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Response of integrated nutrient management on physico-chemical properties of soil and irrigation water quality of research farm of Naini agricultural institute, SHUATS Prayagraj

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Abstract
A survey and mapping for soil parameters/properties was conducted of different departments of Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, (U.P.), India was carried in 2018-19. The main objectives were to collect information of soil type and various parameters like pH, conductivity, bulk density, water retaining capacity, moisture content, available nitrogen, phosphorous and potassium respectively. For this study 5 sampling points were selected from different departments. By analyzing the taken 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 of Naini Agriculture Institute.

Keywords: Prayagraj, district, chemical properties, physical properties, soil, etc.

1. Introduction
Soil is a dynamic natural body developed as a result of pedogenic processes through weathering of rocks, consisting of mineral and organic constituents, possessing definite chemical, physical, mineralogical and biological properties, having a variable depth over the surface of the earth, and providing a medium for plant growth. Thakre *et al*., (2012) [20]. Soil formation is a constructive as well as destructive process. Destructive process predominates the physical and chemical breaking down of materials, plants and animal structures, which result in the partial loss of more soluble and volatile products. Constructive forces develop new chemical compounds, both mineral and organic that provides new distribution or association characteristics, structural properties as well as chemical compositions. These factors influence the plant growth in the soil. Pujar *et al*., (2012) [14]. Nutrients may be defined as the chemical compounds required by an organism. The plant nutrients may be divided into macro-nutrients (Primary and Secondary nutrients) and micro-nutrients. Macro-nutrients are found and needed in plants in relatively higher amounts than micro-nutrients. Das., (2004) [7].
The Vindhayan soil of district Prayagraj in eastern Uttar Pradesh of India exhibit catenary's relation-ship with increase in drainage intensity down the slope, changes in colour from yellowish brown to red-dish grey and texture from loam to clay or silt clay are observed. The C/N ratio of the soil in the low lying areas was higher than in upland and terrace soils of sand stone-shale topo sequences. As one of the oldest geological formation of the country, Vindhayan system covers about 80-90 % portion of the Prayagraj district of Uttar Pradesh. The Naini Agricultural Institute of SHUATS has cultivable and non cultivable land. In this region, inter-cropping of cereal crops with custard apple, guava, crane berry, bael and aonla etc are more suitable under the agri-horti system. The present study was planned to identify the agri-horti system which could promote efficient nutrient recycling to achieve higher improvement in properties of red soils of Vindhyan region in Prayagraj district of India. Yadav *et al*., (1977) [22].
Integrated Nutrient Management refers to the maintenance of soil fertility and of plant nutrient supply at an optimum level for sustaining the desired productivity through optimization of the benefits from all possible sources of organic, inorganic and biological components in an integrated manner.

The main concept of INM is Regulated nutrient supply for optimum crop growth and higher productivity, Improvement and maintenance of soil fertility and Zero adverse impact on agro – ecosystem quality by balanced fertilization of organic manures, inorganic fertilizers and bio- inoculants. Yang and Jacobson., (1990) [21].

Heavy metals are considered one of the major sources of soil pollution. Heavy metal pollution of the soil is caused by various metals, especially Cu, Ni, Cd, Zn, Cr and Pb. Heavy metals exert toxic effects on soil microorganism hence results in the change of the diversity, population size and overall activity of the soil microbial communities. Elevated Pb in soils may decrease soil productivity and a very low Pb concentration may inhibit some vital plant processes i.e. photosynthesis, mitosis and water absorption with toxic symptoms of dark green leaves, wilting of older leaves, stunted foliage and brown short leaves, stunted foliage and brown short roots. The soil properties i.e. organic matter, clay contents and pH have major influences on the extent of the effects of metals on biological and biochemical properties. Cd is the more toxic to enzymes than Pb because of its greater mobility and lower affinity for soil colloids. The heavy metals exert toxic effects on soil microorganism hence results in the change of the diversity, population size and overall activity of the soil microbial communities and observed that the heavy metal (Cr, Zn and Cd) pollution influenced the metabolism of soil microbes in all cases. Contamination of a river with heavy metals may cause devastating effects on the ecological balance of the aquatic environment, and the diversity of aquatic organisms becomes limited with the extent of contamination. Singh *et al*., (2011) [19].

Water quality deals with the physical, chemical and biological characteristics of water in relation to all other hydrological properties. For example, river water having good quality with sediment load can be applied for irrigation successfully but may be objectionable for municipal use without treatment). The salinity of soil is also important factor for the determination of water quality. Soil salinity is developed when soil becomes more salty as a result of water movement in the soil especially due to irrigation. Water quality is critical for the survival of humans, animals, industry and agriculture. The presence of metals in irrigation water also has adverse effects on crop production. Also, high concentration of salts can change the plant nutrients balance in the soil meanwhile some salts are toxic to certain plants. Irrigation water quality is described by different parameters such as Electrical Conductivity (EC), Total Dissolved Solids (TDS) and Residual Sodium Carbonate (RSC) Shakoor *et al*., (2015) [17].

