.93	194.45
		Sogam	508.43	19.63	181.37
		Mean ± SE	386.42 ± 36.8	27.32 ± 4.28	186.97 ± 9.94
		95% C.I	310.1 - 455.8	19.20 - 37.57	167.92 -205.09
Overall mean			**319.03**	**21.54**	**163.79**
HIGH	Agriculture	Sogam	356.52	27.2	163.4
		Laribal	280.03	14.45	145.45
		Chandigam	300.89	25.85	153.51
		Badibera	317.32	16.04	151.56
		Malpora	327.75	23.08	167.66
		Mean ± SE	316.50 ± 12.9	21.32 ± 2.58	156.32 ± 4.05
		95% C.I	290.5 - 342.1	15.25-26.53	148.51 - 165.53
	Horticulture	Chinjimula	301.11	32.33	156.4
		Hayan	288.16	14.63	145.43
		Trehgam	434.37	25.69	161.16
		Villgam	275.15	20.58	200.1
		Sogam	326.25	18.52	143
		Mean ± SE	325.01 ± 28.6	22.35 ± 3.07	161.22 ± 10.3
		95% C.I	281.7 - 380.3	16.58 – 29.01	144.2 - 180.6
	Pasture	Chandigam	306.94	20.51	213.26
		Guglusa	405.18	16.86	144.26
		Tulwara	425.12	23.58	158.8
		Chandigam	296.23	29.99	167.2
		Lasipora	308.44	21.67	143
		Mean ± SE	348.38 ± 27.5	22.52 ± 2.16	165.30 ± 12.8
		95% C.I	301.6 - 415.2	18.69 -26.78	143.6 - 190.2
	Forest	Gundmaschar	314.3	21.93	207.3
		Gund gushi	437.96	30.55	242.37
		Chandigam	467.12	33.03	193.86
		Gundmaschar	506.43	36.63	174.46
		Sogam	309.32	25.2	162.45
		Mean ± SE	407.02 ± 40.4	29.47 ± 2.65	196.09 ± 13.9
		95% C.I	311.8 - 486.8	23.57 – 34.83	168.5 - 224.8
Overall mean			**349.23**	**22.91**	**169.73**

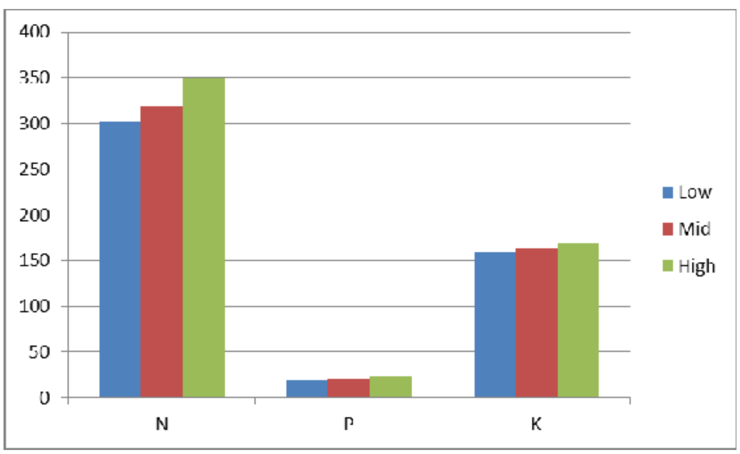

Fig. 1. Distribution of soil available macro-nutrients at different altitudes of district Kupwara.

Co relationship between physico-chemical properties and available macro-nutrients: There is negative and significant correlation between pH and N but non significant correlation with, P and K (Table 2). Similar results were found by Ramana *et al.* (2015); Maqbool *et al*. (2017). Organic carbon showed positive and significant correlation with N, P, and K. This may be due to formation of soluble chelates with organic matter which increases there availability. Similar reports were found by Mukesh *et al*., (2017). Positive and significant correlation was found between CEC with N, P and K. This may be due to increase in the availability of exchange sites with the increase of CEC. Similar reports were observed by García-Ocampo, (2012).

Table 2: Correlation between Physico-chemical properties and available macro-nutrients.

Available macronutrient	Physico-chemical properties		
	pH	OC	CEC
N	-.477**	.526**	.453**
P	-.205	.377**	.935**
K	-.148	.553**	.984**

** Significant at 1% level of significance * significant at 5% level of significance

SUMMARY AND CONCLUSION

The macro-nutrients show wide variation at altitude in different LUSs with nitrogen low to medium range having highest nitrogen content at high altitude and low at low altitude, while under different LUSs it was high in forestry and lowest under agriculture, phosphorous show highest mean value at high altitude and low at low altitude, while under LUSs it was high in forestry and lowest under Pastures in low and mid altitude but at high low in agriculture, potassium in medium range with highest mean value in high altitude and low in low altitude. In case of LUSs it was highest under forestry and lowest under agriculture. The physico-chemical characteristics of different sites at different altitudes under different land uses revealed that the pH varied from acidic to slightly alkaline range under different altitudes in different LUSs with lowest mean value of pH at high altitude and high at low altitude while under LUSs lowest in forestry and highest in pasture. The soil organic carbon show wide variation at different altitudes with highest mean value in high altitudes and low at low altitude, while under different LUSs highest value was under forests followed by pasture and lowest value under horticulture followed by agriculture. CEC showed highest mean value in high altitudes and lowest in low altitude. In case of LUSs it was low in agriculture but high in forests.

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Conflict of Interest. None.

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