Short Research Article

Vertical distribution of Available Nutrients in Boudh Block of Boudh district Catena

Abstract

An investigation was conducted to analyse the distribution of available plant nutrients and to examine the relationships between soil properties and available nutrient status in soil profiles of Eastern India. Three soil profiles were exposed under three different topographic positions. In all the pedons, soil pH was increasing and EC was unevenly distributed with soil depth. The status of available N was decreasing with soil depth and phosphorus was increased with depth of soil, Organic carbon was unevenly distributed with the depth of soil, sulphur was also unevenly distributed with depth of soil which is comparable with the organic carbon. There is similar trend between Soil reaction and Phosphorus.

Keywords- Available nutrients, pedon, soil profile, topography

1.0 Introduction

Understanding the vertical distribution of plant nutrients in soils is important since the roots of the majority of crops extend beyond the surface layers and obtain some of the nutrients they need from there. The soil fertility and crop production are greatly influenced by the features of the soil profile as they are conditioned by the many processes and elements of soil development. Understanding the prevalent soil formation (soil genesis) causes and processes is very necessary in order to evaluate soil characteristics; this requires a detailed and scientific research of soil profiles (Vedadri and Naidu, 2018). Without the careful use of macro and micro nutrient fertilisers to address the current shortages, crop production cannot be increased further. Therefore, it is crucial to have a thorough understanding of how plant nutrients are distributed vertically in soil in order to recommend the right fertiliser schedule for various crops and ensure maximum production. The availability and distribution of plant nutrients, both in surface soils and subsurface soils, are significantly impacted by topographic variations (Dorji *et al.*, 2014). In order to explore the vertical distribution of plant nutrients in various topographic locations, this research was carried out in a well-formed catena (toposequence) located in Eastern India with varied topographic positions.

2.0 Materials and Methods

The selected study area was located in Boudh block of boudh district. Based on slope and elevation, the study area has been divided into three major physiographic units such as upland 108m above mean sea level (N 20^{o}49'04.7" E 84^{o}15'43.1"), Medium land 157m above sea level

(N 20°44'42.1" E 84°13'28.2") and low land 114m above mean sea level (N 20°48'56.7" E84° 15'55.5") total three profiles are excavated. Soil depth of pedons 1, 2,3 were found to be 87, 67 and 97 cm respectively. Soil samples from different genetic horizons were collected, processed and preserved for laboratory studies. The soil samples were analysed for textural class by Bouyoucos Hydrometer method, pH (1:2) and EC (1:2), organic carbon (Jackson, 1973), available nitrogen (Subbiah and Asija, 1956), phosphorus (Bray and Kurtz, 1945), potassium (Hanway and Heidel, 1952), sulphur (Chesnin and Yien, 1950).

3.0 Results and discussion

3.1 Physical and chemical characteristics

Particle size distribution: In pedon 1, a gradual increase in clay content was observed from surface to the depth of 87 cm, which can be attributed to the presences of eluvation process. In pedon 2, there is a equal distribution of clay content. In pedon 3, gradual increases up to 39 cm (Table 1), and there is decreased in clay content with equal distribution on up to 97 cm this says there is absents of eluvation process (Das *et al.,* 2019).

3.2 Soil reaction: The surface soil of pedon 1 was found to be acidic with a pH value of 5.08 which increased with soil depth up to a value of 6.54 almost near to neutral at the lower most horizon 87 cm. The surface soils of pedon 2 were found to be slightly acidic with a pH value of 6.31 which increased with soil depth up to a value of 6.76 almost neutral at lower most horizon 67 cm. The surface soils of pedon 3 were found to be strongly acidic with 4.74 pH value and gradually increased with depth with 6.05 pH value. The increases in soil pH with increasing soil depth could be attributed to leaching of basic cation from upper horizons towards the lower horizons mostly during intensive rainfall. Specially in lower land area i.e., pedon 3 due to heavy leaching of bases dues to leaching and rains. Electronic conductivity (EC) almost nominal in all Pedons (Table 1).

3.3 Organic Carbon content

There is uneven distribution of organic carbon in pedon 1, 2 and 3. In pedon 3 there is high content of 3.45 g kg^{-1} followed we can observe from the results there is uneven distribution of organic carbon content this implies there is uneven distribution of decomposition of crop residues in every year in the surface horizons (Khanday *et al.,* 2018 and Das *et al.,* 2019) observations are mentioned in Table 1.

