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CHEMICAL ESTIMATION OF SOIL FERTILITY STATUS IN AND AROUND THE TEA GARDENS OF GOHPUR SUB-DIVISION, ASSAM

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ABSTRACT

Quantitative measures to monitor soil quality indicators such as soil pH and extractable N-P-K are more developed now and are still being explored as to how these measures affect nutrient levels and the chemical health of the soil. The present research is undertaken with a specific view to strengthen the national and local soil quality database by evaluating chemical indicators of soil quality for better soil management practices. As found out from the experimental results, soils in and around the tea gardens of Gohpur sub-division, Assam, generally have properties that make their management somewhat difficult. The long-term deterioration of soil under the tea gardens in the area has led to impoverishment of soil fertility. It is also observed that the soil health is not in accordance with the fertility rating chart given by ICAR (2005). Soil nutrient imbalance is the key issue that needs to be taken up in the area. A suitable socio-economic and policy environment to maintain and improve soil fertility is also lacking. The researchers feel that environmental aspects of soil quality of this area need serious attention in near future for better agricultural practices.

Key Words: Soil Quality, Acidity, Fertility, ANOVA, Confidential Limit, t-test.

INTRODUCTION

Plant growth and developments are mostly governed by the chemical environment of the soil. The success or failure of agriculture is closely related to the existing soil conditions. For healthy growth of plants, it is necessary that all the needs of plants be met with according to their requirements. A shortage of nutrients can cause serious restrictions to crop growth, thereby decreasing fertility of the soil. Much less is known about the

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fertility status and management of the soils of developing countries. Accurate and consistent assessment of soil quality requires a systematic method for measuring and interpreting soil properties that adequately serve as soil quality indicators[1]. Although such methods exist for monitoring and evaluating air and water quality, no single method has been widely accepted for assessing soil quality due to the great complexity and variability of soil systems. Soil characteristics are generally assessed against guideline values, which differ depending on the land use and the type of soil. The test results are commonly expressed in terms of a sufficient range, the usual notation denoting a test result as being either "low", "medium" or "high". Such a coded system is discussed by Cope[2]. Monitoring changes in soil properties can assist in predicting the future value of soils for agricultural, forestry and other purposes[3].

Quantitative measures to monitor soil quality such as soil pH and extractable N-P-K are more developed now and are still being explored as to how these measures affect nutrient levels and the chemical health of the soil. Although chemical quality of soil in the tea garden belt of Lakhimpur district, Assam was studied by Bhuyan and Sharma[4,5], there is no earlier statistics available for various soil quality parameters in Gohpur sub-division of Sonitpur district, Assam. Gohpur sub-division is situated in the north bank of river Brahmaputra between 26º30' N, 27º02' N latitude and 92º17' E, 93º47' E longitude. It occupies an area of 603 sq. km. There are eight large tea gardens apart from many small tea gardens. Soil samples were collected in and around the four privately owned small tea gardens by adopting lottery method in November, 2007, where no appropriate chemical testing of soils are done on a regular basis. The present research is undertaken with a specific view to strengthen the national and local soil quality database by evaluating chemical indicators of soil quality for better soil management practices.

EXPERIMENTAL

Materials and methodology

Sixteen soil samples were collected in and around the four selected tea gardens by adopting simple random sampling technique by maintaining a distance of about 50 meters between two samples. Soil samples were prepared by collecting small portions of surface soil. A "V" shaped cut of 0 to 6-inch depth at random locations was made in each sampling sites and one inch of soil on either side of pit was scraped and collected in polythene bags. Quartering technique was adopted to reduce the size of the sample to the required mass. The field collected soil samples after assigning identification number were air-dried in oven set at 100 F (38^{0}C) for 12 hours. The air-dried sample is crushed by hand using a pestle and mortar and analyzed for pH, available N, P, K, and % C by selecting standard procedures which, in our experience, are appropriate for soils of the study area[6].

