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SOIL HEALTH STUDY AT IUBAT'S RAJENDRAPUR AGRICULTURAL RESEARCH STATION, GAZIPUR

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ABSTRACT

Twenty soils were collected on April 2024 covering 10 from Northern side and 10 from Southern side at 0-15 cm depths from IUBAT's Rajendrapur Agricultural Research Station. The soils were dried at IUBAT's Lab.1, ground, sieved and labeled properly. Soil health covering the physical (soil colour, land type, and particle density) and chemical (pH, organic carbon, organic matter, total N, P, K, S, Ca, Na, EC, and HCO_3) properties were studied at Humboldt Soil Testing lab, Bangladesh Agricultural University (BAU), Mymensingh-2202. The morphological description of the soils reported in Table 3. Soils were red in colour with clay, silty clay and sandy clay, clay loam type with particle density of 2.388-2.568 g/cc. pH values of the 20 soils varied from 4.60 to 5.45, organic carbon 0.4-1.15%, organic matter 1.11-2.47%, total N 0.067-0.112%, P 2.18-30.72(ppm), K(0.130-0.269 meq/100g), S (6.15-25.76 meq/100g), Ca (0.760-1.956 mg/100g), Na (0.122-0.184 mg/100g), EC (50.4-250 µs/100g), and HCO_3 (244.0-427.0 µs/cm). Results showed minor to major variation of pH, organic carbon, organic matter, total-N, P, K, S, Ca, Na, EC and HCO_3 where standard deviations (SD) produced the depth of variations within the 20 samples covering 10 from Northern and 10 from southern regions. Here high land soils were acidic, rich in forest vegetation require proper management through using of compost, green manuring, water hyacinth, decomposed household wastes for 3-5 years for proper cultivation of rice, other crops and vegetables, and for proper using of land for agricultural research purposes.

Key words: Soil health, soil quality, physical and chemical properties of soils, nutrients status, management.

Introduction

During and after Second World War in 1942-45 the region IndoPak subcontinent including Bangladesh faced severe hunger and starvations where thousands of people died. Even during Pakistan period in 1950s the then East Pakistan (Bangladesh) still faced wide food crisis. During green revolution in 1960s, the Bangladeshi farmers received thousands of tons of N, P, K fertilizers and pesticides free of cost for production of high crop yields. On the basis of natural rains farmers cultivated numerous local varieties of rice crops where they applied huge amount of NPK fertilizers and pesticides. The situations then arose (reached) a great problem with land showing degradation/deptection of nutrients, or strong/hard unproductive land. It was quite different for the farmers for ploughing of such hard land for any crops. During 1965-71, the crop production greatly decreased in the country because of the local varieties, poor/irregular rainfalls severe nutrient depleted land strong and hard unproductive land due to severe uses of fertilizers and pesticides (Sattar, 1972). From January to November 1972, Sattar worked as Research Associate under USAID project at the Dept. of Soil Science, BAU, Mymensingh for the MSc(Ag) degree under the supervision of Prof. Z.H. Bhuiya (then Head of the Dept. and also later served as VC in 1987) where he studied urea transformations in 4-soils and discovered the life of urea (ammonifications and nitrifications) where high doses degraded or depleted organic matter contents, the nutrient, fertility and productivity of soils, and he recommended for wide use of manuring like cowdung, compost, household wastes, water hyacinth, and mixing with green manuring crops like dhaincha, matikalai, cowshed straws etc. Finally, the recommendations were widely circulated in 1973-75 to farmers through BAU central seminars, field visits and field demonstration to the farmers of Muktagacha, Mymensingh. Then farming technology with manuring worked greatly to the farmers throughout the country i.e. using of fertilizers and manurings for better yield of crops. That was the background and origin of organic farming as Sattar established in 1972 through his 199 pages MSc (Ag) research Thesis work i.e. todays organic farming

