



Fertility status of paddy growing soils under Supaul district of Bihar (India)

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ABSTRACT

An investigation was carried out on "Fertility status of paddy growing soils under Supaul district of Bihar". Over this concern, soil pH, EC and ESP were also examined and the result indicated that 54% soil samples were slightly alkaline, 45% neutral and 01% acidic out of the total analyzed soil samples. However, the status of salt in soils fallen 100 % non-saline in nature. In continuation of analyzed soil samples, the exchangeable sodium percentage (ESP) varied from 0.27 to 4.98% in different horizons having decreasing trend from upper to lower soil surfaces. The range of CaCO₃ was 1 to 6.54% in upper horizon whereas 0.78 to 5.10% in lower horizon. The range of organic carbon was 0.06 to 0.59 % in different horizons having decreasing trend from surface to lower surface. In context of macro nutrients in soils, available Nitrogen was deficient, available P₂₀₅ was low to medium and available K₂₀ was medium in all depths of horizons. The available N, P and K varied from 33.34 to 175 kg ha⁻¹, 5.95 to 32 kg ha⁻¹ and 151.77 to 282 kg ha⁻¹.

Key words: Macronutrients, Rice soils, flood prone areas, exchangeable and CaCO₃

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INTRODUCTION

In Bihar, rice is cultivated in an area of 3.2 mha with production of 6.04 MT and productivity 1.95 t ha⁻¹ having geographical areas of about 94.2 thousand square km [1]. The districts like Supaul, Saharsa, Madhepura, Araria and Purnia in north eastern part of Bihar are severely affected by the flood devastation and these districts were severely affected due to flood in Kosi devastation 2008. Supaul is known for the flood prone district in Bihar. Natural calamity like flood devastation in the studied district provided regional impact on ecosystem and livelihood and over this concern, natural disasters can have devastating long-term impacts in terms of farm productivity [25]. In continuation of the flood affected areas, land use referred to the human activities directly related to the land, whereas land cover denoted the natural features covering the land surface [7]. The flood investigation approach has been verified significantly along with the morphology and dynamics of rivers that have high erosive potential and substantial supply of sediments [8]. The precipitation of calcium carbonate from the solution rich in carbonate resulted in the high pH values. High base saturation in these soils is due to high amount of bases in the soil parent materials. The exchangeable cations and extractable bases were considerably high in the studied area. Among the exchangeable cations, Ca was predominant followed by Mg, Na and K [3, 12]. They reported that information with respect to land and water resources is essential for planning and their management under flood prone areas [11]. In continuation of above facts, the present study was carried out for the assessment of available macronutrients in soils under flood prone area.

MATERIALS AND METHODS

Supaul, the study area fallen under Kosi region in North Bihar covering a total geographical area of 2985 sq. km. having geographical extension between 25° 59' to 26° 34' North latitudes and 86° 23' to 87° 06' East longitudes (Fig.1). This district is a part of alluvial plain of Kosi River. Slope gradient from north to south west and streams of the area flow towards Kosi. Kosi region belongs to monsoonal sub-humid to humid climate with around 1300 mm mean annual rainfall. Kosi which brings its load of sediments from

the crystalline region of central Himalayas is notorious for its flood and silting of the lands. The flood plain of the Kosi river is very fertile. The districts under Kosi basin belongs to Purnea, Katihar, Saharsa, Supaul, Madhepura, Araria and Kisanj and stretching virtually the northern part adjoining Naugachia of Bhagalpur district as well as Khagaria district. It comes under Agro-climatic zone II of Bihar. The pedons were exposed to study the macro nutrient characteristics having salinity and alkalinity of the soils following the methods laid down in the Soil Survey Manual. Horizon-wise soil samples were collected, air-dried and processed (2 mm sieve) for various analyses following standard methods. Particle size analysis of sample was carried out by using International Pipette Method [15]. The pH and EC analyzed per the standard procedure by Jackson [5]. In laboratory, all the samples were air-dried, sieved (<2 mm) and processed for analysis. Processed samples were analysed for different parameters as per standard procedures [2,16] for physical as well as chemical properties in the laboratory. The necessary care and precautions were taken to avoid any contamination of foreign material and ions. The calcium carbonate was determined by Titration method [15]. The soil organic carbon estimated by wet digestion method of [24] and the available nitrogen was determined by [22]. The available P in the soil was extracted by employing [13] and the available K was extracted by using Neutral normal ammonium acetate and the content was determined by aspirating the extract into flame photometer [5].