4.0 Distribution of available nutrients

4.1 Available nitrogen: In pedon 1, the highest amount of available N (201.6 kg ha^{-1}) was found in the surface horizon (0-13 cm) and the lowest (100.8 kg ha^{-1}) in the third and fourth layer (28-44 cm and 44-64 cm) and there is slight increase in final layer 112.0 kg ha^{-1}. In pedon 2, the

highest amount of available N was found in the surface (0-26 cm) and lower layer (39-67 cm), 257.6 kg $ha^{-1,}$ 257 kg ha^{-1}, respectively. In pedon 3, highest amount of available nitrogen was found in upper layer (0-13cm) 190.4 kg ha^{-1}, lowest amount recorded in lower layer (77-97 cm) 100.8 kg ha^{-1}. Nitrogen was positively correlated with electronic conductivity (EC), (r = 0.747**) (Table 3.). Available N tended to decrease with soil depth, which might be due to the confinement of falling of plant residues and debris to rhizosphere of plants. In pedon 2, there is a almost equal distribution of available nitrogen. (Sharma *et al.,* 2013 and Das *et al.,* 2019). (Table 2.). (Sharma et al., 2013 and Das *et al.,* 2019).

4.2 Available phosphorous: In pedon 1, the highest amount of available phosphorus was recorded in lower layer (44-64 cm) 105.69 kg ha^{-1}. Low amount was recorded in upper layer (0-13 cm) 29.03 kg ha^{-1}. This shows the clear relation with soil pH as the upper layer of soil was 5.08 acidic pH available phosphorous was low, in contrast the soil pH was 6.54 in lower layer shows high availability of the available phosphorus. In pedon 2, the highest amount of available phosphorus was recorded in lowest layer (39-67cm) 121.50 kg ha^{-1}. Low amount of soil available phosphorus recorded in upper layer (0-26 cm) 96.31 kg ha^{-1}, over all phosphorus available is high in all layers this is due to neutral range of pH (Table 1.). In pedon 3, the highest amount of available phosphorous was recorded in lower layer (26-39 cm) 121.99 kg ha^{-1}. Low amount of available phosphorous was recorded in upper layer (0-13 cm) 52.13 kg ha^{-1}. This is positively correlated with Ex Ca (r = 0.518*) and with pH (r = 0.647**) (Table 3.) The availability is of high and low available phosphorous was closely related to soil pH (Table 1.).

4.3 Available potassium: In pedon 1, the lowest amount of available potassium (248.3 kg ha^{-1}) was found in the surface horizon (0-13 cm) and the highest amount available potassium (114.6 kg ha^{-1}) found in the lower horizon (64-87 cm). In pedon 2, highest amount of available potassium (444.6 kg ha^{-1}) found in the upper horizon (0-26 cm), lowest amount of available potassium (361.8 kg ha^{-1}) found in lower horizon (26-39 cm). In pedon 3, highest amount of available potassium (204.4 kg ha^{-1}) found in 51-64 cm, lowest amount of available potassium (100.70 kg ha^{-1}) found in lower horizon (77-97 cm). potassium was positively correlated with pH (r = 0.704**), EC (r = 0.515*) and Ex Ca (r = 0.657**) (Table 3.). In overall observation found that availability of potassium is corelated with clay percentage (Table 1). (Saini and Grewal, 2014 and Das *et al.,* 2019).

4.4 Available sulphur: In pedon 1, highest amount of available sulphur (79.43 kg ha^{-1}) found in 28-44 cm horizon, lowest amount of available sulphur (62.00 kg ha^{-1}) found in upper horizon 0-13 cm. In pedon 2. Highest amount available sulphur (103.22 kg ha^{-1}) found in 26-39 cm; lowest amount of available sulphur (89.15 kg ha^{-1}) found in upper horizon 0-26 cm. In pedon 3, highest amount of available sulphur (185.00 kg ha^{-1}) found in upper horizon (0-13 cm), low available sulphur (104.56 kg ha^{-1}) found in 39-51 cm horizon. Sulphur was positively correlated to Organic carbon (r = 0.535*) (Table 3.). There is uneven distribution of sulphur in profile this quite related to the organic carbon content (Table 1. and Table 2.).

4.5 Exchangeable Ca and Mg: In pedon 1, highest amount of exchangeable Ca (1020 meq 100 g^{-1}) found in lower layer (64-87cm) and exchangeable Mg (660 meq 100 g^{-1}) found in third horizon (28-44 cm). In pedon 2, highest amount of exchangeable Ca (1290 meq 100 g^{-1}) found in lower horizon (39-67 cm) and exchangeable Mg (200 meq 100 g^{-1}) found in same lower horizon (39-27 cm). In pedon 3, highest amount of exchangeable Ca (800 meq 100 g^{-1}) found in horizon (13-26 cm) found in horizon 13-26 cm and exchangeable Mg (650 meq 100 g^{-1}) found in horizon 64-77 cm. (Table 2.). Ex Ca was positively correlated with pH (r = 0.576*) (Table 3.). (Bungla *et al.*, 2019).

