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Depth Wise Distribution of Available Nutrients of Soils of Langate Block of District Kupwara of Kashmir Valley

Andleeb Mushtaq Khan*, D. Ram, J. A. Wani, Amal Saxena, S. A. Mir and N. A. Bhat

Division of Soil Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar- 191121, Jammu & Kashmir (India)

**Corresponding author*

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A B S T R A C T

Nine typical pedons from Langate Block of Kupwara district during 2017 were selected and surveyed for the purpose of collection of soil samples. The soil samples processed and analyzed for different nutrients. Available Micro and Macro nutrients were determined using standard techniques. The overall results showed that the soils are near slightly acidic to moderate alkaline in reaction, low to medium in organic carbon. In general the soils The available nutrients Nitrogen and Potassium were low to medium with the mean values of 287.99 and 149.69 kg ha^{-1}, whereas Phosphorus and Sulphur were low to high with the mean values of 35.80 and 10.85 kg ha^{-1}., respectively. The micronutrient cations viz., Zinc, Copper and Manganese were medium to high and iron was low to high.

Introduction

Healthy soil is the basis of healthy food system. It produces healthy crops that in turn nourish the people. Managing soil resources for food security on sustainable basis is gaining immense attention keeping in view the increasing pressure on soil due to intensive agricultural production system for rising population. The most important basic natural resource that determines the ultimate sustainability of any agricultural system is the soil. More than 90 per cent of world's food production is dependent on soil and the demands of a growing population for food, feed and fibre are estimated to result in a 60 percent increase by 2050. These pressures combined with unsustainable land uses and management practices, as well as climate extremes, cause severe land degradation (Venkataratnam and Manchanda, 1997). Soil fertility is a dynamic natural property and it can change under the influence of natural and human induced factors to maintain agricultural land at optimum level of fertility and productivity, great attention has been given to assess the physical and chemical properties of the soil resources under different famers' fields. Systematic soil fertility characterization is always needed for evolving soil nutrient management strategies. The change in soil nutrient stocks over time has to be measured in order to quantify the extent of nutrient mining and maintaining the cropping system for sustainable crop production. The studies on nutrient status of soils are essential to generate information regarding efficiency of nutrient availability of soils in order to improve yeild and maintain soil health. Soil nutrients play a vital role in the growth, development and yield of plant and the information on the fertility status of an area can go a long way in planning judicious fertilizers and soil management practices to develop economically viable alternatives for the farming community (Singh, 1995). Keeping in view the above-mentioned facts, present investigation was carried out in Langate block of district Kupwara.

Materials and Methods

The selected study area Langate Block belongs to Kupwara district of Kashmir valley which has an area of 2,379 sq km. The study area Langate Block is located between 34.15^0 N to 34.28^0 N latitude and 74.09^0 E to 74.27^0 E longitude at 1583 metres above msl) of district Kupwara, Jammu and Kashmir. The study area was by actual traversing across the various land forms before the selection of representative sites. Keeping in view surface features like, physiographic changes, altitude and present land use, nine representative soil profiles at different locations were selected for studying the soil properties in detail. Nine sites were selected which represented the whole Block (Table 1) of the valley. Thirty-six samples were taken from different horizons brought to the laboratory and dried in the shade for one week and then grounded with the help of wooden pestle and mortar. The laboratory analyses consisted of detailed routine analyses of the soil samples for required plant nutrients. Available nitrogen was estimated by alkaline potassium permanganate method as given by Subbiah and Asija (1956). The available phosphorus was extracted by 0.5 M NaHCO3 at pH 8.5 and colour developed by stannous chloride was measured with the help of spectrophotometer at 660 nm wave length (Olsen and Sommers, 1982). The available potassium was extracted by 1N ammonium acetate at pH 7 and then determined with the help of flame photometer (Jackson, 1973). Available sulphur was determined turbidimetrically as Barium sulphate by the method of Chesnin and Yein (1950). While as The micronutrient estimation was done by using the method outlined by Lindsay and Norvell (1978) using Atomic Absorption Spectrophotometer (AAS).