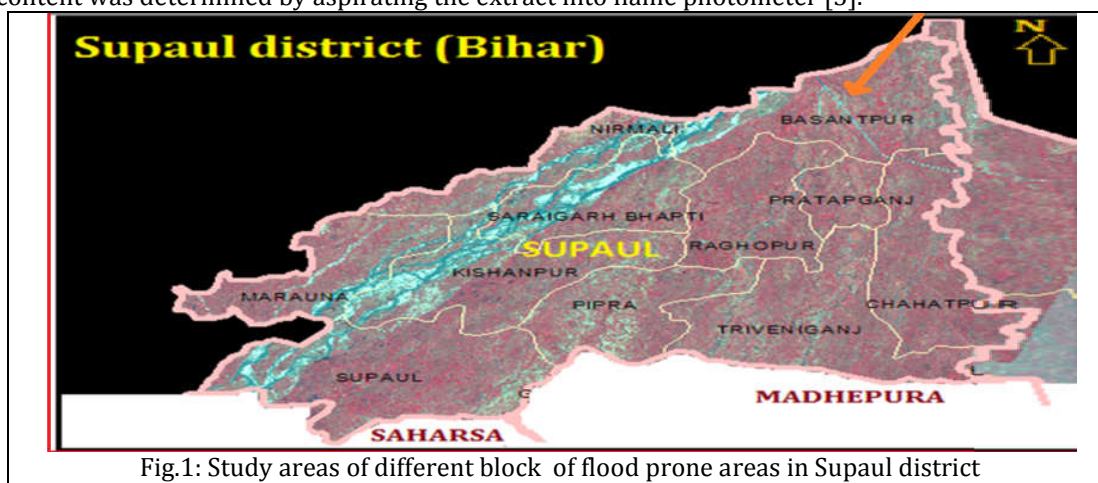


Fig.1: Study areas of different block of flood prone areas in Supaul district

RESULTS AND DISCUSSION

Soil pH and EC

The layer wise (0-15 & 15-30 cm depth) soil samples were collected from 157 fields including five pedon for the characterization with respect to physico-chemical analysis viz. pH, EC, ESP & CaCO₃, and fertility parameters like organic carbon, available N, P and K under paddy growing areas in Supaul district. The results indicated that, in soil surface layer (0-15 cm), the maximum pH (8.49) was found in Kishanpur block and minimum (6.25) was found in Basantpur block. Whereas, in case of sub-surface layer (15-30 cm), the maximum pH (8.83) found in Kishanpur block and minimum (6.56) was found in Basantpur block. However, the pH range varies from 6.25-8.49 and 6.56-8.83 at 0-15 cm and 15-30 cm depth, respectively. Overall results indicated that, the soil reaction having normal to slightly alkaline condition in paddy growing soils of different block in Supaul district. Similar results also reported by [10] and they found that the soil pH relatively high due to the presence of high degree of base saturation in soils. Whereas, in respect of salinity, the maximum EC (0.46 dSm⁻¹) was found in Saraigarh block and minimum (0.04 dSm⁻¹) was found in Basantpur block in soil surface layer (0-15 cm). While, in case of sub-surface layer (15-30 cm), the maximum EC (0.45 dSm⁻¹) found in Saraigarh block and minimum (0.04 dSm⁻¹) was found in Pratapganj and Basantpur block. However, the EC range varies from 0.04-0.46 dSm⁻¹ and 0.04-0.45 dSm⁻¹ at 0-15 cm and 15-30 cm depth, respectively. Overall results indicated that, the soil was non-saline condition due less water deficit and more water surplus in Kosi basin areas of Supaul district. These results also corroborated by [23] and they observed that *Inceptisols* and *Entisols* of Shahibi basin in Haryana and Delhi were non-saline in nature (Table 1 and 2).