technology was established by Sattar in 1972 (Sattar, 1972) and from his thesis work 5 articles were also published in 1974-75 in national and Indian journals. Todays farming technology covers (1) using of improved varieties, (2) proper using of fertilizers, (3) on the basis of diseases, weeds, insects using of proper pesticides (herbicides, fungicides and/or insecticides), (4) regular using/applying of manuring like cowdung, poultry manures, composts, crop residues, household wastes, water hyacinths, leaves of plants, green manuring crops like soyabean, dhaincha, matikalai etc., (5) timely using of watering, (6) other management practices on the basis of the crops. Sattar (2024) supervised more than 50 students on soil fertility situations at different areas including coastal and char lands of Bangladesh. In 2023, Sattar *et al*. (2023) conducted almost similar fertility and soil quality work from the red soil region covering 6-categories of soils. Sattar (1988) widely studied the 16 soil properties covering ranges, average values, SD value and No. of samples studied and the result are reported in Table 1 where standard deviation (SD) showed the variations of ranges of the results (minor to medium). Regarding soil fertility conditions and using of fertilizers BARC (1985) developed guidebook covering on critical, low, medium and optimum levels of nutrients/fertility conditions and then using the necessary amounts of fertilizers against each nutrient (Table 2). Soil Resources Development Institute (SRDI), Dhaka published Upazila level of books covering fertility status and nutrient requirements to every union and/or village in 2000s and they are widely used regarding handling of fertility to the farmers field. They are also using soil sampling kits for helping soil fertility test and fertilizer doses for respective field of the farmers at village levels. Fertility largely helps for guiding the requirements of fertilizers to the particular area/field for better yield of crops.

Table 1. Evaluation, observation and analysis of the nutrient elements for crop fields in Bangladesh (Sattar, 1988)

Sl.	Nutrient elements	Ranges	Average values	Standard deviation (SD)	Results handled (samples)
1.	pH vaues	5.8-7.9	5.93	1.016	49
2.	Organic matter (%)	0.8-6.85	1.52	1.059	42
3.	Total-N (%)	0.05-1.20	0.25	0.289	22
4.	NH_4-N(ppm)	2.0-49.0	21.16	13.334	19
5.	NO_3-N(ppm)	2.2-11.1	6.76	2.839	14
6.	Ca (me/100g)	1.9-19.8	8.16	6.962	33
7.	Mg (me/100g)	0.3-8.44	2.54	1.581	33
8.	K (me/100g)	0.01-0.86	0.26	0.213	33
9.	P (ppm)	2.0-62.0	13.88	8.707	25
10.	S (ppm)	1.0-75.0	9.02	14.382	27
11.	B (ppm)	0.10-120.0	6.49	26.041	20
12.	Cu (ppm)	1.0-27.0	4.77	2.114	27
13.	Fe (ppm)	22.0-374.0	130.19	102.446	27
14.	Mn (ppm)	4.6-105.0	29.39	21.331	27
15.	Zn (ppm)	0.7-6.0	1.87	1.279	27
16.	Mo (ppm)	0.05-0.58	0.26	0.174	17

Table 2. Critical, low, medium and optimum levels of nutrient elements in crop field soils (BARC, 1985)

Sl.	Nutrient elements	Critical levels	Low	Medium range	Optimum range
1.	N (µg/ml)	75	75	76-150	151-300
2.	P (µg/ml)	12	10	13-25	35-75
3.	S (µg/ml)	12	12	13-25	26-75
4.	B (µg/ml)	0.3	0.2	0.81-0.50	0.51-40
5.	K (me/100g)	0.2	0.2	0.21-0.40	0.41-1.5
6.	Mg (me/100g)	0.8	0.8	0.81-2.0	2.1-9.0
7.	Ca (me/100g)	2	2	2.1-4.0	4.1-18
8.	Zn (µg/ml)	2	2	2.1-4.0	4.1-18
9.	Cu (µg/ml)	1	1	1.1-3.0	3.1-10
10.	Mn (µg/ml)	5	5	5.1-10	11-50
11.	Fe (µg/ml)	20	20	21-40	41-200

So, in the present study soil health covering different physical and chemical properties of the soils of IUBAT's Rajendrapur Agricultural Research station was analyzed for observing the soil quality and developing of guideline for proper nutrient management for best crop yields.

