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Effect of integrated nutrient management on soil properties and irrigation water quality of research farms of Naini agricultural institute (NAI) SHUATS, Prayagraj

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Abstract
A survey and mapping for soil study of soil parameters was conducted of chemical properties of soil of different department of Sam Higginbottom University of Agriculture Technology and Sciences was carried in 2018-2019. The main objectives of this study is to collect information of soil type and various parameters like pH, conductivity, bulk density, water retaining capacity, moisture content, available nitrogen, available phosphorous, available potassium. For this study 5 sampling points were selected from different departments. By analyzing the soil sample, soil was found to be light yellowish brown to pale olive in colour. The soil was found to be slightly acidic. The nitrogen, phosphorous, potassium values are found to be low in all departments.

Keywords: Chemical properties, physical properties, soil

Introduction
Soil fertility and erodibility are the elements of soil quality. Soil fertility is an important factor which determines the growth of plant and presence/absence of nutrients *i.e.* macro and micronutrients. Plant growth depends upon soil fertility, the inherent ability of soils to supply nutrient elements to the plants. Soil fertility is related to the amount of available nutrients, which measure it by the yield capacity, and still others look it to be a function of organic matter or even soil texture. In brief soil fertility refers to the availability status of essential macro and micro nutrients in the soil. The use of plant nutrients in a balanced manner is the prime factor for efficient fertilizer program. Balanced nutrient use ensures high production level and helps to maintain the soil health. Soil testing is not static, but a dynamic concept. It does not mean that every time a crop is grown, all the nutrients should be applied in a particular proportion, rather fertilizer application should be tailored to the crop needs, keeping in view the capacity of soils. It promotes synergetic interactions and keeps antagonistic interactions out of crop production system. The importance of primary nutrients in crop production is well recognized. Knowledge of distribution of these nutrients and the influencing factors is very important in assessing their uptake by the crops. To assess the presence of the level of nutrients in the soil in a form that is available to crops is known as 'soil testing'. It is a pre-requisite to know the nutrient content in the soil and apply required amount of nutrients to content imbalances and optimize crop nutrition balanced fertilization does not mean a certain proportion of N, P and K or other nutrients to be added in the form of fertilizers, but it takes into account the available of nutrients already present in the soil, crop requirement and other factors. It should take into account the crop removal of nutrients, the economics of fertilizer use, farmer's investment ability, Agro-techniques, soil moisture regime, soil salinity *etc*. (Rao and Shrivastava, 2001) [9].

Materials and Methods
The present study entitled "Effect of integrated nutrient management on soil properties and irrigation water quality of research farms of Naini Agricultural Institute (NAI) SHUATS, Prayagraj" was conducted in three stages *i.e.* soil survey and mapping, collection of samples and their analysis for different soil parameters. The details of materials used and technique

adopted during the course of study are explained in this chapter. The data recorded during the course of investigation was subjected to statistical analysis done by Fisher (1938). Prayagraj comes under the sub-tropical belt in the South East of Uttar Pradesh. It is situated at 25! 57°N Latitude and 81! 5°E latitude and about 98 meter above sea level. Atmospheric temperature vary widely from 4-5 ^{0}C during winter to 48 ^{0}C during summer. Most of the rainfall is received during the middle of July to end September after which the intensity of rainfall decreases. The mean annual rainfall is about 1100 mm.

