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SOIL PHYSICOCHEMICAL PROPERTIES AS INFLUENCED BY SOIL DEPTH AND CROPPING SYSTEM IN LATERITIC SOIL

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ABSTRACT

To evaluate variation in physicochemical characteristics of lateritic soil under different cropping systems and soil depths, a total of 108 soil samples were taken during 2020-21 from lateritic soils of Birbhum, West Bengal, from five major cropping systems and uncultivated fallow land, at depths of 0-20 cm, 20-40 cm and 40-60 cm. Collected soil samples were processed and analyzed for various physicochemical properties through standard procedures. The soils were moderate to strongly acidic, with pH ranged from 5.81 (rice-potato-sesame) to 6.15 (rice-vegetable), which increased with increasing soil depth. The bulk density ranged from 1.25 g cm^{-3} (fallow land) to 1.32 g cm^{-3} (rice-rice) and increased with increasing soil depth. Organic carbon was low to medium category (ranging from 0.32 to 0.52%) and however, showed a negative correlation with soil depth. Mean available N content ranged from 146.13 kg ha^{-1} (rice-vegetable) to 215.37 kg ha^{-1} (fallow land). Whereas, the mean available P_2O_5 content ranged from 29.47 kg ha^{-1} (rice-potato-sesame) to 38.83 kg ha^{-1} (vegetable-vegetable) cropping system. Both available N and P content decreased with an increase in soil depth. Mean available K_2O content ranged from 129.24 kg ha^{-1} (rice-fallow) to 147.41 kg ha^{-1} (fallow land) which was increased with an increase in soil depth. The available S content varied from 22.10 mg kg^{-1} (fallow land) to 16.55 mg kg^{-1} (rice-potato-sesame) which showed a negative correlation with soil depth. There was a significant positive and negative relationship between most of the studied soil properties. Because of lower availability, the balanced application of N, P, K, and S fertilizers and FYM should be recommended for optimum crop production and upkeeping soil health of the studied lateritic soil of West Bengal.

(Key words: Soil properties, depths, cropping systems, lateritic soil)

INTRODUCTION

Conserving soil and water and keeping long-term soil productivity depend primarily on cropping systems including crop diversification, crop rotation and intercropping and related agronomic practices used in agriculture (Vukicevich *et al.,* 2016). Present agricultural systems are exploitive of nutrients through intensive tillage, mono-cropping year after year, use of high-yielding varieties, imbalanced use of nutrients coupled with limited use of organic manures, less recycling and burning of crop residues, soil erosion, etc. Balanced use of organic, fertilizer and bio-fertilizers play an important role in maintaining soil fertility in the long run. Studying the available soil nutrient status for cropping systems, soil depth, management practices, etc. is helpful for sustainable agricultural land management and economic growth. There is a growing need for creating information databases relating to soil properties, their current status, changes due to cropping systems and management practices for appropriate cropping system planning and soil management. Again, without maintaining soil fertility, it is not possible to increase agricultural production in feeding the alarmingly increasing population. In West Bengal, the red and lateritic soils mainly cover Birbhum, Bankura, Purulia, Jhargram, Burdwan and West Midnapur, with about 2.8 million ha (28% of the total geographical area) of the state. The productivity of these soils is usually low due to light texture, low organic matter content, low water retentivity, acidic soil reaction, the inadequacy of N, P and K and some micronutrients in toxic concentrations (Panda *et al.,* 1991; Kundu, 2017). According to Lepcha and Devi (2020), soil parameters were considerably impacted by land use, soil depth and season. According to Tesfahunegn and Gebru (2020), differences in soil characteristics are connected to the kind of land use and soil management techniques. Knowing the crop's nutrient needs and the soil's capacity to give nutrients will help to apply fertilizers at the correct rates in nutrient-deficient soil (Foth and Ellis, 1997). For balanced nutrient management of various cropping systems, there is a need for a scientific study for monitoring the extent of variations in available soil nutrients under different cropping systems of the lateritic soils. However, information on the effect of

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cropping systems on changes in various soil physicochemical properties in lateritic soils of West Bengal, India is very scanty to maintain optimal and sustainable utilization of land resources. In light of this, the current study was conducted to assess the variation of physicochemical characteristics of soil under different cropping systems and soil depths and to assess the interrelationship between various physicochemical properties of lateritic soils of Birbhum, West Bengal.