Materials and Methods

Twenty soils were collected on April 2024 covering 10 from the Northern Zone (side) and 10 from Southern zone (side) maintaining uniform distance (3-5m) from North to South end of the Rajendrapur Agricultural Research Station (RARS) of IUBAT. Auger was used to collect soils from 0-15cm depth where 3 soils were taken from each location making a composite soil. Usually, 200-250gm composite soil sample was finally taken to the lab from each location, dried at room temperature, ground and sieved properly and preserved in the plastic bags with labelling. The morphological characteristics of the soils are reported in Table 3.

Table 3. Soil sampling records and the morphological description of the study area (RARS, Gazipur)

Sl	Observations/Recorded information	Descriptions/evaluations
1	Soil sampling location (sites)	IUBAT's agriculture research station Gazipur
2	General soil type	Shallow red brown red browns terrace soil
3	Topography	Slightly high land
4	Vegetation (crops grown)	Rice, wheat, maize, pulses, grasses, banana, giner, vegetables, forest plants around and bamboo
5	Drainage/site drain	Well drained
6	Sampling depth	0-6 ″/0-15cm
7	Collection method	By using Auger
8	Date of collection	April, 2024
9	Collected by	Research group
10	No. of samples collected	North site 10, south site 10

Soil health covering some physical properties like land type, texture, soil colour and particle density, and again chemical properties like pH, OC, OM, total-N, P, K, S, Ca, Na, EC and HCO_3 contents were determined following the standard methods of Sattar and Rahman (1987) at Humboldt Soil Testing lab., Dept. of Soil Science, Bangladesh Agricultural University, Mymensingh.

Results and Discussion

The soil health in relation to physical and chemical properties of 20 representative soils (10 from Northern and 10 from Southern regions/areas) of the Rajendrapur Agricultural Research Station (RARS), Gazipur is described here.

1. **Study of soil health in relation to physical properties of the soils:** The soil quality covering the physical properties of the soils are included land type, soil colour and particle density (Table 4) where textural types covered clay, clay loam, silty clay and silty clay loam (average result).

   Land type: Both northern and southern zone areas of the farm showed a high land region where surrounding zones are covered with deep forest plants like sal, seghun, mehogini and gozari.

   Soil colour: Twenty soils covering northern and southern zone areas were almost uniform light red colour. Continuous using of manuring the soil colour of the field gradually changing light red to light brown or brown as true farm land for cultivation of most of the crops.

   Particle density: Ten soils of the northern part showed the particle density from 2.40 to 2.568 g/cc with the average of 2.452 g/cc and SD of 0.041. Again, the particle density varied at the southern part from 2.377-2.568 g/cc. The minor SD values of both sides confirmed that land status produced almost uniform conditions from starting to end covering northern to southern regions (Table 4).

Table 4. Soil physical properties, pH and Organic contents of northern and southern zone areas

Sl	Land type	Soil colour	Particle density (g/cc)	pH values	Organic carbon (%)	Organic matter (%)
	Northern region					
1	High	Light red	2.468	5.26	0.592	1.36
2	High	Light red	2.400	5.07	0.875	2.39
3	High	Light red	2.461	5.03	0.655	1.79
4	High	Light red	2.443	4.89	0.405	1.11
5	High	Light red	2.422	4.80	0.745	2.03
6	High	Light red	2.535	5.05	0.873	2.38
7	High	Light red	2.462	4.85	0.780	2.13
8	High	Light red	2.452	4.60	0.780	2.13
9	High	Light red	2.388	4.75	0.748	2.04
10	High	Light red	2.568	4.77	0.842	2.30
Average	-	-	2.452	4.907	0.7295	1.966
SD	-	-	0.041	0.1842	0.1378	0.4070
	Southern region					
1	High	Light red	2.568	4.74	0.748	2.04
2	High	Light red	2.511	5.13	0.478	2.04
3	High	Light red	2.418	5.07	0.636	1.19
4	High	Light red	2.431	5.25	0.436	1.19
5	High	Light red	2.441	5.45	0.811	2.21
6	High	Light red	2.397	5.30	0.904	2.47
7	High	Light red	2.377	5.31	0.811	2.21
8	High	Light red	2.505	4.81	1.154	3.16
9	High	Light red	2.440	4.89	0.686	1.87
10	High	Light red	2.413	5.04	0.717	1.96
Average	-	-	2.450	5.099	0.7651	2.034
SD	-	-	0.0563	0.2218	0.1757	0.5456