The Organic Carbon (OC %) ranged at surface layer, the maximum organic carbon (0.54%) was found in Triveniganj block and minimum (0.06%) was found in Chhatapur block. Whereas, in case of sub-surface layer (15-30 cm), the maximum organic carbon (0.59%) found in Piprahi block and minimum (0.06%) was found in Chhatapur block. However, the organic carbon range varies from 0.06-0.54% and 0.06-0.59% at 0-15 cm and 15-30 cm depth, respectively. Overall results indicated that, the soil organic carbon status is low to medium condition. Results were supported by the findings of [9] for soils of loktak

catchment area in Manipur region. They found low organic carbon content in piedmont plain and coastal plain of Southern Saurashtra region of Gujarat In case of Dangs district [18] (Table 1 and 2).

ESP (%) and CaCO₃ (%)

The results indicated that, in soil surface layer (0-15 cm), the maximum ESP (4.89%) was found in Raghapur block and minimum (0.27%) was found in Pratapganj block. Whereas, in case of sub-surface layer (15-30 cm), the maximum ESP (4.98%) found in Triveniganj block and minimum (0.27%) was found in Saraigarh block. However, the ESP range varied from 0.27-4.89 % and 0.27-4.98 % at 0-15 cm and 15-30 cm depth, respectively. Overall results indicated that, the soil was non-sodic condition. The exchangeable sodium percentage (ESP) ranged from 0.27 to 4.98 % and that is associated with topography and swelling type clay minerals [21] (Table 1 and 2). The maximum CaCO₃ was found in Triveniganj block and minimum (1.00%) was found at surface (0-15cm) and sub-surface layer (15-30 cm) of different blocks in Supaul block which was found maximum (6.54 % and 5.10%) and minimum (1.00% and 0.78 %), respectively. Overall results indicated that, the soil was non-calcareous condition. The free CaCO₃ was ranged from 0.78 to 6.54% (0-30 cm) and the higher CaCO₃ content might be due pedogenic processes resulting in the depletion of Ca⁺² ions from the soil solution in the form of calcretes (Table 3&4).