2. Materials and Methods

The present study entitled "Response 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. 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.

2.1 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 airtight 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 Nutrients, Phosphorus and Potassium.

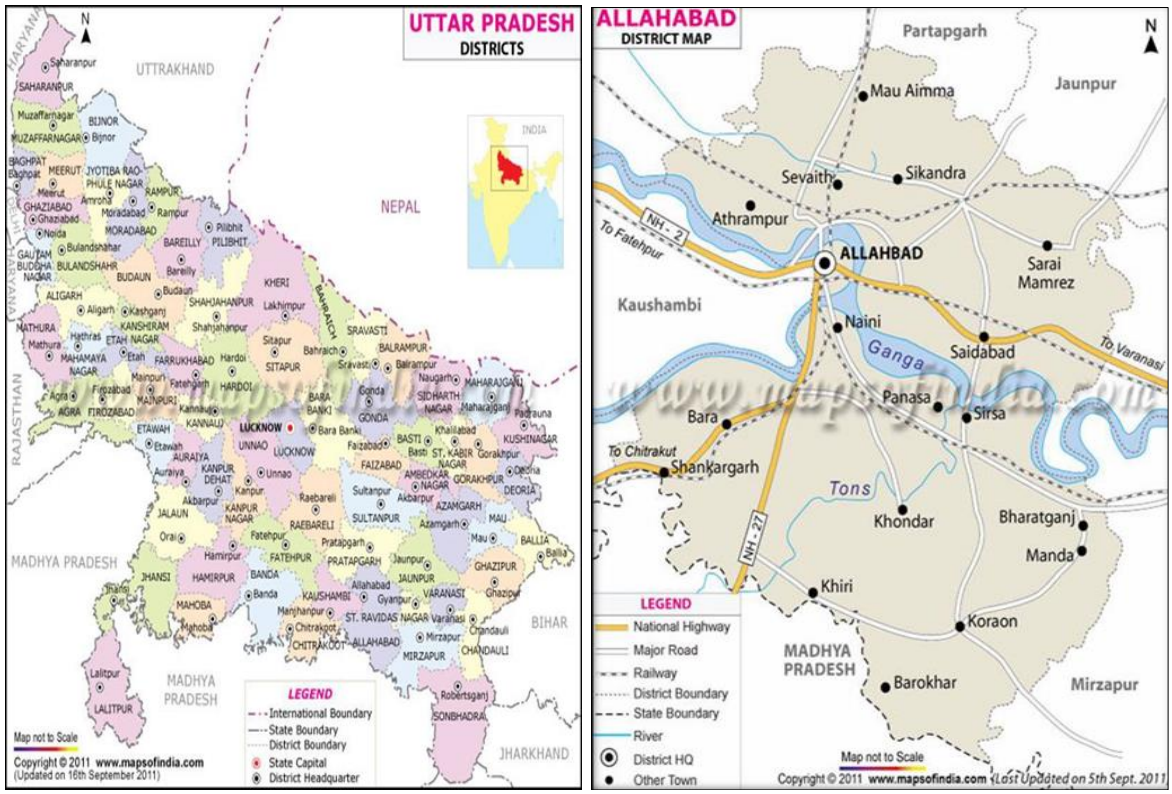

Fig 1: Map of Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj-211 007 (U.P.), India

3. Result and Discussions

3.1 Soil Colour

As depicted in Table 1. 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 D1-Soil Science and Agricultural Chemistry, and D5-Plant Protection and the soil colour- pale olive, light olive brown, yellowish brown and dark yellowish brown was found in D2- Agronomy, D3-Genetics and Plant Breeding, D4-Horticulture respectively. At depth 15-30cm the soil colour- olive yellow, light yellowish brown, light olive brown, yellowish brown, pale olive and dark brown was found in D1-Soil Science, D2-Agronomy, D3-Genetics and Plant Breeding, D4- Horticulture and D5-Plant Protection, respectively. The Table 2 depicted the soil colour (wet-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 0-15cm the soil colour- olive brown was found in D1-Soil Science, D3-Genetics and Plant Breeding and D5-Plant Protection, the soil colour- dark brown was found in D4-Horticultureand olive was found in D2-Agronomy. At depth 15-30cm the soil colour- olive brown was found in D1-Soil Science and Agricultural Chemistry, D2-Agronomy and D3-Genetics and Plant Breeding and the soil colour- dark yellowish brown, olive and dark brown was found in D4-Horticulture and D5-Plant Protection respectively.

