Biological Forum – An International Journal 14(3): 1259-1264(2022)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Distribution and characterization of Nitrogen, Phosphorus and Potassium in different depth of soil profile in ITM research farm at Gwalior Madhya Pradesh

Pragya Verma[1*], Paramita Deb[2], Amit Kumar Nema[3], Mukesh Sheetpal[4], Tirunima Patle[2] and Rishikesh Tiwari[5]

[1]Research Scholar, Department of Soil Science, School of Agriculture,
ITM University, Gwalior (Madhya Pradesh), India.
[2]Assistant Professor, Department of Soil Science, School of Agriculture,
ITM University, Gwalior (Madhya Pradesh), India.
[3]Research Scholar, Department of Agronomy, Department of Agronomy,
RVSKVV University, Gwalior (Madhya Pradesh), India.
[4]Assistant Professor, Department of Soil Science, School of Agriculture,
ITM University, Gwalior (Madhya Pradesh), India.
[5]Junior Research Fellow, Project Coordinating Unit, (Sesame & Niger),
Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (Madhya Pradesh), India.

(Corresponding author: Pragya Verma)*
(Received 15 July 2022, Accepted 16 August, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: A field carried out at research farm at research Farm of ITM University Gwalior in 2021–2022, to evaluate the distribution and characterization of nitrogen, phosphorous, and potassium in various depths of soil profiles. These soil samples were collected at 0–15, 15–30, and 30-45 cm from different locations of research farms, then analyzed. Results showed that the organic carbon was low. Also, Soil textural analysis revealed that sand particles were dominant over silt and clay in the surface layer of all research farms. The soil texture varied from sandy loam to silt. Based on research the pH of soil was saline to slightly alkaline. It ranged from 7.4-8. Electrical conductivity ranged from 0.21-0.68 dsm^{-1}. Organic carbon content was more in surface layer than in sub-surface layer. It ranged from 0.25-0.53 %. The amount of accessible N was typically in the low range (118.5-149.5 kg ha^{-1}), additionally phosphorus was low (9.9-13.8 kg ha^{-1}). Medium K content was found in surface layer with the range of 218.2-329.4kg ha^{-1} at all locations whereas at lower depth it value was found to be low. A decreasing pattern of primary macro nutrient was noticed all profile depth, which may be varied due to accrual of organic matter in surface horizon by the high rate of decomposition under hyperthermic temperature regime and climate. Electrical conductivity show highly positive significant correlation with nitrogen. Phosphorus had highly significant positive correlation with potassium. Porosity and Bulk density had highly significant positive correlation with potassium.

Keywords: Nitrogen, Phosphorus, Potassium, correlation, soil profile, surface layer.

INTRODUCTION

India covers up 328.8 million hectares, or 8% of the total land area in the globe. Of this land, about 51% is cultivated, compared to 11% globally. The present cropping intensity of country has been 142% registered. The current agricultural intensity in the nation is 142%. Furthermore, 65 percent of the total net sown area is contributed by agriculture on rainfed dryland. Due to nutrient shortages and toxicities, the country's 25 million ha of acidic soils have poor yield of less than 1 ton/ha. These arable fields might have their output doubled with the right amount of liming and fertilizer application. The soil of northern Madhya Pradesh is severely deficient in nitrogen and crops grown on it show deficiency symptoms in almost all the professions where it is not applied. Currently, 99 percent of soils suffer from nitrogen deficit, and crops cultivated on those soils invariably exhibit deficiencies in nearly all fields where it is not applied a sufficient supply of nitrogen is typically connected with vigorous vegetative development of plants and rich green colour of leaves (Katyal, 2016). Plants need high amount of phosphorus so it is a crucial element. Despite being abundant in soil in both organic and inorganic forms, it is the main nutrient that regulates plant growth. (Tandon, 1987), While potassium is the seventh most widespread element and the fourth most abundant mineral nutrient in the lithosphere (Sparks *et al*., 1985).

On the crop's root system, Potassium is necessary for many metabolic processes carried out by living cells, including the breakdown of carbohydrates. When determining the long-term availability of potassium to crops and creating a solid foundation for fertilizer recommendations, understanding the various forms of potassium in soil and their distribution is of utmost importance (Lalitha and Dakshinamoorthy 2014). The district of Gwalior is located in Madhya Pradesh's northern region. Typically, the farmers in the region plant wheat, peas, black gramme, green gramme, pearl millet, mustard, peas, and sorghum in the Rabi season. Cereal, cereal-legumes, and cereal-oil seeds are the major cropping systems used by farmers. The present study was planned to determine the distribution of Nitrogen, Phosphorus and Potassium with relationship amongst different soil properties in different depth.

