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Short Communication

Physical and chemical properties of soils collected from surrounding areas of Payra thermal power plant

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ABSTRACT

The study was conducted to observe the physical and chemical properties of the soils of the Payra thermal power plant's surrounding areas. The textural class of 55 collected soil samples was mostly Silt loam, with few Silty clay loam soils. Soil pH ranges from 3.72 to 7.82, with more than 80 % being acidic and only 4% slightly alkaline. The 23 % of samples were highly acidic (pH<4.5). The electrical conductivity ranged from 0.91 to 23.95 dS/m, with 47% of the samples having EC values greater than 8 dS/m; those sample sites were unsuitable for crop cultivation. There was a significant difference between Olsen P and Bray P in soil, having 0.73 to 13.87 and 9.29 to 42.60 ppm, respectively. All the samples had very high sulfur contents (34.3 to 601.4 ppm). Most soil samples (78%) contained very high sodium content.

Introduction

Suspended particulate matter produced from construction activities of the Payra thermal power plant at KalaparaUpazila of Patuakhali district may accumulate in the nearby areas and impact the changing properties of agricultural lands. The duration and extent of tidal water flooding may also greatly influence the deposition of sediments and plant nutrients in the coastal ecosystem (Haque et al., 2023a). The tidal waterborne fine soil particles contain a high quantity of nutrients in available form (Haque et al., 2014). Little attention has been given to characterizing the coastal soils for their suitability for growing various crops (Jodder et al., 2016). The study aimed to assess soil's physical and chemical properties at the Payra thermal power plant's surrounding areas and their impact on crop production.

Fifty-five soil samples were collected from farmers' fields within a 1-5 km radius of the power plant. Soils collected from 0 to 15 cm soil depth from 15 to 20 March were dried, crushed, sieved using a 2-mm sieve, and then analyzed following standard procedures.

Sand, silt, and clay percentages varied from 1.7 to 29.7, 62 to 86.5, and 5.8 to 23.8 with an average of 9.9, 76.6, and 13.5, respectively (Table 1). Textural classes of the soils were Silt loam (69%), Silty clay loam (27%), and Clay loam (4%). The silt and clay fractions were dominant over sand fractions in all the collected samples. The silt and clay-dominated textures in the coastal ecosystem were also reported by Kumar et al. (2018), Haque and Hoque (2023), Sume et al. (2023), and Haque et al. (2023b; 2024a).

Table 1. Textural classes of the soils.

Soil particles	Range of particles (%)	Textural classes	Sample size	% of the total 55 samples
Sand (%)	1.7 - 29.7 (9.9)	Silt loam	38	69
Silt (%)	62 - 86.5 (76.6)	Silty clay loam	15	27
Clay (%)	5.8 - 23.8 (13.5)	Clay loam	2	4

Values in the parenthesis indicate the average value

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In reaction, most of the top soils were strongly acidic to slightly alkaline (pH 3.72 to 7.82) (Table 2). More than 80 % of the soil samples were acidic, 15% neutral, and only 4 % were slightly alkaline in reaction. Extreme acidity (pH <4.5) was found in 23 samples out of 55, indicating that the soil was probably an actual acid-sulfate soil (Haque et al., 2008; Haque et al., 2023c; 2024b). Electrical conductivity (EC) varied from 0.91 to 23.95 dS/m (Table 2). Most of the agronomical crops can tolerate EC values up to 4 dS/m. Among the samples, 38% had EC values lower than 4 dS/m, and those soils are suitable for growing all crops. The salt-tolerant rice varieties can tolerate EC values up to 8 dS/m; in the present study, only 15% of samples were within this range. The 47% of samples had EC values greater than eight dS/m; those sample sites were unsuitable for crop cultivation. Similar electric conductivity was also described by Haque (2018).

Table 2. pH and EC data of soils at Pa.

Interpretation class	Sample size	% of total samples
Soil acidity (pH)		
Very strongly acid (<4.5)	23	42
Strongly acid (4.5 - 5.5)	10	18
Slightly acid (5.6 - 6.5)	12	22
Neutral (6.6 - 7.3)	08	15
Slightly alkaline (7.4 - 8.4)	02	4
Strongly alkaline (8.5 - 9.0)	-	-
pH Range	3.72 - 7.82	
pH Mean	5.29	
Soil salinity class based on EC (dS/m)		
Nonsaline (0 - 2)	06	11
Slightly saline (2 - 4)	15	27
Moderately saline (4 - 8)	08	15
Saline (8 - 12)	15	27
Highly saline (>12)	11	20
EC Range	0.91 - 23.95	
EC Mean	7.75	

There was a big difference between Olsen P and Bray P contents of the same soil sample. The Olsen P varied from 0.73 to 13.87 ppm (Table 3). 96% of samples were very low, and 4% of samples were low in available P content, which indicates that all the tested soils were deficient in P content. However, the opposite result was recorded when the soils were analyzed using the Bray method. Based on the Bray method, none of the samples were very low. Only 2% soils were low, 7% samples were medium and 15% samples were optimum in P content (Table 3). Interestingly, 76% of samples were high and very high in P content. However, phosphorus fixation due to low soil pH in the dry season is also reported in the ecosystem (Hoque et al., 2010).