Table 1: The departments of Naini agricultural institute (NAI), SHUATS, Prayagraj

S. No.	Department	Established Year	Founder HOD`s
1.	Soil Science	1992	Prof. (Dr.) Rajendra Bihari Lal, Hon'ble V C SHUATS, Alld
2.	Agronomy	1932	Rev. B.M. Pugh
3.	Genetics and Plant Breeding	2001	Prof. C. Kole
4.	Horticulture	1932	Prof. W. B. Hayes
5.	Plant Protection	2000	Prof. Dr. (Mrs.) Pramila Gupta

Soil sampling

The soil samples were collected from each of the department research farm at the depths 0-15 cm and 15-30 cm with the help of soil auger. The soil samples were transferred in to air tight polythene bags and brought to the PG laboratory of Deptt. of soil science and agricultural Chemistry. The soil samples then analyzed for soil colour, water retaining capacity of soil, bulk density, moisture content, soil pH, available Nitrogen, Phosphorus and Potassium

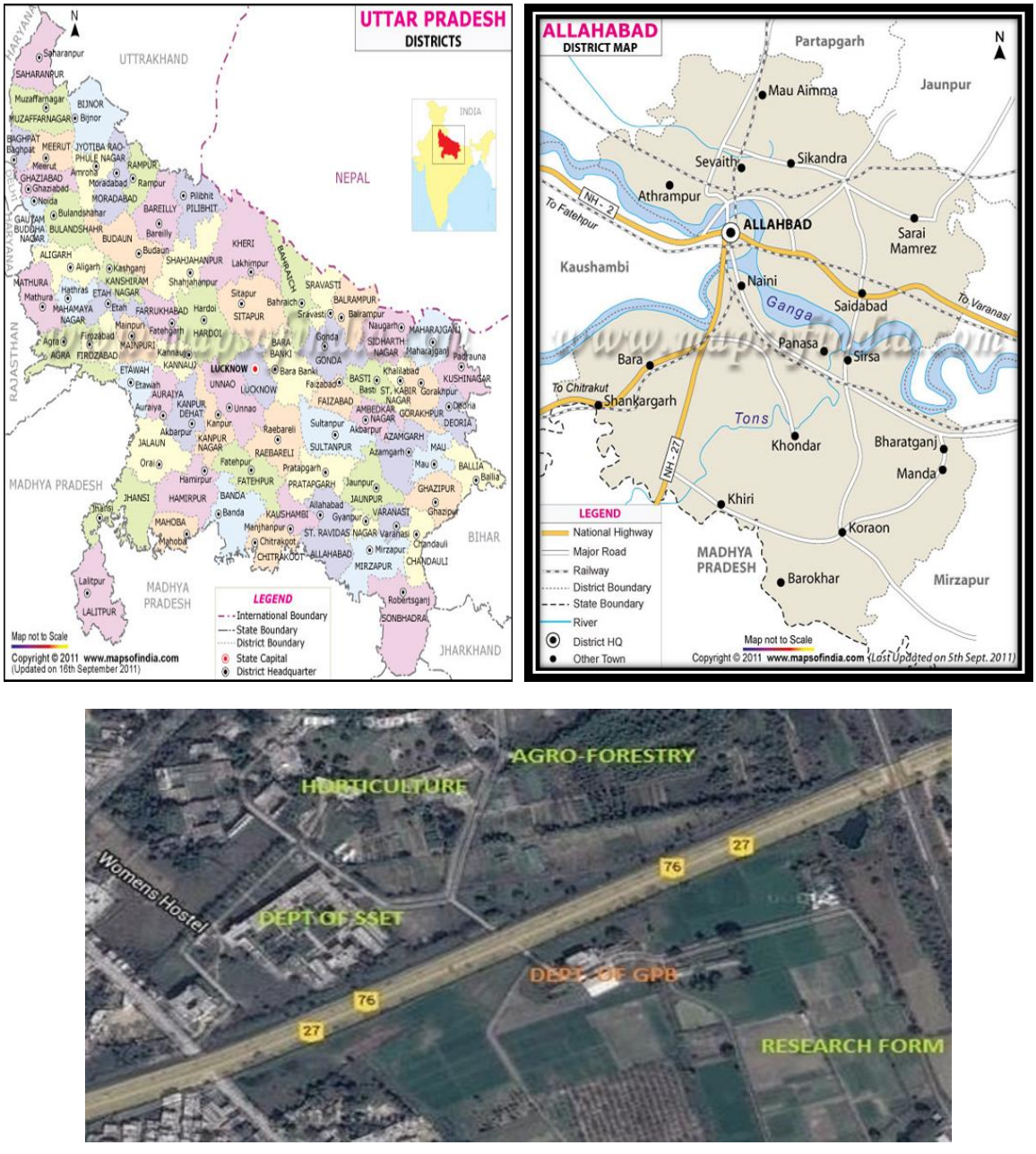

Fig 1: Map of Sam Higginbottom University of agriculture, technology and sciences, Prayagraj-211007 (U.P.), India

Table 2: Methods employed for physical analysis of soil samples:

Particulars	Method employed
Soil colour	(Munsell)
Soil texture	(Bouyoucous 1927) [1]
Bulk density (gcm^{-3})	(Muthuaval *et al*. 1992)
Particle density (gcm^{-3})	(Muthuaval *et al*. 1992)

***Source*:** Soil, Water and Plant analysis, Manual Practical (Jaiswal, 2006)

Table 3: Methods employed for chemical analysis of soil samples

Particulars	Method employed
Soil pH (1:2)	(Jackson 1958) [4]
EC (dS m^{-1})	(Wilcox 1950) [19]
Organic carbon (%)	(Walkley and Black 1947) [18]
Available Nitrogen (kg ha^{-1})	(Subbaih and Asija1956) [14]
Available Phosphorus (kg ha^{-1})	(Olsen *et al*. 1954) [8]
Available Potassium (kg ha^{-1})	(Toth and Prince 1949) [16]

***Source*:** Soil, Water and Plant analysis, Manual Practical (Jaiswal, 2006)

Result and Discussions

i) Soil Colour