Study area. The present study has conducted in research farms (sitholi, CRC 1, CRC 2, Turari 1, Turari 2, polyhouse 1, polyhouse 2) of ITM university Gwaior. The climate of Gwalior has subtropical with hot summers from late March to Early July. The humid monsoon season from late June to Early October, and cool dry winter from Early November to late February. Annual rainfall ranges from 700 to 800 mm, most of which fall during last June to the middle of September. In this area winter rains are occasional and uncertain. The city has a humid subtropical climate.

Data Collection. The soil samples were collected from 0-15 cm, 15-30 cm and 30-45 cm depths of each pit with auger. Hence, samples were collected from soil of Sitholi, CRC1, CRC 2, TURARI 1 Turari 2 Polyhouse 1 and Polyhouse 2 at ITM research farm Gwalior. The soil samples were air dried in the shade, grinded with mortar and pestle and sieved through a 2 mm sieve. The samples were stored in polythene bags properly labeled for soil analysis.

MATERIAL AND METHOD

Measurements of selected physical and chemical properties of the soil sample as bulk density, texture, pH, EC, and Organic carbon were carried out by different methods. Moisture was determined by drying weighed quantity of the air-dried soil at 105° in electric oven for 24 hours (Piper, 1950). The pH of the soils was determined in soil water suspension using a glass electrode pH meter as described by Jackson (1967). The electrical conductivity of the soils was determined in soil water extract with the help of an electrical conductivity meter as given by Jackson (1967). The particle size analysis was done by the Bouyoucos hydrometer method as described by Piper (1950). Depth – wise soil samples were collected using a metal core sampler for bulk density analysis (Blake and Hartge 2018). The organic carbon percent of the soils was estimated by wet digestion method of Walkley and Black (1934). Available nitrogen content of individual soil samples was determined by alkaline permanganate method as given by Subbaiah and Asija (1956). Available phosphorus of the soil is determined by Olsen *et al.* (1954). While, the available potassium content of the soil is determined by Jackson, (1973) using Flame Photometer through Neutral ammonium acetate method.

Statistical analysis. All statistical analysis was performed by OPSTAT software and WASP agri-software. The means of replicates and standard errors of the means were analyzed for selected soil properties under different locations and compared with two-way analysis of variance (ANOVA) test.

RESULT AND DISCUSSION

The experimental findings pertaining to present investigation entitled "Distribution and characterization of Nitrogen, Phosphorus and Potassium in different depth of soil profile in ITM research farm at Gwalior Madhya Pradesh" are discussed under: The soil profile are studied in different location of research farms (sitholi, CRC 1, CRC 2 Turari 1, Turari 2, Polyhouse 1, polyhouse 2). Mechanical analysis of soil profiles are presented in Table 1. Among the different soil fractions viz., sand, silt and clay, the later two fractions appeared to be the major one in all soil profiles. The textural classes was found to be sandy loam at all three depth. Percentage of sand, silt and clay varied from 56.4% - 73.1%, 10%- 20.6% and 14.9% to 24.6% .respectively. The observed data showed that the silt particles decreased significantly with the increase in depth of soil at sitholi, CRC 2, turari 1, poly 1 and turari 2, whereas, it increased with increase in depth at poly 2 and CRC 1 location. While neutral in middile depth at turari 2. Studies given by Sharma *et al.* (2005); Dar (2009); Najar (2009); Naik (2014) reported that, sand decreased with soil depth while clay increased with soil depth in all the farms. Silt did not follow a regular pattern. These results are also found with the observations of Wani (2001); Wani *et al.* (2016). The increasing tendency of clay with depth in soil profiles may be due to leaching from upper to lower layer.