Results and Discussion

Available Macronutrients

The data regarding the available Macronutrient status of the soils in study area is presented in table 2.

The nitrogen content in soils of study area ranged from 180.20 to 393.70 kg ha^{-1} with a mean of 287.99 kg ha^{-1}. The available nitrogen content in surface soils varied from 181.8 to 393.7 kg ha^{-1} while as, in subsurface soils it varied from 180.2 to 298.5 kg ha^{-1}, respectively. Perusal of the data reveals that the available nitrogen content was in the surface horizons as compared to the sub-surface horizons. All the pedons showed a regular decrease in available nitrogen content with the depth. The highest available nitrogen content present in Pedon P_6 and lowest available nitrogen content was in Pedon P_1 (Kralgund). The available nitrogen was medium with higher values confined to the surface horizons which may be attributed to the confinement of organic carbon in surface horizons and the supplementation of depleted nitrogen by crops through external addition of fertilizers during crop cultivation (Naidu and Sireesha, 2013). The available nitrogen decreased more or less with depth of the pedons, which might be due to decreasing trend of organic carbon with depth. This observation was in agreement with the results of Hijbeek *et al.,* (2018).

Available phosphorus content was medium to high with values ranging from 15.68 to 64.96 kg ha^{-1} with the mean value of 35.8 kg ha^{-1}. The available phosphorus content in surface soils varied from 17.92 to 62.72 kg ha^{-1} while as, in subsurface soils it varied from 15.68 to 47.04 kg ha^{-1}. All the pedons showed decrease in phosphorus content with the depth except pedons P_5 that showed an irregular trend. The depth wise available phosphorus exhibited decreasing trend in its vertical distribution. The highest available phosphorus content was present in pedon P_4 (Hangah) and lowest available Phosphorus content was in pedon P_8 (Drungsoo). All the pedons showed decrease in phosphorus content with the depth except pedons P_5 that showed an irregular trend. The depth wise available phosphorus exhibited decreasing trend in its vertical distribution. The reason for high available phosphorus in surface horizons might possibly be due to the confinement of crop cultivation to the rhizosphere which improves the organic carbon content in surface and supplementing the depleted phosphorus by external sources *i.e.*, fertilizers and presence of small amounts of free iron oxide and exchangeable Al^{3+} in the surface horizons (Ringeval *et al.,* 2014). The lower phosphorus content in sub-surface horizons in these pedons could be attributed to the fixation of P by clay minerals and oxides of iron and aluminum (Khanday, 2013 and Kumar *et al.,* (2017). The irregular trends with respect to P content may be attributed to the changes in weathering intensity of phosphatic minerals in these soils (Kirmani, 2004; Bhat, 2010).

The available potassium varied from 95.2 to 204 kg ha^{-1} with the mean value of 149.6 kg ha^{-1}. The highest available potassium content present in pedon P_2 (Guloora) and lowest available potassium content was in pedon P_9 (Khudi). Available potassium was medium in surface horizons and showed a regular decrease with the depth. The available potassium content in surface soils varied from 128.8 to 204.4 kg ha^{-1} while as, in subsurface soils it varied from 95.2 to 186.2 kg ha^{-1}. Available potassium was medium in surface horizons and showed a regular decrease with the depth.

Table.1 Selection of pedon sites and their present land use

Pedon No.	Village /Location	Natural Vegetation	Present land use
P_1	Kralgund	*Populus, Salix, Perrenail grasses*	Apple, Maize
P_2	Guloora	*Salix, Populus, Perrenail grasses*	Vegetables, Apple
P_3	Ujroo	*Populus, Salix, Perrenail grasses*	Paddy
P_4	Hangah	*Salix, Populus, Perrenail grasses, Cedrus, Pinus*	Apple, Maize
P_5	Batagund	*Perrenail grasses, Populus, Salix*	Paddy, Mustard
P_6	Qalamabad	*Perrenail grasses, Populus, Salix*	Vegetables, Apple
P_7	Haril	*Cedrus, Salix, Populus, Perrenail grasses, Pinus*	Paddy
P_8	Drungsoo	*Cedrus, Pinus, Populus, Salix, Perrenail grasses*	Apple, Maize
P_9	Khudi	*Cedrus, Pinus Populus, Salix, Perrenail grasses,*	Vegetables, Apple