The table 4 depicted the soil colour (dry method) of different departments of Naini Agricultural Institute of SHUATS, Prayagraj. The soil sample were taken on respective depths 0-15 cm and 15-30 cm. At depth 0-15 cm the soil colour light yellowish brown was found in the department research farm of D_1-Soil Science and Agricultural Chemistry, and D_5-Plant Protection and the soil colour- pale olive, light olive brown, yellowish brown and dark yellowish brown was found in D_2-Agronomy, D_3-Genetics and Plant Breeding, D_4-Horticulture respectively. At depth 15-30 cm the soil colour- olive yellow, light yellowish brown, light olive brown, yellowish brown, pale olive and dark brown was found in D_1-Soil Science, D_2-Agronomy, D_3-Genetics and Plant Breeding, D_4-Horticulture and D_5-Plant Protection, respectively. In the table 5 depicted soil colour (wet method) of different departments of Naini Agricultural Institute of SHUATS, Prayagraj. The soil samples were taken on respective depths (0-15 cm and 15-30 cm). At depth 0-15 cm the soil colour- olive brown was found in D_1-Soil Science, D_3-Genetics and Plant Breeding and D_5-Plant Protection, the soil colour- dark brown was found in D_4-Horticultureand olive was found in D_2-Agronomy. At depth 15-30 cm the soil colour- olive brown was found in D_1-Soil Science and Agricultural Chemistry, D_2-Agronomy and D_3-Genetics and Plant Breeding and the soil colour dark yellowish brown, olive and dark brown was found in D_4-Horticulture and D_5-Plant Protection respectively.

Table 4: Evaluation of soil colour (dry method) of different depths of various departments of Naini Agricultural Institute, SHUATS, Prayagraj

Departments	0-15 cm	15-30 cm
D_1 Soil Science and Agricultural Chemistry	2.5YR, 6/4 Light Yellowish Brown	2.5YR, 6/6 Olive Yellow
D_2 Agronomy	5YR, 6/4 Pale Olive	2.5YR, 6/4 Light Yellowish Brown
D_3 Genetics and Plant Breeding	2.5YR, 5/4 Light Olive Brown	2.5YR, 5/6 Light Olive Brown
D_4 Horticulture	10YR, 5/4 Yellowish Brown	10YR, 5/4 Yellowish Brown
D_5 Plant Protection	2.5YR, 6/4 Light Yellowish Brown	5YR, 6/4 Pale Olive

