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Assessment of Physico-chemical Properties of Soil from Different Departments of NAI, SHUATS, Prayagraj, U.P., India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An Assessment of Physico-chemical properties of soil from different departments of NAI, SHUATS, Prayagraj carried out 2022-23. The prime objectives of this study were to carry out the physico-chemical properties of soil at different depths of various department research farms to determine the availability of macronutrients and micronutrients in soil of these soil sample provide the assessment 6 sampling locations were selected. Soil samples were collected with depth of 0-15 and 15-30 cm respectively. The soil colour dry condition varied from light yellowish brown, pale olive, light olive brown, yellowish brown, olive yellow, dark brown and in wet condition varied from

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olive brown, dark brown, olive yellow and dark yellowish. The sand, silt and clay varied from 53 to 65 %, 19 to 27 % and 15 to 20 % respectively, soil texture was dominantly sandy loam in every site. The bulk density ranged from 1.20 to 1.34 Mg m^{-3}. The practical density ranged from 2.68 to 2.94 Mg m^{-3}. The pore space ranged from 43.25 to 49.50 %. The water holding capacity ranged from 41.75 to 48.25 %. The soil pH ranged from 7.37 to 7.71. The electrical conductivity ranged from 0.21 to 0.48 dS m^{-1}. The soil organic carbon ranged from 0.32 to 0.45 %. The available nitrogen ranged from 235.17 to 261.12 kg ha^{-1}. The available phosphorous ranged from 19.66 to 25.50 kg ha^{-1}. The available potassium ranged from 152.00 to 214.00 kg ha^{-1}. The available Sulphur ranged from 8.80 to 14.42 mg kg^{-1}. The available zinc ranged from 0.58 to 0.93 mg kg^{-1}. The available boron ranged from 0.58 to 1.10 mg kg^{-1}. The available iron ranged from 5.92 to 8.70 mg kg^{-1}. The available manganese ranged from 3.21 to 3.61 mg kg^{-1}. The available copper ranged from 2.00 to 2.94 mg kg^{-1}. There is an including awareness of the need to pay greater attention in the role of macronutrients enhancement in the soil for good soil health and proper nutrition of plant so as to attain optimum economic yield and soil is suitable for all major tropical and sub-tropical crops.

Keywords: Physico-chemical properties; nutrients distribution; soil health.

1. INTRODUCTION

"Soil and land, though related, are two different entities; Land is two-dimensional entity representing geographical area and landscapes, while soil is a three-dimensional body with length, breadth and depth and is hidden below the land surface. It is largely hidden from the outside world until it is lost and goes out of the site" Kanwar [1]. Soil quality is highly dependent on soil management practices, and it influences crop production. Assessing soil properties under different long-term cropping patterns is essential to preserving soil quality since soil plays an essential role in the ecosystem, linking soil nutrients, water availability, and crop growth [2,3]. "Naturally, soil is a slowly renewable resource with a high degree of degradation and very low rate of regeneration" Chen et al. [4]. "Intensive agriculture leads to soil erosion, depletion of organic matter and other nutrients, which results in permanent soil degradation and significant productivity losses" Coonan et al. [5]. "Soil organic matter undergoes mineralization and releases substantial quantities of nitrogen, phosphorus, sulphur and smaller amount of micronutrients" Rahman et al. [6]. "In most cases, the rapid loss of soil organic matter during the years immediately following the conversion was replaced by slower, but continuing declines due to inappropriate agronomic practices. Long-term records show soil nitrogen content falling by 25–70 % over periods ranging from 30 to 90 years; these records also show soil carbon declining by up to 50% over similar time spans" Bahadur et al. [7]. "The use of microbial inoculants while developing sustainable agriculture techniques in chemical- based farming is one of the most promising alternatives these days Mącik et al. [8]. Input of exogenous organic matter, such as straw or livestock manure, can enrich soil with the necessary elements and prevent soil organic matter (SOM) decomposition" Hammad et al. [9]. "Soil quality parameters can be determined analyzing soil chemical, biological, and physical properties together" Coonan et al. [5]. Soil testing makes complete nutrient control possibility Fertilizer experiments are being patterned to determine economically optimum rates of nutrients application high yields with low production costs per unit area must in modern farming. Farmers of today are different in the failure is more certain and sooner unless they are obtaining reasonably high yields, improved drainage, many improved Cultural practices, disease have helped to set the stage for high yields. Soil provides food, fuel and fodder for meeting the needs of human and animal.

2. MATERIALS AND METHODS

Analysis of the soil samples were under the methods: Soil textural class was determined by using hydrometer Bouyoucos [10]. Bulk density, particle density, water holding capacity was determined by using graduated measuring cylinder method Muthuaval et al. (1992). pH was estimated with the help of digital pH meter after making 1:2.5 soil water suspension Jackson (1958). Electrical conductivity was estimated with the help of digital conductivity meter Wilcox, [11]. Percent organic carbon was estimated by wet oxidation method Walkley and Black [12]. Available nitrogen was estimated by alkaline potassium permanganate method, using kjeldahl apparatus Subbiah and Asija [13]. Available phosphorus was estimated by photoelectric colorimeter method Olsen's et al. (1945). Available potassium was estimated by neutral normal ammonium acetate extraction followed by flame photometric method Toth and Prince [14]. Available Sulphur was estimated by reduction method Johnson and Nishita (1952). Available boron estimation by Kmiecik et al. (2016) and copper, iron, manganese, zinc estimated by Lindsay and Novell [15,16-20].