Table.2 Macronutrient status of arable soils of Langate block of district Kupwara

Pedon	Horizon	Depth (cm)	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	S (kg ha^{-1})
P_1	Ap	0-29	374.80	49.28	180.36	11.85
	AB	29-45	336.20	33.60	169.28	10.47
	Bt1	45-52	286.10	29.10	156.24	9.47
	Bt2	52-62	230.20	26.80	145.42	8.70
	Bt3	62-68	197.50	24.64	145.23	8.60
	Bt4	68-103	180.20	24.24	128.82	8.00
P_2	Ap	0-18	364.60	31.36	204.00	12.40
	AB	18-39	349.80	26.80	196.00	10.90
	Bt1	39-69	266.10	22.40	190.40	10.70
	Bt2	69-128	240.50	23.92	186.20	9.60
P_3	Ap	0-15	181.80	31.30	180.60	8.70
	AB	15-30	344.50	49.28	156.80	16.50
	Bt1	30-60	313.60	20.16	145.60	14.05
	Bt2	60-116	282.50	29.10	134.40	10.38
	Bt3	116-157	219.50	17.92	123.20	9.47
P_4	Ap	0-17	376.00	60.48	175.60	10.47
	AB	17-44	355.20	64.96	162.40	10.30
	Bt1	44-51	283.50	47.04	156.80	9.00
	Bt2	51-90	208.30	20.16	151.20	8.47
P_5	Ap	0-30	360.10	58.24	127.90	14.50
	Bt1	30-60	272.30	44.80	119.40	12.30
	Bt2	60-107	188.10	47.04	117.60	9.37
P_6	Ap	0-30	393.70	47.04	192.50	16.43
	Bt1	30-65	305.80	26.80	165.40	12.47
	Bt2	65-110	298.50	17.92	117.50	10.38
P_7	Ap	0-17	305.40	62.72	160.20	14.47
	Bt1	17-60	265.80	33.60	158.90	12.30
	Bt2	60-85	250.60	22.40	145.60	10.50
P_8	Ap	0-22	313.60	17.92	128.80	10.47
	AB	22-49	282.20	15.68	117.60	9.38
	Bt1	49-93	210.60	15.68	100.80	8.43
P_9	Ap	0-29	383.40	56.00	156.60	12.06
	AB	29-64	363.70	60.48	144.40	10.70
	Bt1	64-88	316.70	47.04	128.80	10.40
	Bt2	88-97	272.30	42.56	123.20	9.38
	C	97-124	194.00	40.34	95.20	9.02
Mean			**287.99**	**35.80**	**149.69**	**10.85**
SD			**64.27**	**15.23**	**27.55**	**2.18**
Max			**180.20**	**15.68**	**95.20**	**8.00**
Min			**393.70**	**64.96**	**204.00**	**16.50**

Table.3 Micronutrient status of arable soils of Langate block of district Kupwara