Table 5: Evaluation of soil colour (wet method) of different depth (0-15 and 15-30 cm) of various departments of Naini Agricultural Institute, SHUATS, Prayagraj

Departments	0-15 cm	15-30 cm
D_1 Soil Science and Agricultural Chemistry	2.5YR, 4/4 Olive Brown	2.5YR, 4/4 Olive Brown
D_2 Agronomy	5YR, 5/4 Olive	2.5YR, 4/4 Olive Brown
D_3 Genetics and Plant Breeding	2.5YR, 4/4 Olive Brown	2.5YR, 4/4 Olive Brown
D_4 Horticulture	10YR, 3/3 Dark Brown	10YR, 4/4Dark Yellowish Brown
D_5 Plant Protection	2.5YR, 4/4 Olive Brown	5YR, 5/6 Olive

ii) Physico-chemical properties of soil

The fig. 2 depicted the statistical accumulation on bulk density of departments and depths which was found to be significant at depth. In soil depth, the highest mean bulk density was found at 0-15 cm (1.38 g cm^{-3}) depth, which is significantly higher than 15-30 cm (1.22 g cm^{-3}). In departments the maximum mean bulk density was found at D_4-Horticulture 1.39 g cm^{-3} and minimum at D_5-Plant Protection 1.21 gcm^{-3}. The bulk density decreases with the increase in soil depth. The bulk density of different soil depth varied from 1.18 to 1.56 g cm^{-3}, similar findings were reported by (Singh and Agarwal 2005) [13]. In departments the highest mean particle density was found at D_4-Horticulture (2.85 g cm^{-3}) and D_3-Genetics and Plant Breeding (2.85 g cm^{-3}), where D_4 and D_3 is significantly higher than others, however D_2-Agronomy (2.76 g cm^{-3}) was found significantly at par followed by D_1-Soil Science and Agricultural Chemistry (2.72 g cm^{-3}) and D_5-Plant Protection (2.76 g cm^{-3}). In soil depth the highest mean particle density was found at 0-15 cm (2.83 g cm^{-3}) depth which is significantly higher than 15-30 cm (2.75 g cm^{-3}). The particle density decreases with the increase in soil depth. Particle density is the density of just the solid part of the soil it does not include any pore space. Particle density varies according to the mineral content of the soil particles, similarly reported by (Brady & Weil 1996). Fig. 3. As it is depicted the statistical accumulation on moisture % and water holding capacity of departments and depths. Moisture % was found to be significant at departments. In departments, the highest mean moisture % was found at D_5-Plant Protection (24.02). In soil depth the maximum mean moisture % was found at 0-15 cm (20.07 %) and minimum at 15-30 cm (20.01 %). Similar finding reported by (Sahu *et al*. 2014) [10]. Water holding capacity of departments and depths which was found to be non-significant at both. In departments the maximum mean water holding capacity was found at D_5-Plant Protection (75.91 %) and minimum at D_1-Soil Science and Agricultural Chemistry (65.62 %). The irregular trend of WHC with depth was due to the illuviation and eluviation of finer fractions in different horizons. Similar findings were reported by (Sahu *et al*. 2014) [10]. In fig.4 It is depicts the statistical accumulation on pH of departments and depths which was found to be significant at both. In departments the highest mean pH was found at D_1-Soil Science and Agricultural Chemistry (7.47). In soil depth the highest mean pH was found at 15-30 cm (7.44) depth which is significantly higher than 0-15 cm (7.36). Similar results were reported by