RESULTS AND DISCUSSION

Measurements, which involve characterization of the soil solution and its constituents and the composition of the inorganic and organic phases in soil, are broadly termed as chemical. In this study, the tools for data analysis are mainly experimental, aimed at defining possible relationships, trends, or interactions among the measured variables of interest. Descriptive statistics in the forms of mean, variance (V), standard deviation (SD), standard error (SE), median, range, confidential limit (CL) at 95%, percentile at 25%, 75%, 95% and t-test (t) are calculated for all soil quality parameters under null hypothesis (H_0) by taking assumption that the experimental chemical soil quality data are consistent with the standard rating given by the chemical ranking chart of Indian Council of Agricultural Research (I.C.A.R.)[7]. Statistical analysis along with one-way ANOVA is carried out by using ORIGIN 6.1 version.

Table 1. Soil quality parameters inside tea gardens

Sample No.	pH	N (kg/ha)	P (kg/acre)	K (kg/acre)	% C
A1	3.48	259.5	2.01	23.29	0.78
A2	3.82	264.2	2.10	25.42	0.77
B1	4.83	583.9	3.14	23.38	1.76
B2	4.95	492.3	3.18	26.78	1.79
C1	3.48	168.7	2.01	16.65	0.51
C2	3.90	172.4	2.28	22.43	0.65
D1	4.33	506.1	6.94	23.37	1.52
D2	4.72	498.7	7.04	28.62	1.62
		Statistical analysis			
Mean	4.19	368.2	3.59	23.74	1.18
Median	3.9	264.2	2.28	23.37	0.78

Cont…

Sample No.	pH	N (kg/ha)	P (kg/acre)	K (kg/acre)	% C
Variance	0.359	28391.9	4.632	12.618	0.296
SD	0.599	168.49	2.15	3.55	0.55
SE	0.21	59.57	0.76	1.26	0.19
Range	1.47	415.2	5.03	11.97	1.28
P 25%	3.82	259.5	2.1	23.29	0.77
P 75%	4.72	498.7	3.18	25.42	1.62
P 95%	4.95	583.9	7.04	28.62	1.79
95% CL	[3.69 – 4.69]	[227.35 – 509.09]	[1.79 – 5.39]	[20.77 – 26.71]	[0.72 – 1.63]
Av Rating	8.5	560	62	690	0.75
ICAR Rating	6.0-8.5 Normal	280-560 Medium	25-62 Medium	272-690 Medium	0.5-0.75 Medium
| t |	20.34	3.22	76.76	530.49	2.20
Comment	HS	S	HS	HS	NS

[HS = Highly significant, NS = Non significant, S = Significant]

Table 2. Soil quality parameters outside tea gardens

Sample No.	pH	N (kg/ha)	P (kg/acre)	K (kg/acre)	% C
A11	4.85	441.2	4.90	36.64	1.32
A12	4.92	458.1	5.12	41.32	1.40
B11	4.96	570.9	6.95	51.07	1.72
B12	5.02	582.1	7.32	58.73	1.50
C11	5.23	467.2	8.96	87.68	1.40
C12	5.28	475.3	9.20	89.04	1.42

Cont…

Sample No.	pH	N (kg/ha)	P (kg/acre)	K (kg/acre)	% C
D11	4.24	635.9	5.89	188.72	1.91
D12	4.72	645.3	6.41	168.34	1.94
		Statistical analysis			
Mean	4.90	534.5	6.84	90.19	1.58
Median	4.92	475.3	6.41	58.73	1.42
Variance	0.106	6960.7	2.59	3371.3	0.06
SD	0.33	83.43	1.61	58.06	0.25
SE	0.12	29.49	0.57	20.53	0.09
Range	1.04	204.1	4.3	152.08	0.62
P 25%	4.85	467.2	5.89	51.07	1.4
P 75%	5.02	582.1	7.32	89.04	1.72
P 95%	5.28	645.3	9.2	188.72	1.94
95% CL	[4.63 – 5.17]	[464.75 – 604.25]	[5.50 – 8.19]	[41.65 - 138.73]	[1.37 – 1.78]
Av Rating	8.5	560	62	690	0.75
ICAR Rating	6.0-8.5 Normal	280-560 Medium	25-62 Medium	272-690 Medium	0.5-0.75 Medium
| t |	31.25	0.87	96.98	29.22	9.51
Comment	HS	NS	HS	HS	S