Nutrient Status

Macronutrients: The results indicated that, in soil surface layer (0-15 cm), the maximum available nitrogen (175 kg ha⁻¹) was found in Kishanpur block and minimum (37.72 kg ha⁻¹) was found in Chhatapur block. Whereas, in case of sub-surface layer (15-30 cm), the maximum available nitrogen (154.7 kg ha⁻¹) found in Kishanpur block and minimum (33.34 kg ha⁻¹) was found in Chhatapur block. However, the available nitrogen range were varies from 37.72-175 kg ha⁻¹ and 33.34-154.7 kg ha⁻¹ at 0-15 cm and 15-30 cm depth, respectively. Overall results indicated that, the soil available nitrogen status was deficient condition (Table 3 and 4). The results need proper management of available nitrogen in these soils through addition of more organic matters/ manures for possible improvement of crop yield. Results were supported by the findings of [9] for soils of loktak catchment area in Manipur region. They found low available nitrogen content in piedmont plain and coastal plain of Southern Saurashtra region of Gujarat [18]. The maximum available P₂O₅ (32 kg ha⁻¹) was found in Pipra block and minimum (6.89 kg ha⁻¹) was found in Supaul block in soil surface layer (0-15 cm). Whereas, in case of sub-surface layer (15-30 cm), the maximum available P₂O₅ (27.64 kg ha⁻¹) found in Pipra block and minimum (5.95 kg ha⁻¹) was found in Supaul block. However, the available P₂O₅ range was varies from 6.89-32 kg ha⁻¹ and 5.95-27.64 kg ha⁻¹ at 0-15 cm and 15-30 cm depth, respectively. Overall results indicated that, the soil available P₂O₅ status was low to medium condition of paddy growing soils of different block in Supaul district. The major soils belonged to low to medium status of available phosphorus. The major soils belonged to low to medium status of available phosphorus and as result appropriate measures are required to be taken up for P- management of these soils in order to fulfill crop demand for achieving higher yield of crop (Table 3 and 4). The maximum available K₂O (282 kg ha⁻¹) was found in Pipra block and minimum (173.65 kg ha⁻¹) was found in Chhatapur block in soil surface layer (0-15 cm). Whereas, in case of sub-surface layer (15-30 cm), the maximum available K₂O (246.46 kg ha⁻¹) found in Piprahi block and minimum (151.77 kg ha⁻¹) was found in Chhatapur block. However, the available K₂O range was varies from 173.65-282 kg ha⁻¹ and 151.77-246.46 kg ha⁻¹ at 0-15 cm and 15-30 cm depth, respectively. Overall results indicated that, the soil available K₂O status was medium condition (Table 3 and 4). Results of phosphorus and potassium were supported by the findings of [17] for soils of Karnataka, [19] for soils of Amritsar district of Punjab [4] for pear orchard soils of Kashmir, [19] for ravenous land in Chambal region of Madhya Pradesh.

CONCLUSION

The physico-chemical properties under paddy growing soils of Supaul district was assessed after Kosi devastation, revealed that the soils were near normal to slightly alkaline in reaction, non-saline and low to medium in organic carbon. The ESP and CaCO₃ were non-sodic and non-calcareous in nature due to regular flood visit. The soils were low in available N, low to medium in available P and medium in available K. From farmer's point of view, farmers have been applied FYM and vermin-compost and incorporation of crop residue to maintain the fertility status of soils and sustain the soil health.

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Table 1: pH, EC, OC and ESP of different blocks in Supaul District at depth (0-15 cm)

Block	N	Depth of sampling (0-15 cm)							
		pH (1:2.5)		EC (dSm ⁻¹)		OC (%)		ESP (%)	
		Range	Mean	Range	Mean	Range	Mean	Range	Mean
Triveniganj	12	7.25-8.21	7.89±0.32	0.24-0.41	0.32±0.06	0.25-0.54	0.39±0.10	0.47-4.83	2.58±1.28
Supaul	16	7.45-7.60	7.52±0.05	0.06-0.08	0.07±0.01	0.32-0.43	0.38±0.03	0.30-4.83	2.38±1.35
Chhatapur	14	7.97-8.26	8.11±0.12	0.06-0.07	0.07±0.01	0.06-0.35	0.22±0.08	0.29-4.75	2.39±1.31
Raghopur	11	6.80-7.23	7.01±0.16	0.05-0.07	0.06±0.01	0.32-0.54	0.44±0.07	0.27-4.89	2.44±1.50
Kishanpur	18	7.07-8.49	7.63±0.42	0.07-0.09	0.08±0.01	0.29-0.39	0.35±0.03	0.28-4.72	2.37±1.45
Pipra	10	8.31-8.41	8.36±0.04	0.08-0.12	0.09±0.01	0.38-0.50	0.45±0.04	0.27-4.65	2.22±1.48
Basantpur	21	6.25-7.60	6.98±0.34	0.04-0.25	0.16±0.05	0.24-0.54	0.38±0.10	0.27-4.82	2.25±1.44
Marauna	12	7.46-8.42	7.93±0.37	0.25-0.43	0.32±0.07	0.09-0.28	0.20±0.06	0.34-4.12	2.24±1.26
Saraigarh	13	6.83-7.38	7.10±0.22	0.06-0.46	0.28±0.12	0.42-0.52	0.47±0.04	0.27-4.68	2.39±1.36
Pratapganj	14	6.45-7.15	6.80±0.24	0.04-0.06	0.05±0.01	0.23-0.34	0.29±0.03	0.27-4.58	2.24±1.39
Nirmali	16	7.84-8.48	8.06±0.16	0.08-0.19	0.12±0.03	0.41-0.50	0.45±0.03	0.35-4.62	2.45±1.26
Overall	157	6.25-8.49	7.58±0.56	0.04-0.46	0.15±0.10	0.06-0.54	0.36±0.10	0.27-4.89	2.35±1.33