(Malla *et al.* 2007) [6] and (Kiran *et al.* 2012) [5]. In fig. 5. states that in departments the highest mean EC was found at D_2-Agronomy (0.06 dS m^{-1}), where D_2 is significantly higher than, In soil depth the maximum mean EC was found at 0-15 cm (0.05dS m^{-1}) depth and minimum at 15-30 cm (0.04dS m^{-1}). All the different soil depths have shown low electrical conductivity (EC) values ranging from 0.04 to 0.07dS m^{-1}, indicating non-saline nature. In fig. 6 it is depicts that in departments the highest mean organic carbon % was found at D_4-Horticulture (0.80 %). In soil depth the highest mean organic carbon % was found at 0-15 cm (0.68 %) depth which is significantly higher than 15-30 cm (0.55 %). The organic C content decreased with depth in all the departments and this is due to the addition of plant residues and farmyard manure to surface horizons than in the lower horizons (Nayak *et al.* 2002) [7]. In fig. 7 it is found that in departments the highest mean available nitrogen was found at D_2-Agronomy (240.62 kg ha^{-1}). In soil depth the highest mean available nitrogen was found at 0-15 cm (204.42 kg ha^{-1}) depth which is significantly higher than 15-30 cm (190.00 kg ha^{-1}) was found significantly at par with 0-15 cm. The available nitrogen decreases abruptly with the increase in soil depth, similar findings were noticed by (Satish Kumar and Naidu 2012) [11]. In departments the maximum mean available phosphorous was found at D_5-Plant Protection (17.52 kg ha^{-1}) and minimum at D_2-Agronomy (16.57 kg ha^{-1}). In soil depth 0-15 cm the maximum mean available phosphorous was found (17.19 kg ha^{-1}) and minimum at 15-30 cm (17.08 kg ha^{-1}). The available P varied from 15.77 to 17.78 kg ha^{-1}in different soil depth and departments. (Thangasamy *et al.* 2005) [15]. In department the highest mean available potassium was found at D_4-Horticulture (191.63 kg ha^{-1}). In soil depth the highest mean available potassium was found at 0-15 cm (189.91 kg ha^{-1}) depth which is higher than 15-30 cm (185.91 kg ha^{-1}). The highest K content was observed in the surface horizons and less decreasing trend with depth. (Sharma and Anil Kumar 2003) [12].

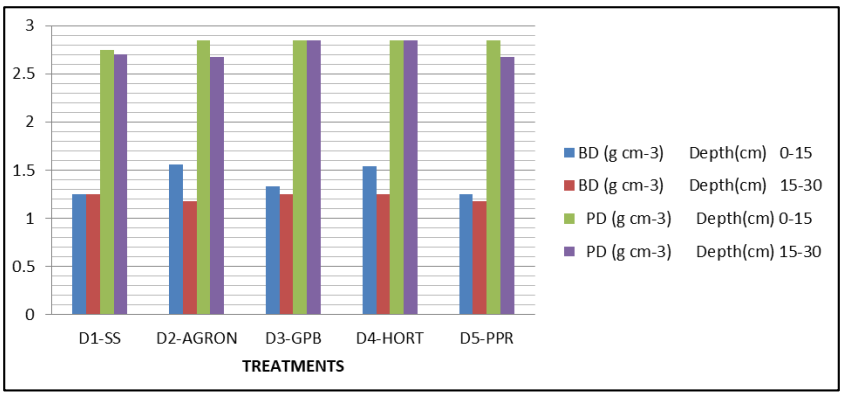

Fig 2: Soil Bulk density (g cm^{-3}) and Particle density (g cm^{-3}) of various depths (0-15 and 15-30 cm) of various department of Naini Agricultural Institute, SHUATS, Prayagraj