MATERIALS AND METHODS

Soil sampling and analysis

Soil samples were taken from different depths (0-20, 20-40 and 40-60 cm) of rice-rice, rice-fallow, rice-vegetable, rice-potato-sesame and fallow land of lateritic soil of Birbhum, West Bengal in 2020-21 and analyzed in the Dept. of Soil Science and Agricultural Chemistry, Palli Siksha Bhavana, Visva-Bharati, Sriniketan. The actual number of soil samples that were gathered and processed for the analysis was 108 [6 (cropping systems) X 6 (typical fields) X 3 (depths) = 108]. Separate core samples from each soil depth were collected for bulk density (BD). Soil properties like pH (Jackson, 1973), oxidizable organic carbon (OC) (Walkley and Black, 1934), clay content (hydrometer method), BD by core method, available N by alkaline permanganate method (Subbiah and Asija, 1956), available P_2O_5 by Bray's method (Bray and Kurtz, 1945), available K_2O (Hanway and Heidel, 1952), available $CaCl_2$ extractable S (Chesnin and Yein, 1950) were estimated.

Statistical analysis

The analysis of variance (ANOVA) of the effects of cropping systems and soil depths on soil properties was tested by the procedure as described by Gomez and Gomez (1984). Simple Pearson's correlation analysis was also done to estimate the relationship among the soil properties using SPSS software (version 20).

RESULTS AND DISCUSSION

Depth-wise variation of BD, clay, pH and OC content

Results showed that the BD, pH and OC content of the studied soils were significantly influenced by the soil depth (P d" 0.01) of the various cropping systems (Table 1). However, clay contents was not significantly influenced by the soil depth (P d" 0.01). Dhaliwal *et al.* (2023) also reported that with changes in soil depth clay content did not alter considerably.

In all the cropping systems including fallow land, the highest and lowest of mean BD were recorded in sub-surface (40-60 cm) and surface (0-20 cm) soil layers respectively. Again, irrespective of cropping systems, the highest (1.33 g cm^{-3}) and lowest (1.22 g cm^{-3}) mean BD were found in subsurface soil and surface soil respectively. Thus, the BD was increased with an increase in soil depth (Table 1). Datta *et al.* (2015) also observed when soil depth grew, the BD of soil also did so.

The highest and lowest soil pH were recorded in sub-surface and surface soil respectively of all the studied cropping systems including fallow land. Irrespective of cropping systems, the highest (6.12) and lowest (5.85) pH were found in sub-surface and surface soil respectively. In general, soil pH values were increased with an increase in soil depth (Table 1). Gikonyo *et al.* (2022) and Dhaliwal *et al.* (2023) also noted that despite no discernible variations in cropping patterns, soil pH typically rose with depth.

The highest and lowest OC contents were recorded in surface and sub-surface soil of all the studied cropping systems including fallow land. Irrespective of cropping systems, the highest (0.53%) and lowest (0.27%) mean OC were recorded in surface and sub-surface soil respectively. Thus, OC content was decreased with an increase in soil depth (Table 1). Similar decreasing trend of OC with increase in depth has been reported by Todmal *et al.* (2008). According to Gikonyo *et al.* (2022), soil organic matter decreased with depth, with winter wheat-summer maize having the greatest values in the deeper layers. Dhaliwal *et al.* (2023) also reported a drop in OC content with greater soil depth.