Bulk density ranged from 1.55-1.48 in sitholi; 1.50-1.55 in CRC 1; 1.49-1.54 in CRC 2; 1.47-1.57 in Turari 1; 1.45 -1.51 in Turari 2; 1.52-1.59 in polyhouse 1; 1.55-1.60 in polyhouse 2. The observed data showed that the bulk density of soil increased significantly with the increase in depth of soil at all locations whereas, it decreased with increase in depth at sitholi location. Porosity ranged from 48.78-41.32 in sitholi; 49.56-43.29 in CRC 1; 49.36-42.87 in CRC 2; 45.40-40.26 in Turari 1; 43.62-37.71 in Turari 2; 49.20-41.98 in polyhose 1; 48.96-42.54 in polyhouse 2. It showed the increase in depth of soil the porosity decreased. The colour of the soil in the different locations at different depths varied from light yellow brown (10YR 5/3) /dark brown (10YR 4/3) to dark yellowish brown (10YR 3/4) (10YR 4/4) while as dark brown (10YR 4/3). The studied profiles could be attributed to presence of $CaCO_3$ or may be due to coagulation of iron or calcium with humus (Dhir, 1967; Gupta, 1992). The various shades like dark brown, very dark brown, yellowish brown colour in surface and subsurface horizons of profiles indicate a good drainage condition of the soils (Mahajan *et al.*, 2007) and may be ascribed to difference in soil organic matter, topographic position and geographical location (Sawhney *et al.*, 2005; Khanday, 2013; Naidu and Sireesha 2013; Wani *et al.* 2017).

Physico-chemical properties of the soil profiles are represented in Table 2. The pH values ranged from 8.08-7.81 in sitholi; 7.67-7.58 in CRC 1; 7.58-7.44 in CRC2; 8.27-7.90 in Turari 1; 8.18-7.98 in Turari 2; 8.16-7.60 in polyhouse 1; and 7.63-7.46 in polyhouse 2. The soils were slightly acidic to slightly alkaline in reaction. According to Thangaswamy *et al.* (2005) the higher pH could be due to increase in accumulation of exchangeable sodium, variation in organic matter and calcium carbonate. The decreased in pH with depth had also been reported by Wani *et al.* (2017). Similar results were given by Naik (2016). EC ranged from 0.28-0.55 dSm^{-1} in sitholi; 0.50-0.61 dSm^{-1} in CRC 1; 0.44-0.56 dSm^{-1} in CRC 2; 0.36-0.49 dSm^{-1} in Turari 1; 0.39-0.53 dSm^{-1} in Turari 2; 0.50-0.70 dSm^{-1} in polyhouse 1; 0.63-0.76 dSm^{-1} in polyhouse 2. EC values in the study area are not in safe limits (>0.1 dSm^{-1}) with salinity and alkalinity hazards in the top soil. It showed increasing trend with the increase in the depth of soil. The EC in general showed increasing trend with depth as compared to surface horizons and was found to be in normal range in both horizons of poly 2 and CRC 1. All soil sample were found to be normal (EC< 1.0 dSm^{-1}). The increase of electrical conductivity with depth could be attributed to leaching of bases from surface to sub surface horizons. The results are in agreement with the findings of Najar (2009); Tuba and Kaleem (2016). Organic carbon followed decreasing trend with in all seven locations Its ranged from 0.54-0.25 in sitholi; 0.49-0.30 in CRC 1; 0.50-0.30 in CRC 2; 0.48-0.29 in Turari 1; 0.50-0.31 in Turari 2; 0.56-0.29 in polyhouse 1; 0.45-0.30 in polyhouse 2. Low organic carbon % was observed at the surface layer of the locations. The high content of organic carbon in upper layers as against lower depths might be as a result of incorporation of crop residues and fallen leaves. These findings are in accordance with Sharma *et al.* (2005); Najar *et al.* (2009); Wani *et al.* (2016). Coarse-textured soils are generally low in organic carbon (Yadav and Meena 2009). The low organic carbon% in this type soils may be attributed to the high rate of organic matter decomposition under hyperthermic temperature regime which leads to high oxidation condition, removal of surface soils containing high organic carbon due to erosion which was responsible for the lower organic carbon (Rajeswar *et al.,* 2009).