Table 2: Table 1: pH, EC, OC and ESP of different blocks in Supaul District at depth (15-30 cm)

Block	N	Depth of sampling (15-30 cm)							
		pH (1:2.5)		EC (dSm ⁻¹)		OC (%)		ESP (%)	
		Range	Mean	Range	Mean	Range	Mean	Range	Mean
Triveniganj	12	7.40-8.37	8.05±0.33	0.23-0.39	0.30±0.06	0.15-0.45	0.25±0.11	0.49-4.98	2.74±1.29
Supaul	16	7.82-7.98	7.90±0.05	0.06-0.07	0.07±0.01	0.30-0.41	0.36±0.03	0.31-4.98	2.49±1.40
Chhatapur	14	8.21-8.51	8.35±0.12	0.06-0.07	0.07±0.01	0.06-0.33	0.21±0.08	0.29-4.97	2.45±1.36
Raghopur	11	7.14-7.59	7.36±0.17	0.05-0.06	0.07±0.01	0.27-0.50	0.38±0.06	0.28-4.75	2.22±1.51
Kishanpur	18	7.35-8.83	7.93±0.43	0.07-0.09	0.08±0.01	0.17-0.37	0.29±0.07	0.48-4.93	2.65±1.42
Pipra	10	8.56-8.66	8.61±0.04	0.08-0.12	0.09±0.01	0.21-0.59	0.36±0.12	0.28-4.98	2.33±1.56
Basantpur	21	6.56-7.98	7.33±.35	0.04-0.24	0.16±0.05	0.12-0.50	0.25±0.13	0.32-4.93	2.11±1.49
Marauna	12	7.98-8.49	8.22±0.40	0.24-0.42	0.31±0.07	0.10-0.26	0.18±0.04	0.28-4.98	2.33±1.56
Saraigarh	13	7.24-7.82	7.52±0.23	0.06-0.45	0.27±0.12	0.22-0.50	0.39±0.10	0.27-4.98	2.45±1.41
Pratapganj	14	6.90-7.65	7.27±0.26	0.04-0.06	0.05±0.01	0.15-0.31	0.24±0.06	0.28-4.92	2.50±1.42
Nirmali	16	8.07-8.73	8.31±0.17	0.07-0.18	0.12±0.03	0.23-0.46	0.28±0.07	0.36-4.51	2.50±1.27
Overall	157	6.56-8.83	7.89±0.50	0.04-0.45	0.14±0.10	0.06-0.59	0.29±0.10	0.27-4.98	2.43±1.40

Table 3: Calcium carbonate and available NPK content of different blocks in Supaul District at depth (0-15 cm)