Depth-wise variation of available N, P_2O_5, K_2O and S content in soil

The available N, P_2O_5 K_2O and S content of the studied soils was significantly affected by soil depth (P d" 0.01) (Table 1) of the various cropping system studied. The highest and lowest N content were recorded in surface (0-20 cm) and sub-surface (40-60 cm) soil respectively of all the studied cropping systems including fallow land. Regardless of cropping systems, the surface and subsurface soils had the highest (188.66 kg ha^{-1}) and lowest (150.85 kg ha^{-1}) available N, respectively. Thus, it's values were decreased with an increase in soil depth (Table 1). Similar drecement of available N with increment in depth was given by Gikonyo *et al.* (2022).

Except rice-fallow and fallow land (Table 1), the highest and lowest available P_2O_5 were recorded in surface (0-20 cm) and sub-surface (40-60 cm) soil layers, respectively. Regardless of land uses, the mean of available P_2O_5 was highest (35.86 kg ha^{-1}) in surface and lowest (30.38 kg ha^{-1}) in sub-surface soil. In general, the available soil P_2O_5 values decreased with the increase in soil depth (Table 1). Decresing trend of it's content below depth was also detected by Kumar *et al.* (2017). The fixing of P by clay minerals and oxides of iron and aluminium in these pedons might be the reason of the decreased phosphorus concentration in sub-surface layer. Gikonyo *et al.* (2022) also showed that the soil's available phosphorus (P) content was greater at 0–20 cm soil depth than they were at subsurface depth.

Except rice-vegetable (Table 1), the highest and lowest of available soil K_2O were recorded in 40-60 cm and 0-20 cm soil layers respectively. Irrespective of cropping systems, the mean available soil K_2O was highest (146.01 kg ha^{-1}) in sub-surface and lowest (128.88 kg ha^{-1}) in surface soil. In general, available K_2O increased with the increase in soil depth (Table 1). Increasing trend of it's content below depth was also noted by Natarajan and Renukadevi (2003). However, Gikonyo *et al*. (2022) demonstrated that the soil's available potassium (K) content was better at 0–20 cm depth than they were at subsurface depth.

The highest and lowest of available S content were recorded in surface (0-20 cm) and sub-surface (40-60 cm) soil in all the cropping systems except vegetable-vegetable cropping system (Table 1). Irrespective of crpping systems, it's content was highest (22.36 mg kg^{-1}) in surface and lowest (16.34 mg kg^{-1}) in sub-surface soil. In general, the available S content of soil decreased with the increase in soil depth (Table 1). A reduced concentration of available S was also reported by Singh and Singh (2016) in the red soils of the Vindhyan area (district Mirzapur, Uttar Pradesh), which might be due to weathering, leaching, erosion and inadequate management techniques.

Cropping system-wise variation of BD, clay, pH and OC content in soil

While comparing cropping systems-wise variations of BD, it was observed that in 0-20 cm soil, the highest (1.27 g cm^{-3}) and lowest (1.18 g cm^{-3}) BD were observed in rice-rice and rice-vegetable cropping systems, respectively. In mid-surface (20-40 cm) as well as sub-surface (40-60 cm) soil, the highest (1.33 and 1.36 g cm^{-3}) and lowest (1.23 and 1.31 g cm^{-3}) of BD were observed in rice-rice and fallow land cropping systems, respectively. Irrespective of soil depths, the mean BD for rice-rice was highest (1.32 g cm^{-3}) and that of the fallow land was lowest i.e. 1.25 g cm^{-3} (Table 2).

Again, in surface soil, the highest (32.08 %) and lowest (22.58 %) clay content were observed in rice-rice and vegetable-vegetable cropping systems, respectively. Similarly, in mid-surface and sub-surface soil the highest and lowest clay content were observed in rice-rice and vegetable-vegetable cropping systems, respectively. Regardless of depths, the clay content for rice-rice and vegetable-vegetable cropping systems were highest i.e. 32.89 % and lowest i.e., 23.08 % respectively (Table 2). However, Gikonyo *et al*. (2022) and Dhaliwal *et al.* (2023) reported that with changes in land uses clay content did not alter considerably.