Available N content varied from 124.74-112.24 kg ha^{-1} in sitholi; 139.94-125.99 kg ha^{-1} in CRC 1; 141.70-129.74 kg ha^{-1} in CRC 2; 142.30-131.02 kg ha^{-1} in Turari 1; 130.62-117.44 kg ha^{-1} in Turari 2; 147.60-134.90 kg ha^{-1} in polyhouse 1; 143.28-131.68 kg ha^{-1} in polyhouse 2. Low available N was observed in all the locations. The available nitrogen was higher in surface soils which showed a linear decreasing trend with an increase in soil depth in all the seven locations. Similar results were reported by Najar (2002); Dar *et al.* (2013) and Naidu, Sireesha (2013) and Wani *et al.* (2017). It is revealed from the results that efficiency of nitrogen is very low due to the fact that nitrogen lost through various mechanisms, like NH_3 volatilization, de-nitification, chemical and microbial nitrogen fixation, leaching and run off (Sharma *et al.*, 2008). Available P content varied from 13-11.68 kg ha^{-1} in sitholi; 12.14-9.64 kg ha^{-1} in CRC 1; 11.90-10.18 kg ha^{-1} in CRC 2; 10.96-9.98 kg ha^{-1} in Turari 1; 10.72-9.62 kg ha^{-1} in Turari 2; 12.68-1.02 kg ha^{-1} in polyhouse 1; 12.42-10.66 kg ha^{-1} in polyhouse 2; The available phosphorus showed a decreasing trend with all three depth, medium amounts were recorded in surface soils. In general the soils of upper layer showed higher levels of available phosphorus content followed by mid and low depths. Similar results about soils of Kashmir were also reported by Wani (2001); Dar *et al.* (2009). The lower phosphorus content in subsurface soils could also be attributed to the fixation of P by clay-minerals and oxides of iron and aluminium (Thangasamy *et al.*, 2005; Khanday, 2013; Maqbool *et al.*, 2017). Available K content varied from 304.94-240.04 in sitholi; 302.43-288.78 in CRC 1; 317.28-278.54 in CRC 2; 222.26-223.15 in Turari 1; 230.34-210.10 in Turari 2; 291.86-261.44 in polyhouse 1; 283.26-264.22 in polyhouse 2. Available K content decreased with increasing depth, low amount of K was found at surface layer in all seven location. At lower depth low to medium available K was observed. The available potassium showed a decreasing trend with depth, higher amounts were recorded in surface soils. These results are also noticed with those of Najar (2002) and Dar (2009).

Correlation coefficients (r) of soil physico-chemical characteristics in 0-15 cm depth of soil. Perusal of the correlation coefficient (r = values) presented in Table 6, 7 and 8 revealed that electrical conductivity (r =0.582**) show highly positive significant correlation with nitrogen. While silt (r = 0.271) had positive non significant correlation. Phosphorus had highly significant positive correlation with potassium (r = -0.673**), porosity (r = 0.583**) and Bulk density (r = 0.679**). Porosity (r = 0.690**) and Bulk density (r = 0.478**), had highly significant positive correlation with potassium, While pH had highly negative significant negative relationship with available potassium. Sand had negative non-significant correlation with potassium.

Table 1: Depth wise distribution of sand, silt, clay porosity, BD and moisture.

Location	Sand%			Silt%			Clay%			Porosity%			Bulk density (Mgm^{-3})			Moisture%		
	Depth(cm)			Depth(cm)			Depth(cm)			Depth(cm)			Depth(cm)			Depth(cm)		
	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45
sitholi	67.10	64.90	61.90	12.84	13.10	12.14	20.00	21.96	25.88	48.78	48.78	41.32	1.55	1.54	1.48	14.04	15.63	18.15
CRC 1	59.80	55.40	53.00	17.93	20.34	19.58	22.18	24.20	27.38	49.56	49.56	43.29	1.50	1.55	1.55	12.91	15.00	16.80
CRC 2	60.20	55.90	53.50	18.30	18.46	17.90	21.44	25.64	28.54	49.36	49.36	42.87	1.49	1.53	1.54	12.53	14.22	15.88
Turari 1	65.10	62.30	59.04	15.96	14.06	13.80	18.88	23.60	27.15	45.40	45.40	40.26	1.47	1.51	1.57	12.16	12.72	14.08
Turari 2	65.50	61.50	58.80	13.06	13.74	13.36	21.40	24.76	27.76	43.62	43.62	37.71	1.45	1.49	1.51	12.87	14.95	16.07
Poly 1	69.90	67.70	65.42	12.80	12.96	11.30	17.26	19.32	23.28	49.20	49.20	41.98	1.52	1.54	1.59	13.10	13.71	14.77
Poly 2	65.90	63.60	58.43	12.72	13.82	17.00	21.31	22.50	24.57	48.96	48.96	42.54	1.55	1.55	1.60	12.59	14.09	15.26
CV	3.36	4.38	4.50	8.23	11.75	13.56	7.84	6.80	4.73	4.68	4.68	7.42	4.68	2.88	2.17	8.17	8.17	6.79
SD	3.63	4.54	4.38	2.54	2.94	3.15	1.75	2.11	1.88	2.35	2.35	1.93	0.04	0.02	0.04	0.59	0.96	1.34
SE	1.37	1.71	1.65	0.96	1.11	1.19	0.66	0.80	0.71	0.89	0.89	0.73	0.01	0.01	0.02	0.22	0.36	0.51
CD at 5% level	2.83	3.50	3.42	1.58	2.32	2.64	2.07	2.04	1.61	2.90	2.90	NS	0.05	NS	0.04	NS	1.52	1.39