Block	N	CaCO ₃ (%)		Nitrogen (kg ha ⁻¹)		P ₂ O ₅ (kg ha ⁻¹)		K ₂ O (kg ha ⁻¹)	
		Range	Mean± SD	Range	Mean	Range	Mean	Range	Mean
Triveniganj	12	3.14-6.54	4.19±0.93	60-98	80±12.35	12.25-25.36	18.84±3.80	185-255	201±18.88
Supaul	16	1.00-4.50	3.00±1.15	87-112	100±8.42	6.89-15.06	10.8±2.53	200-220	210±6.65
Chhatapur	14	1.13-2.50	1.87±0.47	37-86	62±19.25	16.07-21.0	18.09±1.85	173-209	193±14.88
Raghopur	11	1.25-3.75	2.50±0.97	82-100	92±4.89	10.0-20.0	15.31±3.31	232-268	254±10.20
Kishanpur	18	2.00-5.50	3.97±1.15	103-175	143±17.41	15.27-28.23	20.64±3.87	198-231	218±10.11
Pipra	10	2.50-3.75	3.04±0.55	62-100	76±13.07	18.0-32.0	25.83±5.27	232-282	260±16.45
Basantpur	21	2.50-4.23	3.4±0.60	51-98	76±14.12	14.25-24.36	19.2±3.21	174-245	199 ±16.60
Marauna	12	1.35-3.48	2.39±0.77	85-113	98±9.14	13.25-25.65	17.62±3.97	197-245	215±13.91
Saraigarh	13	3.00-5.62	4.42±0.79	50-125	87±24.81	14.97-20.51	17.56±1.97	194-206	201±3.66
Pratapganj	14	4.38-6.25	5.57±0.63	62-74	68±4.38	15.36-20.36	17.73±1.81	194-232	215±13.62
Nirmali	16	1.25-5.12	3.27±1.31	75.95-87.89	81±4.35	10.45-15.51	13.36±2.53	190-204	198±5.19
Overall	157	1.00-6.54	3.41±1.31	37-175	87±26.09	6.89-32	17.87±4.69	173-282	216±22.84

Table 4: CaCO₃ and available NPK content of the sub- surface layer (15-30 cm) of different blocks in Supaul District

Block	No of sample	CaCO ₃ (%)		Nitrogen (kg ha ⁻¹)		P ₂ O ₅ (kg ha ⁻¹)		K ₂ O (kg ha ⁻¹)	
		Range	Mean± SD	Range	Mean± SD	Range	Mean± SD	Range	Mean± SD
Triveniganj	12	2.45-5.10	3.27±0.73	53-86	71±10.91	10.58-21.91	16.28±3.28	162-222	176±16.50
Supaul	16	0.78-3.51	2.34±0.90	77-99	88±7.44	5.95-13.01	9.33±2.19	175-192	183±5.80
Chhatapur	14	0.88-1.95	1.46±0.37	33-76	55±17.02	13.88-18.14	15.63±1.60	151-183	169±13.01
Raghopur	11	0.98-2.93	1.95±0.76	73-88	81±4.32	8.64-17.28	13.28±2.86	203-234	222±8.92
Kishanpur	18	1.56-4.29	3.09±0.90	91-154	126±15.39	13.19-24.39	17.84±3.35	173-201	190±8.84
Pipra	10	1.95-2.93	2.37±0.43	54-88	68±11.55	15.55-27.65	22.31±4.56	202-246	227±14.38
Basantpur	21	1.95-3.30	2.65±0.47	45-87	67±12.48	12.31-21.05	16.59±2.77	152-214	174±14.50
Marauna	12	1.05-2.71	1.86±0.60	75-99	86±8.08	11.45-22.16	15.23±3.43	172-214	188±12.15
Saraigarh	13	2.34-4.38	3.45±0.62	44-110	77±21.93	12.94-17.72	15.17±1.71	169-180	176±3.20
Pratapganj	14	3.42-4.88	4.35±0.49	54-65	60±3.87	13.27-17.59	15.32±1.57	170-202	188±11.90
Nirmali	16	0.97-3.99	2.55±1.02	67-77	72±3.85	9.02-13.40	11.55±1.48	166-178	173±4.54
Overall	157	0.78-5.10	2.66±1.02	33-154	77±23.06	5.95-27.65	15.4±4.05	151-246	189±19.96

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