In surface soil, the highest (6.02) and lowest (5.67) soil pH were observed in soils of rice-potato-sesame and rice-vegetable cropping systems, respectively. Again, in other two depths also similar highest and lowest pH were observed in rice-potato-sesame and rice-vegetable cropping systems respectively. Regardless of soil depth, the rice-potato-seasame cropping systems had the greatest mean pH i.e. 6.15 and rice-vegetable cropping systems had the lowest pH i.e. 5.81 (Table 2). According to Dhaliwal *et al.* (2023) regardless of soil depths, soil pH was decreased in order of crop land > barren land > horticulture > forest land.

In surface soil, the highest (0.63%) and lowest (0.48%) OC were observed in fallow land and vegetable-vegetable cropping systems respectively. In both mid-surface and sub-surface soil, the highest and lowest OC were observed in fallow and rice-vegetable cropping systems, respectively. Thus, regardless of depth, the OC for fallow land was recorded highest (0.52 %) and that of rice-vegetable cropping system was lowest i.e. 0.32 % (Table 2). The decreased soil OC content under various land uses was forest > horticulture > barren land > crop land (Dhaliwal *et al.,* 2023).

Cropping system-wise variation of available N, P_2,O_5, K_2,O and S content in soil

In both surface and mid-surface soil, the highest (230.45, 216.49 kg ha^{-1}) and lowest (155.96, 148.45 kg ha^{-1}) N content were observed in fallow and rice-vegetable cropping systems, respectively. In sub-surface soil, the highest (199.16 kg ha^{-1}) and lowest (116.42 kg ha^{-1}) N content were observed in fallow and rice-potato-sesame cropping systems, respectively. Irrespective of soil depths, the available N content for fallow land and rice-vegetable cropping systems were highest i.e. 215.37 kg ha^{-1} and lowest i.e.146.13 kg ha^{-1} respectively (Table 2).

In surface soil, the highest (42.15 kg ha^{-1}) and lowest (29.26 kg ha^{-1}) available soil P_2O_5 were noted in vegetable-vegetable and rice-fallow cropping systems, respectively (Table 2). However, in both mid-surface and sub-surface soil, highest (38.53, 35.81 kg ha^{-1}) and lowest (29.81, 25.98 kg ha^{-1}) P_2O_5 were observed in vegetable-vegetable and rice-potato-sesame cropping systems, respectively. Irrespective of soil depths, it's content in vegetable-vegetable and rice-potato-sesame cropping systems was recorded highest i.e. 38.83 kg ha^{-1} and lowest i.e. 29.47 kg ha^{-1}, respectively.

The highest available K_2O concentrations in surface, mid-surface, and sub-surface soil (138.34, 148.93 and 155.90 kg ha^{-1}) were noted in rice vegetable, fallow, fallow land respectively and its lowest content in surface, mid-surface, and sub-surface soil (117.83, 133.06 and 136.84 kg ha^{-1}) were noted only in rice-fallow cropping system. Irrespective of soil depths, it's content for fallow land was highest (147.41 kg ha^{-1}) and for rice-fallow cropping system was lowest (129.24 kg ha^{-1}). There was no significant cropping systems-wise variation of available S content in various soil depth.

Verma *et al*. (2012) reported that the application of both organic and inorganic fertilizers together produced the maximum yield of maize-wheat cropping systems and soil nutrient status. There is a need for soil management techniques that can increase soil fertility and crop productivity in a region like ours, as noted by Thakare and Ingle (2010) in their study of the soil properties of the Jalgaon district. They found that the available nitrogen, phosphorus, and potassium levels in the soil are also low. Gikonyo *et al*. (2022) also said that in order to boost productivity of single-cropping patterns, alternative soil management practices must be used, particularly for spring

Table 1. Depth-wise variation of BD, clay, pH, OC, and available N, P, K, S content in soil of various cropping systems