Table 2: Depth wise distribution of Organic carbon, EC, pH, nitrogen, phosphorus and potassium.

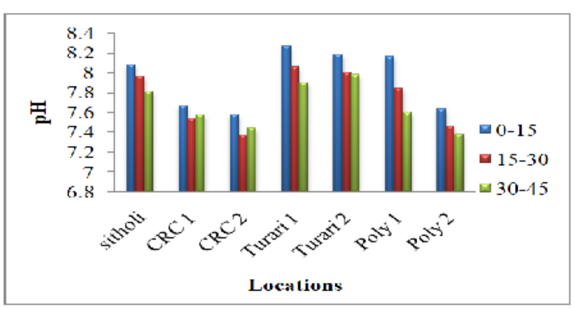
Location	Organic Carbon%			pH			EC (dsm^{-1})			Nitrogen(kg ha^{-1})			Phosphorus(kg ha-^{1})			potassium(kg ha^{-1})		
	Depth(cm)			Depth(cm)			Depth(cm)			Depth(cm)			Depth(cm)			Depth(cm)		
	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45
Sitholi	0.54	0.42	0.25	8.08	7.97	7.81	0.28	0.51	0.55	124.7	120.0	112.2	13.00	12.26	11.68	304.9	262.5	240.0
CRC 1	0.49	0.37	0.30	7.67	7.54	7.58	0.50	0.59	0.61	139.9	131.9	126.0	12.14	10.74	9.64	302.4	292.9	288.8
CRC 2	0.50	0.41	0.30	7.58	7.37	7.44	0.44	0.53	0.56	141.7	135.7	129.7	11.90	11.08	10.18	317.3	287.8	278.5
Turari 1	0.48	0.36	0.29	8.27	8.06	7.90	0.36	0.45	0.49	142.3	134.4	131.0	10.96	10.32	9.98	222.3	214.9	223.1
Turari 2	0.50	0.38	0.31	8.18	8.00	7.98	0.39	0.49	0.53	130.6	124.5	117.4	10.72	10.28	9.62	230.3	224.2	210.1
Poly 1	0.56	0.41	0.29	8.16	7.84	7.60	0.50	0.69	0.70	147.6	140.5	134.9	12.68	11.94	11.02	291.9	276.4	261.4
Poly 2	0.45	0.41	0.30	7.63	7.46	7.38	0.63	0.70	0.76	143.3	138.1	131.7	12.42	11.42	10.66	283.3	270.7	264.2
CV	4.68	9.93	9.54	2.48	3.03	3.14	4.68	7.30	9.62	3.52	4.10	4.13	5.31	6.95	8.03	3.41	1.42	6.51
SD	0.04	0.02	0.02	0.30	0.28	0.23	0.11	0.10	0.10	8.00	7.39	8.30	0.85	0.77	0.76	37.55	30.39	28.94
SE	0.01	0.01	0.01	0.11	0.11	0.09	0.04	0.04	0.04	3.02	2.79	3.14	0.32	0.29	0.29	14.19	11.49	10.94
CD at 5% level	9.92	NS	NS	0.26	0.30	0.31	0.05	0.05	0.08	6.31	7.02	6.74	0.82	1.00	1.08	12.31	4.80	21.27

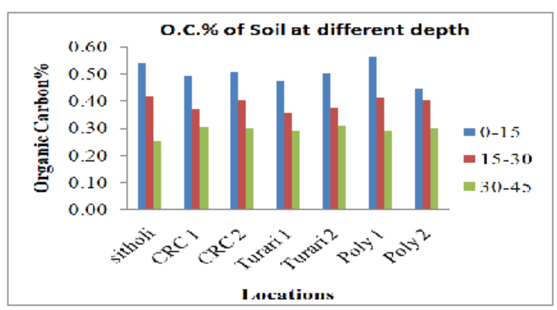
Table 3: Correlation coefficients (r) of soil pysico-chemical characteristics in 0-15 cm depth of soil.