2. **Study of soil health in relation to the chemical properties of the soils:** The soil quality studied at the region covered the chemical properties like pH, organic carbon (OC), organic matter (OM), total-N, P, K, S, Ca, Na, EC and HCO_3 and the results are reported in Tables 4-5. Here soil fertility and soil quality were observed under 11 factors (criteria) for proper judgment, and they are described below:

Soil pH: Table 4 showed the pH values of the 20 soils from North and South parts of the field where pH values recorded to 4.60-5.26 at the northern region and 4.74-5.45 to the southern zone with average values of 4.907 and 5.099 and SD values of 0.1842 and 0.2218, respectively. A very minor differences of SD values confirmed almost uniform level of the pH values of the entire land. The entire land is belonged to acid soil.

Soil organic carbon content: The representative 20 soils showed the ranges of organic carbon contents 0.405-0.873% at the northern region and 0.436-0.904% at southern area with averages of 0.729% and 0.765%, respectively (Table 4). Here SD values of 0.1378 (North side) showed slightly lower than that of southern zone (0.1757). According to Bangladesh conditions most soils of the region (North and south parts) are rich in organic carbon for best crops yield for most of the crops.

Soil organic matter content: Table 4 showed the organic matter content of the 20 soils (North and south zones) recorded the yield of 1.11-2.39%, from the northern area and 1.19-3.16% from southern zone where SD values of 0.4070 (North) and 0.5456 (South) showed wide variations of the status of organic matter contents. Practically, Bangladesh soils contain 1.0-2.5% organic matter where soils showed

>1.5% organic matter can be recognized as good productive land for most of the crops as also showed in Table 1. Here 80-90% samples showed acceptable organic matter for best crop yield where management practicees have to be improved.

Total-N contents of the soils: Total-N content of the Northern 10 soils varied from 0.067 to 0.100% and Southern regions of 10 soils 0.067 to 0.112% where SD values of 0.0102 (North) and 0.0133 (South) showed minor variations of total-N content of the region (Table 5).

Phosphorus (P) content of soils: Table 5 showed P-contents of the 10 soils of the Northern zone with variations from 1.44 to 18.56ppm and Southern zone from 1.28 to 26.50ppm. Here wide variations were observed within 10 soils of the North and 10 soils of the South parts and the respective SD values of northern zone recorded to 5.432 and 9.8237 of southern part where the soils were better in relation to P status than those of the northern part.

Potassium (K) status of the soils: The K content recorded from 10 soils of the Northern area were 0.130 to 0.230 meq/100g and south part from 0.145-0.533 meq/100g where average and SD values were 0.1693 and 0.2695 meq/100g and 0.0355 and 0.1255, respectively (Table 5) i.e. the variations were minor.

Sulphur (S) content in soils: Sulphur content of the 20 soils covering northern 10 soils and southern regions 10 soils recorded to 6.15-30.76 meq/100g and 8.10-30.00 meq/100g, respectively (Table 5) where wide variations were found as observed 7.445 (SD of North) and 8.234 (SD of south).