CS/Depth	R-F	R-R	R-P-S	R-V	V-V	F	Mean
			Soil BD (g cm^{-3})				
0-20 cm	1.24	1.27	1.24	1.18	1.21	1.21	1.22
20-40 cm	1.33	1.33	1.31	1.32	1.29	1.23	1.30
40-60 cm	1.35	1.36	1.34	1.34	1.31	1.31	1.33
SE(m)	0.01	0.01	0.02	0.02	0.01	0.01	0.01
CD(0.05)	0.029	0.030	0.059	0.060	0.030	0.029	0.030
			Clay content (%)				
0-20 cm	29.75	32.08	24.55	24.52	22.58	25.05	26.42
20-40 cm	31.10	32.93	25.55	25.52	23.00	25.48	27.26
40-60 cm	31.90	33.65	26.63	26.23	23.65	26.10	28.03
SE(m)	1.68	1.61	1.22	3.58	1.19	1.29	1.76
CD(0.05)	-	-	-	-	-	-	-
Soil pH							
0-20 cm	5.84	5.87	6.02	5.67	5.91	5.79	5.85
20-40 cm	5.96	5.97	6.14	5.85	6.02	5.89	5.97
40-60 cm	6.16	6.17	6.28	5.93	6.10	6.07	6.12
SE(m)	0.02	0.01	0.01	0.01	0.02	0.02	0.01
CD(0.05)	0.058	0.030	0.029	0.030	0.060	0.059	0.030
			Organic C (%)				
0-20 cm	0.53	0.56	0.49	0.51	0.48	0.63	0.53
20-40 cm	0.43	0.41	0.31	0.26	0.36	0.48	0.38
40-60 cm	0.24	0.3	0.21	0.18	0.23	0.46	0.27
SE(m)	0.01	0.01	0.01	0.02	0.01	0.04	0.02
CD(0.05)	0.030	0.029	0.030	0.059	0.030	0.120	0.060
			Available N (kg ha^{-1})				
0-20 cm	180.83	189.60	184.81	155.96	190.30	230.45	188.66
20-40 cm	169.45	179.53	149.65	148.45	163.11	216.49	171.11
40-60 cm	158.86	167.17	116.42	133.98	129.53	199.16	150.85
SE(m)	3.06	2.47	2.14	2.11	3.30	2.46	2.59
CD(0.05)	9.18	7.40	6.43	6.33	9.90	7.37	7.76
			Available P_2O_5 (kg ha^{-1})				
0-20 cm	29.26	35.95	32.62	39.68	42.15	35.51	35.86
20-40 cm	30.06	32.32	29.81	36.04	38.53	32.40	33.19
40-60 cm	33.48	27.42	25.98	29.95	35.81	29.67	30.38
SE(m)	1.34	2.15	1.53	2.35	0.54	1.67	1.60
CD(0.05)	-	6.46	4.58	7.06	1.62	-	4.81
			Available K_2O (kg ha^{-1})				
0-20 cm	117.83	121.95	129.08	138.34	128.67	137.41	128.88
20-40 cm	133.06	133.48	145.33	137.69	144.47	148.93	140.49
40-60 cm	136.84	140.44	155.43	138.61	148.82	155.90	146.01
SE(m)	2.79	3.09	3.35	4.69	2.98	3.21	3.35
CD(0.05)	8.38	9.28	10.04	-	8.93	9.63	10.06
			Available S (mg kg^{-1})				
0-20 cm	22.71	23.59	19.64	21.37	22.07	24.80	22.36
20-40 cm	18.55	20.83	16.43	18.23	18.76	22.12	19.15
40-60 cm	16.08	17.54	13.57	15.29	16.19	19.38	16.34
SE(m)	1.23	0.76	0.60	1.26	2.63	0.74	1.21
CD(0.05)	3.70	2.29	1.80	3.77	-	2.22	3.63

CS= cropping systesm, R-F= rice-fallow, R-R= rice-rice, R-P-S =rice-potato-sesame, R-V = rice-vegetable, V-V = vegetable-vegetable, F = fallow

Table 2. Cropping system-wise variation of BD, clay, pH, OC, and available N, P content in soil