	N(kg ha^{-1})	P (kg ha^{-1})	K(kg ha-^{1})	Moisture%	Sand%	Silt%	Clay%	Porosity%	OC%	BD (Mg m-^{3})	pH	EC (dSm^{-1})
N(kg ha^{-1})	1											
P(kg ha^{-1})	-0.111	1										
K(kg ha^{-1})	0.015	0.673**	1									
Moisture%	- 0.259	0.365*	0.249	1								
Sand%	-0.043	0.283	-0.223	0.259	1							
Silt%	0.271	-0.253	0.208	-0.224	-0.851**	1						
Clay%	-0.248	-0.206	0.151	-0.198	-0.777**	0.331	1					
Porosity%	0.174	0.583**	0.690**	0.152	-0.107	0.128	0.039	1				
OC%	-0.043	0.121	0.206	-0.017	0.242	-0.125	-0.286	0.064	1			
BD(Mgm^{-3})	-0.036	0.679**	0.478**	0.133	0.284	-0.376*	-0.061	0.425*	0.218	1		
pH	-0.162	-0.232	-0.548**	0.039	0.484**	-0.359*	-0.439**	-0.344*	0.323	-0.220	1	
EC(dSm^{-1})	0.582**	0.094	0.216	-0.169	-0.109	0.045	0.143	0.230	-0.242	0.164	-0.494**	1

*   Correlation significant at the 0.05 level

* Correlation significant at the 0.05 level.





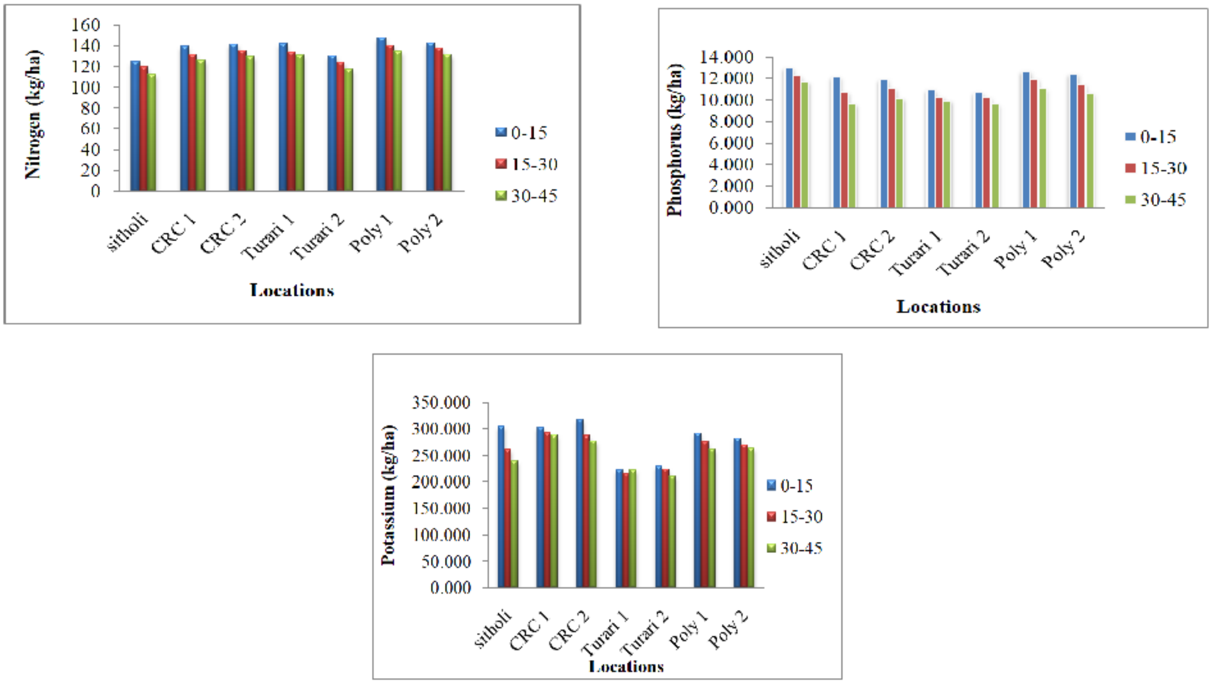


Fig. 1. Graphical parameter of pH, EC, OC, N, P and K.