3. RESULTS AND DISCUSSION

3.1 Physical Properties

The soil colour dry condition varied from light yellowish brown, pale olive, light olive brown, yellowish brown, olive yellow, dark brown and in wet condition varied from olive brown, dark brown, olive yellow and dark yellowish. The soil textural classes identified as sandy loam. The sand, silt and clay varied from 53 to 65 % sand, 19 to 27 % silt and 15 to 20 % clay in Sandy Loam. Minimum bulk density was recorded 1.20 Mg m^{-3} in D_4- horticulture at 0-15 cm, and maximum 1.34 Mg m^{-3} in D_6- agro forestry at 15-30 cm. Minimum particle density was recorded 2.68 Mg m^{-3} in D_4- horticulture at 0-15 cm, and maximum 2.94 Mg m^{-3} in D_6- agro forestry at 15-30 cm. Minimum pore space was recorded 43.25 % in D_1- soil science and agricultural chemistry at 15-30 cm and maximum 49.50 % in D_5- plant protection at 0-15 cm. Minimum water holding capacity was recorded 41.75 % in D_1- soil science and agricultural chemistry at 15-30 cm and maximum 48.25 % in D_4- horticulture at 0-15 cm, respectively (Table 1).

3.2 Chemical Properties

Minimum pH was recorded 7.37 in D_2- agronomy at 0-15 cm and maximum 7.71 in D_6- agro forestry at 0-15 cm. Minimum EC was recorded 0.21 dS m^{-1} in D_6- agro forestry at 0-15 cm, and maximum 0.48 dS m^{-1} in D_2- agronomy at 15-30 cm. Minimum organic carbon was recorded 0.32 % in D_1- soil science and agricultural chemistry at 15-30 cm and maximum 0.45% in D_4- horticulture at 0-15 cm, respectively (Table 2).

3.3 Macronutrients

Minimum nitrogen was recorded 261.12 kg ha^{-1} in D_4- horticulture at 0-15 cm, and maximum 235.17 kg ha^{-1} in D_1- soil science and agricultural chemistry at 15-30 cm. Minimum phosphorus was recorded 25.50 kg ha^{-1} in D_4- horticulture at 0-15 cm, and maximum 19.66 kg ha^{-1} in D_1- soil science and agricultural chemistry at 15-30 cm. Minimum potassium was recorded 214.00 kg ha^{-1} in D_5- plant protection at 0-15 cm, and maximum 152.00 kg ha^{-1} in D_3- genetic and plant breeding at 15-30 cm. Minimum Sulphur was recorded 14.42 mg kg^{-1} in D_2- agronomy at 0-15 cm, and maximum 8.80 mg ka^{-1} in D_5- plant protection at 15-30 cm, respectively (Table 3).

Table 1. Evaluation of bulk density, particle density, water holding capacity and pore space in various depths at different research farm of NAI, SHUATS, Prayagraj

Department	Bulk density (Mg m^{-3})		Particle density (Mg m^{-3})		Pore space (%)		Water holding capacity (%)	
	0-15 cm	**15-30 cm**	**0-15 cm**	**15-30 cm**	**0-15 cm**	**15-30 cm**	**0-15 cm**	**15-30 cm**
D_1-Soil Science	1.28	1.32	2.90	2.92	47.25	43.25	45.75	41.75
D_2-Agronomy	1.20	1.22	2.75	2.80	49.25	46.75	47.75	45.25
D_{3-} GPB	1.32	1.36	2.88	2.92	48.75	46.25	47.25	45.25
D_4- Horticulture	1.20	1.22	2.68	2.74	49.25	48.25	48.25	46.25
D_5-Plant Protection	1.26	1.34	2.72	2.91	49.50	48.00	47.75	46.75
D_6- Agro-Forestry	1.30	1.38	2.86	2.94	48.25	43.75	46.75	42.25
	Depth	**Site**	**Depth**	**Site**	**Depth**	**Site**	**Depth**	**Site**
S. Em. (±)	0.084	0.018	0.116	0.039	2.059	0.882	2.070	0.858
C.D. at 5%	0.179	0.037	0.246	0.083	4.364	1.870	4.388	1.819
F-test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**

S. Em.(±): Standard Error of mean, C.D. at 5%: Critical Difference, S (for F-test): significant

Table 2. Estimation of pH, electrical conductivity and organic carbon in various depths at different research farm of NAI, SHUATS, Prayagraj