Table 1: Evaluation of soil colour (dry method) of different depth of various departments of Naini Agricultural Institute, SHUATS, Prayagraj

Departments	0-15cm	15-30cm
D1Soil Science and Agricultural Chemistry	2.5YR, 6/4 Light Yellowish Brown	2.5YR, 6/6 Olive Yellow
D2 Agronomy	5YR, 6/4 Pale Olive	2.5YR, 6/4 Light Yellowish Brown
D3 Genetics and Plant Breeding	2.5YR, 5/4 Light Olive Brown	2.5YR, 5/6 Light Olive Brown
D4 Horticulture	10YR, 5/4 Yellowish Brown	10YR, 5/4 Yellowish Brown
D5 Plant Protection	2.5YR, 6/4 Light Yellowish Brown	5YR, 6/4 Pale Olive

Table 2: Evaluation of soil colour (wet method) of different depth of various departments of Naini Agricultural Institute, SHUATS, Prayagraj

Departments	0-15cm	15-30cm
D1 Soil Science and Agricultural Chemistry	2.5YR, 4/4 Olive Brown	2.5YR, 4/4 Olive Brown
D2 Agronomy	5YR, 5/4 Olive	2.5YR, 4/4 Olive Brown
D3 Genetics and Plant Breeding	2.5YR, 4/4 Olive Brown	2.5YR, 4/4 Olive Brown
D4 Horticulture	10YR, 3/3 Dark Brown	10YR, 4/4 Dark Yellowish Brown
D5 Plant Protection	2.5YR, 4/4 Olive Brown	5YR, 5/6 Olive

3.2 Physico-chemical properties of soil

In fig 1. 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 m-3. In departments the maximum mean bulk density was found at D4-Horticulture1.39 g cm-3 and minimum at D5- Plant Protection 1.21 g cm-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). Fig. 2. depicts 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 D5-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). 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 D5-Plant Protection 75.91 % and minimum at D1-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 results were reported by Sahu *et al*., (2014).

In fig. 3. 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 D1-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) [12] and Kiran *et al*, (2012) [10]. In fig. 4 states that in departments the highest mean EC was found at D2-Agronomy 0.06 dS m-1, where D2 is significantly higher than, In soil depth the maximum mean EC was found at 0-15 cm 0.05 dS m-1 depth and minimum at 15-30 cm 0.04 dS m-1. All the different soil depths have shown low electrical conductivity (EC) values ranging from 0.04 to 0.07 dS m-1, indicating non-saline nature.

In fig. 5 depicts that in departments the highest mean organic carbon (%) was found at D4- 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) [13].

In fig. 6. depicts that in departments the highest mean available nitrogen was found at D2- Agronomy 240.62 kg N ha-1. In soil depth the highest mean available nitrogen was found at 0-15 cm 204.42 kg N ha-1 depth which is significantly higher than 15-30 cm 190.00 kg N ha-1 was found significantly at par with 0-15 cm. The available nitrogen decreases abruptly with the increase in soil depth, similar results were noticed by Satish Kumar and Naidu (2012). In departments the maximum mean available phosphorous was found at D5-Plant Protection 17.52 kg ha-1 and minimum at D2-Agronomy 16.57 kg ha-1. In soil depth the maximum mean available phosphorous was found at 0-15 cm 17.19 kg ha-1 depth 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). In departments the highest mean available potassium was found at D4-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) [18].

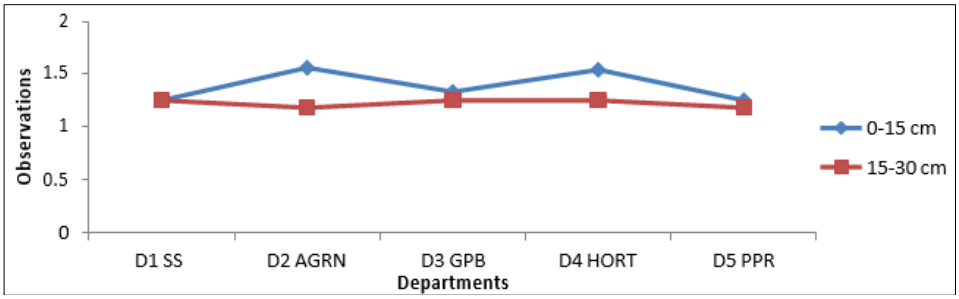

Fig 1: Soil Bulk Density (g cm-3) of various depths (0-15 and 15-30 cm) of various department of Naini Agricultural Institute, SHUATS, Prayagraj