pH: The pH values of the soil reflect the health status of the soil as to whether it is fit for cultivation or not. Soil pH is a good indicator for possible nutrient problems. Soils in the study area are highly acidic, with pH ranging from 3.48 to 5.28. The factors like constant addition of chemicals to the soil, coupled with high temperature, and excessive rainfall results in severe acidity build up in the soil system. This may affect the nutrient uptake of the tea plantation and nearby paddy fields. One way ANOVA analysis at the 0.05 level clearly shows that the pH inside and outside tea gardens are significantly different ($F = 8.75368$, $p = 0.01037$).

Total nitrogen (N): Nitrogen is essential for plant growth and thus, causes problems, when it is deficient. The nitrogen contents of soils in the study area are marginal as according to the chemical rating chart (ICAR, 2005)[7]. The highly acidic nature of soils of the study area prevents organic matter from breaking down, resulting in an accumulation of organic matter and the tie up of nitrogen, that are held in the organic matter. One way ANOVA analysis at 0.05 level ($F = 6.25636$, $p = 0.0254$) also suggests that nitrogen status inside and outside tea gardens are significant.

Phosphorus (P): Phosphorus (P) is an important element classified as a macronutrient because of the relatively large amounts of P required by plants. In acid soils, there is a tendency towards low phosphorus levels over time. The very low value of phosphorus in all the investigated soil samples may be due to fixation of P to unavailable forms. The ANOVA test ($F = 1.74858$, $p = 0.00408$) at 0.05 level too suggests that the means are significantly different.

Potassium (K): Soil potassium (K) is found in three forms; trapped between clay layers (relatively unavailable), adsorbed on the surface of soil colloids (exchangeable), and in the soil solution (available). The soils in and around the tea gardens of the study area are potassium deficient and is not in accordance with the rating (lower limit 272 kg/acre) given by ICAR, 2005[7]. Soil potassium status is also significant in the study area as interpreted by ANOVA test ($F = 10.43899$, $p = 0.00604$).

Organic carbon: Monitoring levels of soil organic carbon provides a good measure of the fertility of soil. Within the study area, there is a wide variety of soils. Some are widespread throughout the area, while others are much more limited in their distribution. Some are highly productive and extremely important for agriculture, while others are thin and infertile with low agricultural potential. Good soils are generally understood to be sandy loom soils high in organic matter (4-10%). Soil organic matter = % Organic carbon x 1.724 (Allison, 1965)[7]. The soil samples of tea gardens of Gohpur sub-division, Assam are found to contain low organic matter contents. Exploitative, environmentally damaging land management practices in the area tend to reduce soil carbon levels.

CONCLUSION

As found out from the experimental results, soils in and around the tea gardens of Gohpur sub-division, Assam, generally have properties that make their management somewhat difficult. The long term deterioration of soil under the tea gardens in the area has led to impoverishment of soil fertility and stabilization of yields, despite increasing application of external inputs such as fertilizers and pesticides. Among various chemical parameters of soil quality pH, available N, P, K and % C are considered to be sensitive environmental parameters and have direct bearing on the productivity and fertility of soils. The analysis of the soil samples of paddy fields around the plantation area of tea gardens of Gohpur sub-division also reveal that the soil health is not in accordance with the fertility rating chart given by (ICAR, 2005)[7]. Thus, the inherent fertility of soils in the study area is poor because of low nutrient status in soils. Soil nutrient imbalance is the key issue that needs to be taken up in the area. A suitable socio-economic and policy environment to maintain and improve soil fertility is also lacking. The researchers feel that environmental aspects of soil quality of this area need serious attention in near future for better agricultural practices.

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