Pedon	Horizon	Depth (cm)	Zn (ppm)	Cu (ppm)	Fe (ppm)	Mn (ppm)
P_1	Ap	0-29	1.80	2.51	47.20	36.11
	AB	29-45	1.24	1.86	41.83	34.23
	Bt1	45-52	0.89	1.23	38.53	24.26
	Bt2	52-62	0.80	1.17	38.14	22.30
	Bt3	62-68	0.57	1.03	29.91	18.04
	Bt4	68-103	0.51	1.02	23.46	16.73
P_2	Ap	0-18	1.52	2.96	41.83	32.52
	AB	18-39	1.13	2.33	35.54	27.76
	Bt1	39-69	0.68	1.76	32.11	22.38
	Bt2	69-128	0.72	1.57	25.08	18.62
P_3	Ap	0-15	0.60	1.39	22.11	17.34
	AB	15-30	1.99	2.64	44.20	38.15
	Bt1	30-60	1.30	2.03	31.86	29.65
	Bt2	60-116	0.95	1.78	25.48	22.31
	Bt3	116-157	0.62	1.13	22.11	19.62
P_4	Ap	0-17	1.89	2.88	42.31	35.80
	AB	17-44	1.06	2.34	38.34	29.88
	Bt1	44-51	0.98	1.78	24.31	20.38
	Bt2	51-90	0.70	1.06	21.40	18.94
P_5	Ap	0-30	1.12	2.56	40.21	30.49
	Bt1	30-60	1.07	1.78	28.38	22.11
	Bt2	60-107	0.37	1.02	21.50	17.38
P_6	Ap	0-30	1.66	3.06	48.28	35.54
	Bt1	30-65	1.03	2.51	35.08	20.63
	Bt2	65-110	0.28	1.80	28.62	17.56
P_7	Ap	0-17	1.80	2.33	45.51	35.80
	Bt1	17-60	1.18	1.99	38.38	24.26
	Bt2	60-85	0.93	1.16	23.91	18.55
P_8	Ap	0-22	1.38	2.80	46.03	36.94
	AB	22-49	0.98	1.86	34.43	25.08
	Bt1	49-93	0.72	1.20	27.50	16.50
P_9	Ap	0-29	1.78	2.98	47.40	30.83
	AB	29-64	1.32	2.12	36.11	24.26
	Bt1	64-88	0.88	1.64	27.48	22.31
	Bt2	88-97	0.62	1.35	24.30	18.98
	C	97-124	0.43	1.24	22.13	17.83
Mean			**1.04**	**1.89**	**33.36**	**25.00**
SD			**0.46**	**0.65**	**8.78**	**7.01**
Max			**0.28**	**1.02**	**21.40**	**16.50**
Min			**1.99**	**3.06**	**48.28**	**38.15**

The available potassium content in surface soils varied from 127.9 to 204.0 kg ha^{-1} while as, in subsurface soils it varied from 95.2 to 186.2 kg ha^{-1}, respectively. Slow weathering and fixation of released potassium might have resulted in low exchangeable potassium status (Rosemary *et al.,* 2017). Amount and type of clay, organic carbon, soil pH and CEC significantly affects the K-availability in the soil. The similar results were also recorded from observation of Fageria and Baligar (2003) and Auge *et al.,* (2017). The higher amount of potassium in surface soils was due to due to greater exposure of these minerals to weathering agencies at surface than sub-soils, higher weathering of potassium bearing minerals in surface soils, CEC of the clay minerals soil pH soil moisture temperature and aeration, potassium leaching and also due to fertilizer and manure. Same results were also observed by Naik (2014) and Ho *et al.,* (2019).

The available sulphur ranged from 8.00 to 16.50 kg ha^{-1} with the mean value of 10.85 kg ha^{-1}. The highest available sulphur content present in pedon P_3 (Ujroo) and lowest available sulphur content was in pedon P_1 (Kralgund). Available sulphur content was low to high in general and showed a regular decreasing trend with the depth in all pedons except pedons P_3 and P_4 that showed irregular sulphur content with the depth. In general, available sulphur was higher in surface horizons as compared to sub-surface horizons. The available sulphur content in surface soils varied from 8.70 to 16.43 kg ha^{-1} while as, in subsurface soils it varied from 8.00 to 16.50 kg ha^{-1}. Available sulphur content was low to high in general and showed a regular decrease with the depth in all the pedons except pedons P_3 and P_4 that showed irregular sulphur content with the depth. In general, available sulphur was higher in surface horizons as compared to sub-surface horizons. This might be due to varying land use and parent material (Farida, 1997). The type of clay mineral, soil pH, presence of hydrous oxides in soil, soil depth and soil organic matter and sulphur mineralization and immobilization determine the availability of sulphur in soil. The results are in agreement with Kulhanek *et al.,* (2016) and Bier and Singh (2018).