Department	pH		Electrical conductivity (dS m^{-1})		Organic carbon (%)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
D_1-Soil Science	7.52	7.62	0.37	0.41	0.35	0.32
D_2-Agronomy	7.37	7.53	0.42	0.48	0.38	0.36
D_{3-} GPB	7.43	7.48	0.28	0.30	0.39	0.36
D_4- Horticulture	7.47	7.53	0.36	0.42	0.45	0.38
D_5-Plant Protection	7.51	7.53	0.38	0.44	0.41	0.37
D_6- Agro-Forestry	7.71	7.82	0.21	0.23	0.39	0.35
	Depth	**Site**	**Depth**	**Site**	**Depth**	**Site**
S. Em. (±)	0.166	0.032	0.121	0.013	0.037	0.011
C.D. at 5%	0.352	0.069	0.258	0.027	0.079	0.024
F-test	S	S	S	S	S	S

Table 3. Evaluation of nitrogen, phosphorus, potassium and Sulphur in various depths at different research farm of NAI, SHUATS, Prayagraj

Department	Nitrogen (kg ha^{-1})		Phosphorus (kg ha^{-1})		Potassium (kg ha^{-1})		Sulphur (mg kg^{-1})	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
D_1-Soil Science	242.24	235.17	22.32	19.84	195.00	182.00	12.36	11.90
D_2-Agronomy	253.84	242.37	23.14	20.86	203.00	188.00	14.42	13.96
D_{3-} GPB	246.85	242.44	24.21	21.18	166.00	152.00	10.36	08.96
D_4- Horticulture	261.12	250.26	25.50	21.82	192.00	177.00	13.26	11.20
D_5-Plant Protection	250.54	245.26	23.28	20.57	214.00	194.00	09.67	08.80
D_6- Agro-Forestry	248.30	241.43	22.86	19.66	171.00	164.00	11.26	09.96
	Depth	**Site**	**Depth**	**Site**	**Depth**	**Site**	**Depth**	**Site**
S. Em. (±)	7.893	1.870	1.353	0.331	24.049	2.708	2.632	0.400
C.D. at 5%	16.732	3.964	2.868	0.701	50.983	5.741	5.581	0.849
F-test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**

Table 4. Evaluation of zinc, copper, manganese, boron and iron in various depths at different research farm of NAI, SHUATS, Prayagraj

Department	Zinc (kg ha^{-1})		Copper (kg ha^{-1})		Manganese (kg ha^{-1})		Boron (kg ha^{-1})		Iron (kg ha^{-1})	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
D_1-Soil Science	0.74	0.69	2.20	2.00	3.24	3.21	0.64	0.58	6.10	5.92
D_2-Agronomy	0.89	0.78	2.94	2.86	3.28	3.24	1.10	0.94	8.14	8.03
D_{3-} GPB	0.67	0.58	2.30	2.26	3.61	3.59	0.98	0.78	6.90	6.55
D_4-Horticulture	0.93	0.81	2.08	2.02	3.57	3.54	1.04	0.94	8.70	7.90
D_5-Plant Protection	0.86	0.77	2.24	2.18	3.49	3.46	0.88	0.62	7.70	7.28
D_6-Agro Forestry	0.81	0.62	2.06	2.00	3.54	3.48	0.64	0.60	7.45	7.26
	Depth	**Site**	**Depth**	**Site**	**Depth**	**Site**	**Depth**	**Site**	**Depth**	**Site**
S. Em. (±)	0.131	0.030	0.463	0.038	0.222	0.009	0.254	0.055	1.226	0.197
C.D. at 5%	0.278	0.064	0.981	0.080	0.471	0.019	0.538	0.117	2.599	0.417
F-test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	S

3.4 Micronutrients

Minimum zinc was recorded 0.62 mg kg^{-1} in D_6- agro forestry at 15-30 cm, and maximum 0.93 mg ka^{-1} in D_4- horticulture at 0-15 cm. Minimum copper was recorded 2.00 mg kg^{-1} in D_1- soil science and agricultural chemistry at 15-30 cm, and maximum 2.94 mg ka^{-1} in D_2- agronomy at 0-15 cm. Minimum manganese was recorded 3.21 mg kg^{-1} in D_1- soil science and agricultural chemistry at 15-30 cm, and maximum 3.61 mg ka^{-1} in D_3- genetic and plant breeding at 0-15 cm. Minimum boron was recorded 0.58 mg kg^{-1} in D_1- soil science and agricultural chemistry at 15-30 cm, and maximum 1.10 mg ka^{-1} in D_5- D_2- agronomy at 0-15 cm. Minimum iron was recorded 5.92 mg kg^{-1} in D_1- soil science and agricultural chemistry at 15-30 cm, and maximum 8.70 mg ka^{-1} in D_4- horticulture at 0-15 cm, respectively (Table 4).

4. CONCLUSION

It concluded that soil of all research farm of Naini Agricultural Institute have low level in organic carbon and nitrogen but medium in phosphorous and potassium content. Thus balance nutrient additions through organic manures, inorganic and bio-fertilizer sources are essential to maintain soil fertility in research farms of Naini Agricultural Institute, SHUATS.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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