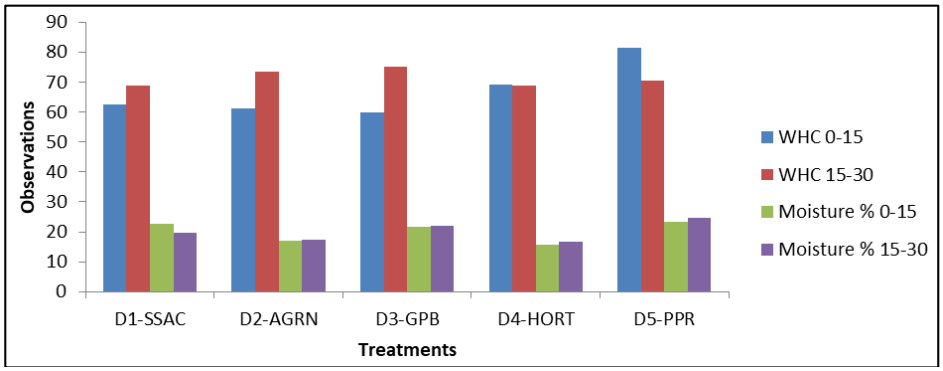

Fig 3: Soil Water holding capacity (%) and soil moisture % of different depth (0-15 and 15-30 cm) of various department of Naini Agricultural Institute, SHUATS, Prayagraj

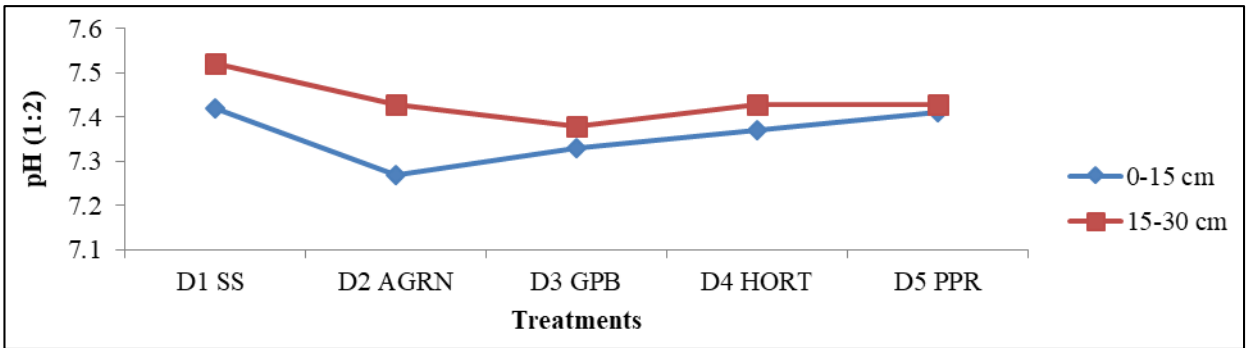

Fig 4: Soil pH of various depths (0-15 and 15-30 cm) of various department of Naini Agricultural Institute, SHUATS, Prayagraj

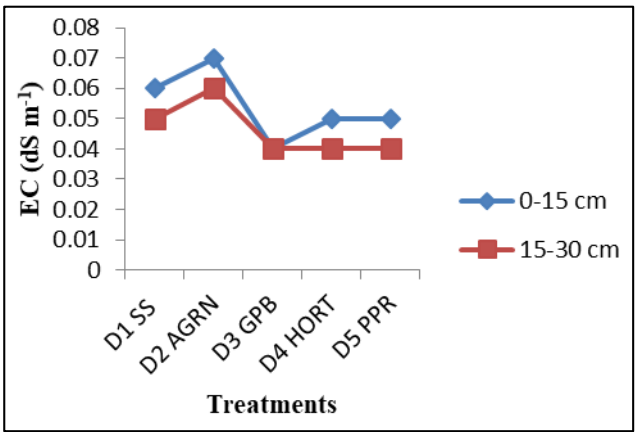

Fig 5: Soil EC (dS m^{-1}) of various depths (0-15 and 15-30 cm) of various department of Naini Agricultural Institute, SHUATS, Prayagraj