Available Micronutrients

The data pertaining to available micro nutrient cations was tabulated in Table 3 reveals that all the pedons of the study area were normal in zinc content with a decreasing trend in the sub-surface horizons with the depth whereas pedons P_2 and P_3 showed an irregular trend in the pedon. In general, the zinc content ranged from 0.60 to 1.99 ppm in surface horizons as compared to sub-surface horizons where it showed a decrease in its value up to 0.28 ppm. The highest (1.99 ppm) was observed in pedon 3 (Ujroo), and lowest (0.28 ppm) was found in pedon 5 (Batagund). All the pedons of the study area were normal in zinc content with a decreasing trend in the sub-surface horizons with the depth whereas pedons P_2 and P_3 showed an irregular trend in the pedon. In general, the zinc content ranged from 0.60 to 1.99 ppm in surface horizons as compared to sub-surface horizons where it showed a decrease in its value up to 0.28 ppm. The trend variation may be attributed to the root distributional patterns of principle crops in soil pedons. The variation in amount of zinc may be due to changing soil pH and its interaction with other ions. The results are in accordance with Khanday *et al.,* (2017).

Copper content was medium to high with a range of 2.33 to 3.06 ppm in surface horizons and decreased up to 1.02 ppm in sub-surface horizons. The highest was observed in pedon 6 (Qalamabad) and lowest was found in pedon 5 (Batagund). All the pedons showed decreased copper content with the pedon depth. Copper ranged from medium to high in all pedons and showed variable distribution with the pedon depth. The trend variation may be attributed due to the root distributional patterns, pH variation along the depths (Ali *et al.,* 2016). The variation in Cu content with the depth may also be attributed to the positive relation with organic carbon, clay content and cation exchange capacity of the soils (Yadav and Meena, 2009).

Iron was present in sufficient amounts 21.40 – 48.28 ppm with the mean value of 33.36 ppm. In the surface horizons iron was in the range of 40.21 to 48.28 ppm as compared to the sub-surface horizons where it showed a decrease in its value up to 21.40 ppm. All the Pedons showed decrease in iron content down the pedon. The highest was observed in pedon 6 (Qalamabad) and lowest was found in pedon 4 (Hangah). All the Pedons showed decrease in iron content with the depth of pedon. The variation in the amount of iron may be due to chelation of iron, soil pH and bicarbonate content, excessive water and poor aeration, variable amount of organic matter, type of soil texture and presence of other cations. It might be due to reduction of organic carbon in the sub surface horizons. Surface horizons had higher concentration of DTPA-extractable Fe due to relatively higher organic carbon in surface horizons (Shah *et al.,* 2012 and Wang *et al.,* 2018).

The available Manganese content varied from medium to high in general with a range of 16.50 to 36.94 ppm with the mean range of 25.01 ppm. The highest and lowest was found in pedon 8 (Drungsoo). Manganese content varied with a range of 30.83 to 36.94 ppm in surface horizons and decreased with the depth up to a value of 16.50 ppm. All the Pedons showed decrease in iron content down the pedon except P_3 which showed an irregular trend. Manganese content was medium to high and showed trends of indefinite pattern with the depth in most of the pedons which might be due to the changes in pH as well as organic, higher biological activity and organic carbon in the surface horizons, the higher content of available Mn in surface soils was attributed to the chelation of organic compounds released during the decomposition of organic matter left after harvesting of crop. Similar results were also observed by Cremer and Prietzel (2017).

The availability of these ions (Zn, Cu, Fe and Mn) increased with increase in organic matter because organic matter acts as a chelation agent for making complex of these micronutrients which reduces their adsorption, oxidation and precipitation into unavailable forms.

In conclusion the available nitrogen and potassium content was medium and showed higher values in the surface horizons while as phosphorus and sulphur was medium to high and irregularly distributed within the pedons indicating the prevalence of weathering process in phosphatic and sulphatic minerals. The micro-nutrients cations were medium to high in concentration which showed distributional patterns as per root distribution within the pedons. In the light of the findings of this research, the following main recommendations are forwarded:

It is necessary to implement appropriate land use practices such as plantation and successful introduction and adoption of agricultural technologies on a sustained basis.

Organic manuring and soil structural management with organic materials are the recommended improvements for its use and the use of balanced fertilizer.

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