Soil Depth/Cropping system	0-20 cm	20-40 cm	40-60 cm	Mean
		Soil BD (g cm^{-3})		
Rice-Fallow	1.24	1.33	1.35	1.30
Rice-Rice	1.27	1.33	1.36	1.32
Rice-Potato-Sesame	1.24	1.31	1.34	1.29
Rice-Vegetable	1.18	1.32	1.34	1.28
Vegetable-Vegetable	1.21	1.29	1.31	1.27
Fallow	1.21	1.23	1.31	1.25
SE(m)	0.02	0.01	0.01	0.01
CD(0.05)	0.059	0.030	0.028	0.030
		Clay content (%)		
Rice-Fallow	29.75	31.10	31.90	30.92
Rice-Rice	32.08	32.93	33.65	32.89
Rice-Potato-Sesame	24.55	25.55	26.63	25.58
Rice-Vegetable	24.52	25.52	26.23	25.42
Vegetable-Vegetable	22.58	23.00	23.65	23.08
Fallow	25.05	25.48	26.10	25.54
SE(m)	1.99	1.87	1.98	1.95
CD(0.05)	5.98	5.60	5.95	5.85
		Soil pH		
Rice-Fallow	5.84	5.96	6.16	5.99
Rice-Rice	5.87	5.97	6.17	6.00
Rice-Potato-Sesame	6.02	6.14	6.28	6.15
Rice-Vegetable	5.67	5.85	5.93	5.81
Vegetable-Vegetable	5.91	6.02	6.10	6.01
Fallow	5.79	5.89	6.07	5.92
SE(m)	0.01	0.01	0.02	0.01
CD(0.05)	0.030	0.029	0.060	0.030
		Organic C (%)		
Rice-Fallow	0.53	0.43	0.24	0.40
Rice-Rice	0.56	0.41	0.30	0.42
Rice-Potato-Sesame	0.49	0.31	0.21	0.34
Rice-Vegetable	0.51	0.26	0.18	0.32
Vegetable-Vegetable	0.48	0.36	0.23	0.36
Fallow	0.63	0.48	0.46	0.52
SE(m)	0.02	0.01	0.03	0.02
CD(0.05)	0.060	0.029	0.090	0.059
		Available N (kg ha^{-1})		
Rice-Fallow	180.83	169.45	158.86	169.71
Rice-Rice	189.60	179.53	167.17	178.76
Rice-Potato-Sesame	184.81	149.65	116.42	150.30
Rice-Vegetable	155.96	148.45	133.98	146.13
Vegetable-Vegetable	190.30	163.11	129.53	160.98
Fallow	230.45	216.49	199.16	215.37
SE(m)	2.73	2.37	2.77	2.62
CD(0.05)	8.20	7.10	8.30	7.87
		Available P_2O_5 (kg ha^{-1})		
Rice-Fallow	29.26	30.06	33.48	30.93
Rice-Rice	35.95	32.32	27.42	31.90
Rice-Potato-Sesame	32.62	29.81	25.98	29.47
Rice-Vegetable	39.68	36.04	29.95	35.22
Vegetable-Vegetable	42.15	38.53	35.81	38.83
Fallow	35.51	32.40	29.67	32.53
SE(m)	1.69	1.63	1.77	1.70
CD(0.05)	5.06	4.90	5.30	5.10

Table 3. Cropping system-wise variation of available K and S content in soil

Soil depth/	0-20 cm	20-40 cm	40-60 cm	Mean
Cropping system	Available K_2O (kg ha^{-1})			
Rice-Fallow	117.83	133.06	136.84	129.24
Rice-Rice	121.95	133.48	140.44	131.96
Rice-Potato-Sesame	129.08	145.33	155.43	143.28
Rice-Vegetable	138.34	137.69	138.61	138.21
Vegetable-Vegetable	128.67	144.47	148.82	140.65
Fallow	137.41	148.93	155.90	147.41
SE(m)	3.63	2.97	3.59	3.40
CD(0.05)	10.88	8.92	10.76	10.19
		Available S (mg kg^{-1})		
Rice-Fallow	22.71	18.55	16.08	19.11
Rice-Rice	23.59	20.83	17.54	20.65
Rice-Potato-Sesame	19.64	16.43	13.57	16.55
Rice-Vegetable	21.37	18.23	15.29	18.30
Vegetable-Vegetable	22.07	18.76	16.19	19.01
Fallow	24.80	22.12	19.38	22.10
SE(m)	1.42	1.40	1.34	1.39
CD(0.05)	-	-	-	-