CONCLUSION

At seven research farms of ITM University Gwalior, the most recent distribution and characterization of primary macronutrient in various depths of soil profile have been analysed and collated. According to the results of the examination, the soil at the ITM research farm had extremely low levels of organic carbon, accessible nitrogen, and phosphorus, and its pH was slightly alkaline. It has been demonstrated that soil pH needs to be strictly managed in order to maximize phosphorus availability to plants and prevent phosphorus fixation. N must also be used in particular circumstances according to the requirements. Therefore, a prolonged application of organic manures or the addition of inorganic fertilizers is required to solve the N and organic carbon deficiencies. On the other hand, there are no indications of a potassium deficit in the soil's top layer. The current study should be very helpful to horticulturists in creating future research plans.

Acknowledgement. Authors greatly acknowledge, Department of Soil Science, School of Agriculture, ITM University, Gwalior (Madhya Pradesh), India to provide all necessary facilities for conduction of research trail.
Conflict of Interest. None.

REFERENCES

Blake, G. R., Hartge, K. H. (2018). Bulk density in methods of soil analysis part 1 physical and mineralogical method. *Soil Science Society of America. Madison, Wisconsin*, USA, pp. 363-375.

Dar, J. A., and Sundarapandian, S. M. (2013). Soil organic carbon stock assessment in two temperate forest types of western Himalaya of jammu and kashmir, India. *Forest Research, 5*(3): 114-116.

Dar, M. A., Wani, J. A., Bhat, M. Y., and Imtiyaz, A. W. (2013). Variation in leaf macro nutrient status of pear orchards of Kashmir with altitudes. *Journal of Progressive Agriculture, 4*(2): 95-97.

Dar, M. A., Wani, J. A., Raina, S. K., Bhat, M. Y., Malik, M. A., and Najar, G. R. (2012). Effect of altitude and depth on available nutrients in pear orchard soils of Kashmir. *Agropedology, 22*(2): 115-118.

Dhir, R. P. (1967). Pedagogical characteristics of some soils of the north western Himalayas. *Journal of the Indian Society of Soil Science, 15*(3): 61- 69.

Gupta, N., Rudra, R., Parkin, G. and Whiteley, H. R. (1992). Fractal behaviour of soil physical and hydraulic properties. *International congress on modelling and simulation proceedings.* Townsville, Australia. MODSIM03/Volume 02/A09/05.

Jackson, M. L. (1973). Soil chemical analysis. Oxford and IBH publishing House, Bombay, pp 38.

Jackson, J. J. (1967). Social gerontology and the Negro: A review. *The Gerontologist*, (3, PT. 1), 168–178.

Katyal, S., Garcha and Sharma, V. (2016). Microbial diversity in soil under different land use systems in sub-mountainous zone of Punjab. *Journal of the Indian Society of Soil Science, 64*(3): 271-275.

Khanday, M. (2013). Characterization and classification of soils of namblan Sub-catchment of jehlum basin for rational land use planning. M. Sc. Thesis submitted to SKUAST- Kashmir pp, 1- 72.

Lalitha, M., and Dakshinamoorthy, M. (2014). Forms of soil potassium-a review. *Agricultural reviews*, *35*(1): 64-68.

Mahajan, A., Sharma, S. K., Gupta, R. D., and Sharma, R. (2007). Morphological, physical and chemical properties of soils from Northwest Himalayas. *Bulgarian Journal of Agricultural Science, 13*: 607-618.

Maqbool, M., Rehman, N. Z., Rasool, R., and Akhtar, F. (2017). Available macronutrient status of soil under different land use systems of district ganderbal, Jammu and Kashmir, India. *Journal of the Indian Society of Soil Science, 65*(3): 256-263.

Jackson, M. L., Lee, S. Y., and Brown, J. L. (1973). Soil Science society - Wiley Online Library.

Naidu, M. V. S., and Sireesha P. V. G. (2013). Studies on genesis, characterization and classification of soils in semi-arid Agri-ecological region: A case study in Banaganapalle Mandal of Kurnool district in Andhra Pradesh. *Journal of the Indian Society of Soil Science, 61*(3): 167-178.