Table 3. P contents (ppm) of soils.

Interpretation class	Sample size	% of total samples
Olsen P		
Very Low (≤ 7.5)	53	96
Low (7.51 - 15.0)	02	4
Medium (15.1 - 22.5)	-	-
Optimum (22.51 - 30.0)	-	-
High (30.1 - 37.5)	-	-
Very high (> 37.5)	-	-
P range	0.73 - 13.87	
P means	2.47	
Bray P		
Very Low (≤ 5.25)	-	-
Low (5.25 - 10.5)	01	2
Medium (10.51 - 15.75)	04	7
Optimum (15.76 - 21.0)	08	15
High (21.1 - 26.25)	10	18
Very high (> 26.25)	32	58
Bray P range	9.29 - 59.97	
Bray P mean	27.29	

Available sulfur was observed to be very high in all (100%) soil samples, and it ranged from 34.3 to 601.4 ppm (Table 4), which has a chance of being toxic through the formation of acid sulfate soils (Hoque et al., 2011). The exchangeable potassium content ranged from 0.11 to 0.51 meq/100g soil (Table 4). Of 55 soil samples, 62 % contained low K, and 20 % had medium K concentration. Only 8% of samples had high and very high K content. The lowland rice in delta soils would rarely respond to the application of potassium, although only some upland rabi crops, including maize, responded to K application, especially in saline soils (Haque, 2020).

Table 4. S, K, and Na contents of soils.

Interpretation class	Sample size	% of total samples
Available S (ppm)		
Very Low (≤ 7.5)	-	-
Low (7.51 - 15.0)	-	-
Medium (15.1 - 22.5)	-	-
Optimum (22.51 - 30.0)	-	-
High (30.1 - 37.5)	-	-
Very high (> 37.5)	5	100
Range	34.3 - 601.4	
Mean	272.9	
Exchangeable potassium (meq/100 g soil)		
Very Low (≤ 0.09)	01	02
Low (0.91- 0.18)	34	62
Medium (0.181 - 0.27)	11	20
Optimum (0.271 - 0.36)	05	09
High (0.361 - 0.45)	02	04
Very high (> 0.45)	02	04
Range	0.06 - 0.51	
Mean	0.20	
Exchangeable sodium (meq/100 g soil)		
Very Low (≤ 0.09)	-	-
Low (0.91- 0.18)	03	06
Medium (0.181 - 0.27)	-	-
Optimum (0.271 - 0.36)	09	16
High (0.361 - 0.45)	-	-
Very high (> 0.45)	43	78
Range	0.17 - 2.70	
Mean	1.01	

Exchangeable sodium was found to be very high compared to the potassium content of the collected soil samples (Table 4) and varied from 0.17 to 2.53 meq/100g soil. Among the tested soil samples, only 6 % had low, and 16 % had optimum P levels. Unfortunately, 78 % of samples had very high Na content. Although sodium is not an essential plant nutrient element, in lower concentrations, it enhances plant growth; similarly, in higher concentrations, it is excessively toxic to plants (Shila et al., 2016; Sikder et al., 2016; Akter et al., 2021; Sultana et al., 2021). There was a very strong and significant relation (R^2=0.948) of the soil's sodium content with the soil's electrical conductivity. It was found that increasing sodium content in soil linearly increases the electrical conductivity of soil (Fig. 1).

It might be concluded that in the surrounding areas of the Payra thermal power plant, fine textured silt and clay particles were dominant, the soils were generally acidic in reaction with a very low percentage of slightly alkaline reaction, and widespread deficiency of Olsen P with low to medium availability of K. The sodium toxicity was very consistent over the study area.

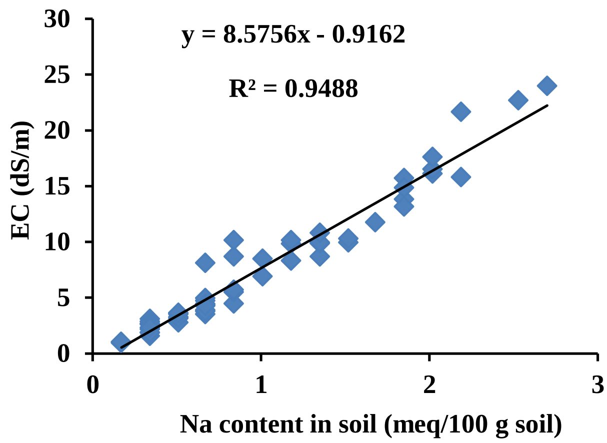

Fig. 1. Regression relation of Na content with EC of soil (n=55).