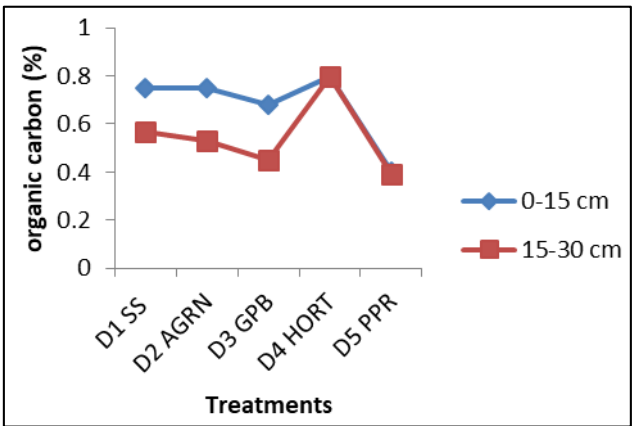

Fig 6: Soil organic carbon (%) of various depths (0-15 and 15-30 cm) of various department of Naini Agricultural Institute, SHUATS, Prayagraj

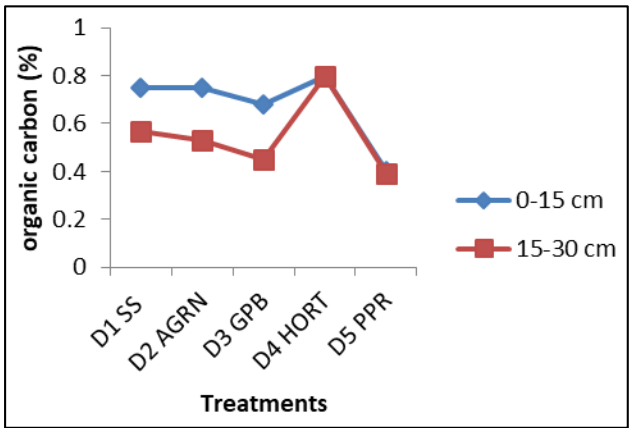

Fig 7: Soil available nitrogen, phosphorus and potassium (kg ha^{-1}) of various depths (0-15 and 15-30 cm) of various department of Naini agricultural institute, SHUATS, Prayagraj

Summary and Conclusion

The soil colour (dry method) of soil varied from light yellowish brown, olive yellow, pale olive, pale yellow, light olive brown, yellowish brown, dark brown, pale brown and dark yellowish brown; the Soil Colour (wet method) of soil varied from olive brown, olive, olive yellow, dark brown and dark yellowish brown. Bulk Density was varied from 1.11 to 1.56 g cm^{-3}. The bulk density decreases with the increase in soil depth. The soil Moisture (%) ranged from 11.56 to 24.69 % and the moisture percentage was found high in Plant Protection department at 15-30 cm depth. The Water Holding Capacity (%) ranged from 52.91 to 81.25 % and department of Plant Protection hold the water best at 81.25 %. The pH value ranged from 7.27 to 7.74 pH of Soil Science and Agricultural Chemistry department is high at 7.47 pH. The Electrical Conductivity ranged from 0.02 to 0.07 dS $m^{-1}$and the soil was found to be non-saline. The organic C content of these soils was found to be low to medium and ranging from 0.39 to 0.80 %. %). The highest organic carbon % was found at D_4-Horticulture (0.80 %). Available Nitrogen content of soil ranged from 122.60 to 367.80 kg ha^{-1} and nitrogen content was low in all the departments. Available Phosphorous content of soil ranged from 15.82 to 19.64 kg ha^{-1} thus phosphorous content was found low in all the departments. Available Potassium content of soil ranged from 166.47 to 193.39 kg ha^{-1}.

It was concluded from the trial that the effect of macro and micro nutrients status at various soil depth was found to be significant and the best suitable soil parameters yield attributes of various crops were reported from department research farm of Soil Science and Agricultural Chemistry, NAI. SHUATS, Prayagraj,

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