Table 4. Pearson's correlation matrix for linear relationship between various soil physicochemical properties

	pH	OC	Av. N	Av. P	Av. K	Av. S	BD	Clay
pH	1.000							
OC	-0.606**	1.000						
Av. N	-0.430**	0.767**	1.000					
Av. P	-0.405**	0.206*	0.112	1.000				
Av. K	0.408**	-0.316**	-0.199*	-0.284**	1.000			
Av. S	-0.515**	0.612**	0.660**	0.134	-0.135	1.000		
BD	0.624**	-0.645**	-0.489**	-0.347**	0.199*	-0.490**	1.000	
Clay	0.106	-0.019	0.084	-0.469**	-0.121	0.144	0.262**	1.000

* and ** indicates correlation is significant at the 0.05 and 0.01 level respectively (2-tailed) as per SPSS software (version 20.0); critical r values (for n = 108) are 1.983 and 2.623 at 5% and 1% level of significance, respectively; OC = organic carbon, Av. N = available N, Av. P = available P_2O_5, Av. K= available K_2O, Av. S = available S, BD = bulk density

maize in low land plain of North China, whose organic matter fell the greatest.

Inter-relationships amongst different soil properties

The Pearson's correlation coefficient study (Table 4) showed that there was highly significant correlation (Pd"0.01) between pH and OC (r = -0.606**), pH and available N (r = -0.430**), pH and available P_2O_5 (r = -0.405**), pH and available S (r = -0.515**), pH and available K_2O (r = 0.408**), pH and BD (r = 0.624**), OC and available K (r = -0.316**), OC and BD (r= -0.645**), OC and available N (r = 0.767**), OC and available S (r = 0.612**), available N and BD (r = -0.489**), available N and available S (r = 0.660**), available P and available K (r= -0.284**), available P and BD (r= -0.347**), available P and clay (r= -0.469**), available S and BD (r= -0.490**) and BD and clay (r= 0.262**) and significant correlation was noted (Pd"0.05) between OC and available P (r = 0.206*), available N and available K (r = -0.199*), available K and BD (r= 0.199*).

From the above results, it can be inferred that the studied soils were moderate to strong acidic in pH ranged from 5.81 (rice-potato-sesame) to 6.15 (rice-vegetable) that was increased with the increase in soil depth. The BD ranged from 1.25 g cm^{-3} (fallow land) to 1.32 g cm^{-3} (rice-rice) and was also increased with the increasing soil depth. Organic C was low to medium category (ranging from 0.32 to 0.52%) and showed a negative correlation with soil depth. Available N content ranged from 146.13 kg ha^{-1} (rice-vegetable) to 215.37 kg ha^{-1} (fallow land) and available P_2O_5 ranged from 29.47 kg ha^{-1} (rice-potato-sesame) to 38.83 kg ha^{-1} (vegetable-vegetable) and both decreased with the increase in soil depth. Mean available K_2O content ranged from 129.24 kg ha^{-1} (rice-fallow) to 147.41 kg ha^{-1} (fallow land), increased below soil depth. The available S content, varied from 16.55 mg kg^{-1} (rice-potato-sesame) to 22.10 mg kg^{-1} (fallow land) and exhibited a negative correlation with soil depth. There was significant corelationship among most of the studied soil properties. Because of lower availability, the balanced application of N, P, K and S fertilizers along with FYM should be optional for optimum crop production and upkeeping soil health of the studied lateritic soil of West Bengal.

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