References

Akter N, Haque MA and Hoque MF. Improvement of maize growth by application of silicon through its suppressing effect on sodium uptake under salt stress conditions. *J. Bangladesh Acad. Sci.* 2021; 45(2): 251-253.

Haque MA and Hoque MF. Nitrogen fertilizer requirement and use efficiency in sunflower at Ganges delta coastal salt-affected soils. *Commun. Soil Sci. Plant Anal.* 2023; 54(16): 2248-2262.

Haque MA, Hoque MF, Jahiruddin M, Hossain MB, Satter MA, Haque ME and Bell RW. Performance evaluation of different sources and rates of silicon in rice at eastern Gangetic coastal plains. *J. Soil Sci. Plant Nutr*. 2023b; 23: 5084-5096.

Haque MA, Jahiruddin M, Hoque MA, Rahman MZ and Clarke D. Temporal variability of soil and water salinity and its effect on the crop at Kalapara upazila. *J. Environ. Sci. Nat. Resourc.* 2014; 7(2): 111-114.

Haque MA, Jahiruddin M, Hoque MF, Islam MS, Hossain MB, Satter MA, Haque ME and Bell RW. Increasing the use efficiency of fertilizer phosphorus for maize in low-P Ganges delta soils. *J. Plant Nutr*. 2023c; 46(10): 2257-2275.

Haque MA, Jharna DE, Hoque MF, Uddin MN and Saleque MA. Soil solution electrical conductivity and basic cations composition in the rhizosphere of lowland rice in coastal soils. *Bangladesh J. Agril. Res*. 2008; 33(2): 243-250.

Haque MA, Kabir ME, Akhter S, Hoque MF, Sarker BC, Anik MFA, Ahmed A, Pranto S, Sima AS, Lima F, Jahiruddin M, Hossain MB, Haque ME, Satter MA and Bell RW. Crop nutrient limitations in intensified cropping sequences on the Ganges delta coastal flood plains. *J. Soil Sci. Plant Nutr*. 2023a; 23: 1996-2006.

Haque MA, Mobaswera A, Sume MA, Pranto S, Jahiruddin M, Hoque MF and Bell RW. Silicon supplementation improves yield and silicon uptake in maize at eastern Ganges delta coastal soils. *J. Plant Nutr*. 2024a, 47(2): 190-204.

Haque MA, Sima AS, Jahiruddin M and Bell RW. Minimizing phosphorus mining through optimum phosphorus fertilization in maize. *J. Soil Sci. Plant Nutr*. 2024b; 24(1): 1-13

Haque MA. Increasing yield of maize through potash fertilizer management in saline soil. *J. Bangladesh Agric. Univ*. 2020; 18(2): 362-366.

Haque MA. Variation in salinity through the soil profile in south coastal region of Bangladesh. *J. Bangladesh Acad. Sci*. 2018; 42(1): 11-23.

Hoque MF, Haque MA, Hossain MK, Haque MZ and Hussain ASMI. Characterization of some coastal delta soils of Bangladesh. *J. Bangladesh Soc. Agric. Sci. Technol*. 2011; 8(1 & 2): 77-82.

Hoque MF, Saleque MA, Rashid MH, Haque MA and Islam MR. Phosphorus sorption as influenced by soil characteristics on four Ganges Tidal Floodplain soils of Bangladesh. *J. Patuakhali Sci. Tech. Univ.* 2010; 2(1):1-11.

Jodder R, Haque MA, Kumar T, Jahiruddin M, Rahman MZ and Clarke D. Climate change effects and adaptation measures for crop production in South-West coast of Bangladesh. *Res. Agric. Livest. Fish.* 2016; 3(3): 369-378.

Kumar T, Haque MA, Islam MS, Hoque MF and Jodder R. Effect of polythene mulch on growth and yield of sunflower (*Helianthus annuus*). *Arch. Crop Sci*. 2018; 2(1): 38-46.

Shila A, Haque MA, Ahmed R and Howlader MHK. Effect of different levels of salinity on germination and early seedling growth of sunflower. *World Res. J. Agric. Sci.* 2016; 3(1): 048-053.

Sikder MU, Haque MA, Jodder R, Kumar T and Mondal D. Polythene mulch and irrigation for mitigation of salinity effects on maize (*Zea mays* L.). *The Agriculturists*, 2016; 14(2): 01-13.

Sultana N, Haque MA, Hoque MF, Hossain MB, Satter MA and Jahiruddin M. Effect of silicon application on growth and biomass yield of rice under salinity stress. *J. Bangladesh Agric. Univ*. 2021; 19(4): 429-436.

Sume MA, Haque MA, Mobaswera A, Hoque MF, Jahiruddin M and Bell RW. Identifying varietal differences for silicon mediated improvement of leaf architecture and plant growth in rice. *Silicon*, 2023; 15: 6299-6311.