Naik, Z. R. (2014). Characterization, classification and evaluation of cultivated soils under different toposequences in Pulwama District of Kashmir Valley. M.Sc. thesis submitted to SKUAST-Kashmir.

Naik, Z. R., Ram, D., Wani, J. A., and Maqbool, M. (2017). Classification and evaluation of cultivated soils under different toposequences in pulwama district of kashmir valley. *Journal of the Indian Society of Soil Science, 65*(3): 239-247.

Najar, G. R. (2009). Studies on pedogenesis and nutrient indexing of apple (Red Delicious) growing soils of Kashmir. Ph.D. thesis submitted to SKUAST Kashmir, pp. 1-204.

Olsen, S. R., Cole C. V., Vatanabe, F. S., and Dean, L. A. (1954). Estimation of available phosphorus in soil by extraction with sodium bicarbonate. *Circulation of US department of Agriculture, 939*: 1-19.

Piper, C. S. (1950). Soil and plant analysis. *Intel Science Publishers, Inc. New York*.

Rajeshwar, M., and Khan, M. A. A. (2008). Characterization and classification of forest soils of nizamabad district of Andhra Pradesh. *An Asian Journal of soil Science, 3*(1): 11-16.

Sireesha, J. S., Sharma, B. D., and Uppal, H. S. (2013). Morphostratification and characterization of siwalik piedmont of semi-arid tract of Punjab. *Journal of Indian Society of Soil Science, 53*(3): 273-280.

Sharma, S. D., Bhatia, H. S., and Singh, R. P. (2005). Influence of climate on bloom, fruit set, yield and quality of apple in Himachal Pradesh. *Progressive Horticulture, 37*(2): 298-302.

Sparks, D. L., and Carski, T. H. (1985). Soil Science society of America- Wiley Online Library.

Subbiah, B. V., and Asija, E. C. (1956). A rapid procedure for estimation of available nitrogen in soil. *Current Science, 25*: 259-260.

Tandon, S. M., and Hassan, G. D. (1987). Biogas production from pretreated wheat straw, lantana residue, apple and peach leaf litter with cattle dung. *Shalimar Biological Wastes, 21*(2): 75-83.

Thangasamy, A., Naidu, M. V. S. and Ramavatharam, N. (2005). Clay mineralogy of soils in the sivagiri micro-waterhsed of Chittor District Andhra Pradesh. *Journal of the Indian Society of Soil Science, 52*(4): 454-461.

Tuba, A., and Kaleem, A. (2016). Spatial variability in soil properties and diagnostic leaf characteristics of apple (*Malus domestica*) in apple growing region of Dheerkot Azad Jammu and Kashmir (Ajk), Pakistan. *Pakistan Journal of Botany, 48*(2): 503-510.

Walkley, A., and Black, I. A. (1934). An examination of the degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil Science, 37*: 29-38.

Wani A. S., Najar, G. R., Ali, T., and Akhtar, F. (2016). Morphology, genesis and classification of pear growing soils of Pulwama district in Lesser Himalayas of temperate Kashmir, *Journal of Environmental Biology, 37*: 1021 -1027.

Wani K. A., Yadav, R., Singh, S., Upadhyay, K. K. (2014). Comparative study of physicochemical properties and fertility of soils in Gwalior, Madhya Pradesh, *World Journal of Agricultural Sciences, 10*(2): 48-56,

Wani, G. N. (2001). Studies on the distribution of secondary nutrient elements (Ca, Mg and S) in apple orchard soils of north Kashmir. M. Sc thesis submitted to SKUAST- Kashmir pp, 75.

Wani, S. A., Najar, G. R., Padder, B. A. (2017). Altitudinal and depth - wise variation of soil physico-chemical properties and available nutrients of pear orchards in Jammu & Kashmir, India. *Chemical Science Review and Letters, 6*(23): 1638-1645.

Yadav, R. L., and Meena, M. C. (2009). Available micronutrients status and their relationship with soil properties of degana soil series of Rajasthan. *Journal of the Indian Society of Soil Science, 57*(1): 38-1578.

How to cite this article: Pragya Verma, Paramita Deb, Amit Kumar Nema, Mukesh Sheetpal, Tirunima Patle and Rishikesh Tiwari (2022). Distribution and characterization of Nitrogen, Phosphorus and Potassium in different depth of soil profile in ITM research farm at Gwalior Madhya Pradesh. *Biological Forum – An International Journal, 14*(3): 1259-1264.