Table. 5. Soil chemical properties and ionic contents from north and south part of the field

Sl	Total-N (%)	P (ppm)	K (meq/100g)	S (meq/100g)	Ca (mg/100g)	Na (mg/100g)	EC (µS/cm)	HCO_3 (µS/cm)
	Northern region							
1	0.072	18.56	0.210	17.69	0.978	0.184	104.4	274.4
2	0.084	12.54	0.210	10.43	0.869	0.152	92.6	305.0
3	0.072	11.39	0.150	6.15	0.869	0.122	62.2	244
4	0.067	1.41	0.130	8.08	0.760	0.184	72.1	274.5
5	0.089	6.40	0.145	12.69	0.760	0.184	88.8	305.0
6	0.095	3.97	0.193	30.76	0.869	0.152	114.1	305.0
7	0.089	2.18	0.130	21.92	0.869	0.152	50.4	274.5
8	0.084	2.17	0.230	9.47	1.086	0.122	86.9	305.0
9	0.089	2.18	0.150	8.08	0.978	0.152	85.1	244.0
10	0.100	8.19	0.145	8.100	1.086	0.152	901	305.0
Average	0.0841	6.894	0.1693	13.337	0.9129	0.1554	84.67	283.64
SD	0.0102	5.432	0.0354	7.4454	0.1108	0.0218	17.908	23.825
	Southern region							
1	0.072	8.19	0.436	29.82	1.630	0.184	107.5	244.0
2	0.078	11.52	0.533	30.00	1.956	0.184	250.0	335.0
3	0.067	1.28	0.145	18.07	1.195	0.152	64.7	305.0
4	0.078	3.46	0.193	11.92	1.304	0.122	98.4	366.0
5	0.078	30.72	0.206	25.76	1.413	0.122	127.0	183.0
6	0.078	21.76	0.193	9.95	1.413	0.122	71.8	366.0
7	0.089	25.78	0.210	8.10	1.195	0.122	73.2	579.0
8	0.112	23.04	0.254	11.15	1.413	0.152	106.6	396.0
9	0.095	20.74	0.150	11.92	1.413	0.122	86.8	427.0
10	0.100	26.50	0.375	9.62	1.630	0.152	107.8	427.0
Average	0.0847	17.294	0.2695	16.625	1.5317	0.1434	109.38	362.95
SD	0.0133	9.8237	0.1255	8.2340	0.24411	0.0241	50.4442	103.385

Calcium (Ca) content in soils: The calcium status of the 10 soils of the Northern part of farm varied from 0.760 to 1.086 mg/100gm within the average values of 0.9129 mg/100g and similarly, 10 soils from Southern region showed the Ca of 1.195 to 1.956 mg/100g with average values of 1.532 mg/100g. Here Ca values were higher for all 10 samples of south than those of the 10 samples from Northern zone. SD values of North and South zones were 0.1108 and 0.0241, respectively.

Sodium (Na) content of the soils: Table 7 showed the sodium (Na) content of North 10 soils varied from 0.122 to 0.184 mg/100g with of 0.1554 and SD of 0.0218 and similarly, south 10 soils showed the yield 0.122 to 0.184 mg/100g with value of 0.1434 and SD of 0.0241 mg/100g (Table 5).

EC content of the soils: The EC values of soils of the Northern region varied from 62.2 to 114.1 µg/cm with average 84.67 µg/cm and SD of 17.908 and that of 10 soils from Southern region were 64.7 to 250.0 µg/cm with average of 109.38 µg/cm and SD of 50.4442 where wide variations were recorded within the 10 samples (Table 5).

HCO_3 content of the soils: Table 7 showed the HCO_3 contents of the 20 represented soils of the farm. Ten soils of the Northern zone varied from 244.0 to 305 µg/cm with the average value of 283.64 µg/cm and SD value of 23.825. Ten soils of the Southern region showed the HCO_3 contents varied from 183.0 to 4240 µg/cm with the value of 362.95 and SD of 103.385 that confirmed the wide variations within 10 samples (Table 5).

Conclusion

The IUBAT's farm at Rajendrapur Agricultural Research Station is a typical land inside the forest area of Madhupur tract covering acidic red soils. The farmland within the forest land is a fertile land where manuring for 3-5 years are required through proper using of various manures like cowdung, poultry manure, compost, water hyacinth, decomposed household wastes, crop residues, green manuring crops dhaincha, matikalai, soyabean etc. and then the field would be treated as fertile and productive land for wide agricultural research for most of the crops.

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