Table 1. Depth wise distribution of particle size, soil pH and Organic carbon in representative pedons of Boudh block

Horizon Depth (cm)	Sand (%)	Slit (%)	Clay (%)	pH	EC (dSm^{-1})	Organic Carbon ($g\ kg^{-1}$)
Pedon 1. (Upland)						
0-13	72.5	17.5	10	5.08	0.607	0.75
13-28	72.5	17.5	10	5.31	0.189	0.75
28-44	72.5	17.5	10	5.15	0.117	2.85
44-64	67.5	12.5	20	5.67	0.16	0.15
64-87	59	16	25	6.54	0.235	0.3
Pedon 2. (Medium land)						
0 - 26	69	11	20	6.31	0.286	1.2
26 - 39	59	21	20	6.16	0.963	2.4
39 - 67	59	21	20	6.76	0.619	2.25
Pedon 3. (Lowland)						
0 - 13	74	16	10	4.74	0.146	3.45
13 - 26	69	16	15	5.34	0.116	1.05
26 - 39	69	6	25	5.55	0.108	0.3
39 - 51	64	16	20	5.83	0.149	3.0
51 - 64	69	11	20	6.16	0.152	4.5
64 - 77	69	11	20	6.14	0.147	2.7
77 - 97	69	11	20	6.05	0.113	3.0

Table 2. Depth wise distribution of available nutrients in representative pedons of Boudh block

Horizon Depth (cm)	N	P	K	S	Ca	Mg
	kg ha^{-1}				meq $100g^{-1}$	
Pedon – 1 (Upland)						
0-13 cm	201.6	29.03	114.6	62.00	430	290
13-28 cm	112.0	47.91	122.4	66.36	230	110
28-44 cm	100.8	98.34	131.0	79.43	660	660
44-64 cm	100.8	105.69	211.8	76.41	710	80
64-87 cm	112.0	103.11	248.3	68.03	1020	250
Pedon -2 (Medium land)						
0 - 26 cm	257.6	96.31	444.6	89.15	760	160
26 - 39 cm	246.4	115.08	361.8	103.22	910	180
39 - 67 cm	257.6	121.50	377.1	95.85	1290	200
Pedon – 3 (Lowland)						
0 - 13 cm	190.4	52.13	177.4	185.00	240	50
13 - 26 cm	134.4	98.83	152.7	156.85	800	70
26 - 39 cm	145.6	121.99	191.8	109.26	430	40
39 - 51 cm	123.2	116.67	194.2	104.56	460	40
51 - 64 cm	112	108.05	204.4	125.68	450	120
64 - 77 cm	123.2	92.08	167.1	130.04	150	650
77 - 97 cm	100.8	100.70	182.3	124.00	450	50

Table 3. Correlation between soil properties

	% Sand	% Clay	% Slit	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	S (kg ha^{-1})	Ca m.eq/100g	Mg m.eq/100g	pH	E.C	OC content (g kg^{-1})
% Sand	1											
% Clay	-0.675**	1										
% Slit	-0.355	-0.448	1									
N (kg ha^{-1})	-0.302	-0.005	0.372	1								
P (kg ha^{-1})	-0.647**	0.785**	-0.210	-0.033	1							
K (kg ha^{-1})	-0.625**	0.496	0.129	0.737	0.478	1						
S (kg ha^{-1})	0.222	-0.057	-0.196	0.016	0.061	-0.100	1					
Ca m.eq /100g	-0.759**	0.364	0.457	0.430	0.518*	0.657**	-0.284	1				
Mg m.eq/100g	0.102	-0.208	0.139	-0.102	-0.083	-0.158	-0.228	-0.055	1			
pH	-0.789**	0.773**	-0.023	0.236	0.647**	0.704**	-0.223	0.576*	0.027	1		
E.C	-0.529*	0.006	0.632	0.747**	-0.014	0.515*	-0.281	0.488	0.036	0.288	1	
OC content (g kg^{-1})	0.082	-0.133	0.070	-0.023	0.129	-0.015	0.535*	-0.236	0.139	0.058	-0.051	1

*** = 5 % significances**

**** = 1 % Significances**

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