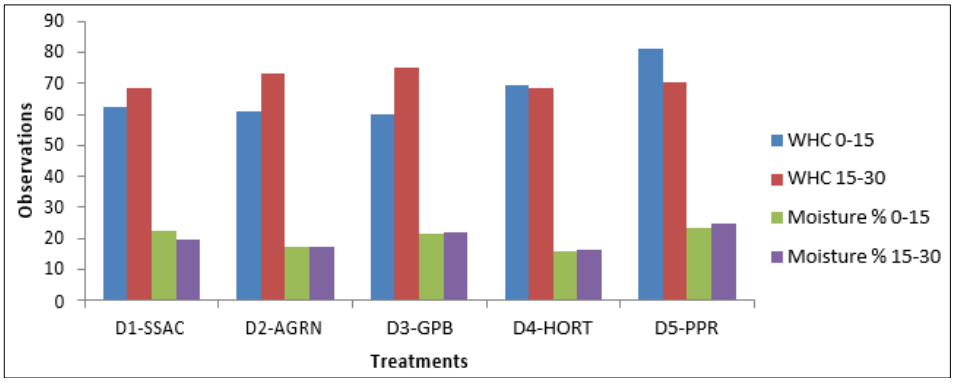

Fig 2: Soil Water Holding Capacity (%) and Soil Moisture % of different depth (0-15 and 15-30 cm) of various department of Naini Agricultural Institute, SHUATS, Prayagraj

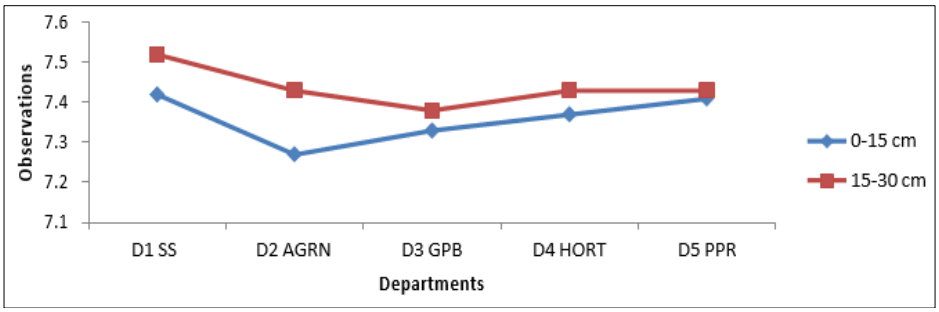

Fig 3: Soil pH of various depths (0-15 and 15-30 cm) of various department of Naini Agricultural Institute, SHUATS, Prayagraj

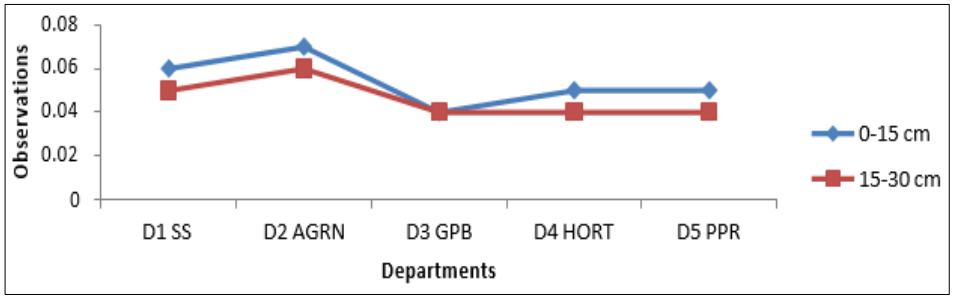

Fig 4: Soil EC (Ds m-1) of various depths (0-15 and 15-30 cm) of various department of Naini Agricultural Institute, SHUATS, Prayagraj.

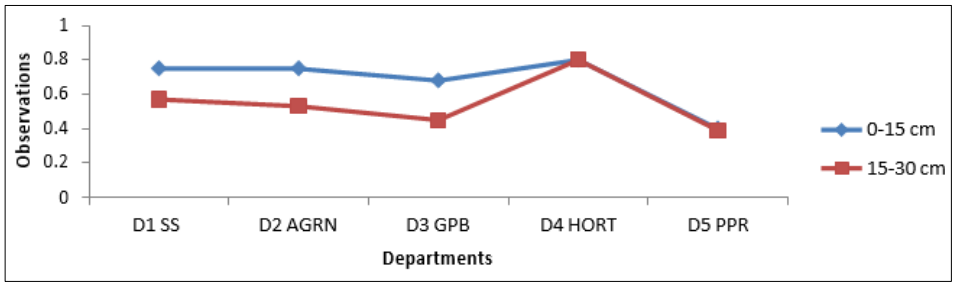

Fig 5: Soil Organic Carbon (%) of various depths (0-15 and 15-30 cm) of various department of Naini Agricultural Institute, SHUATS, Prayagraj

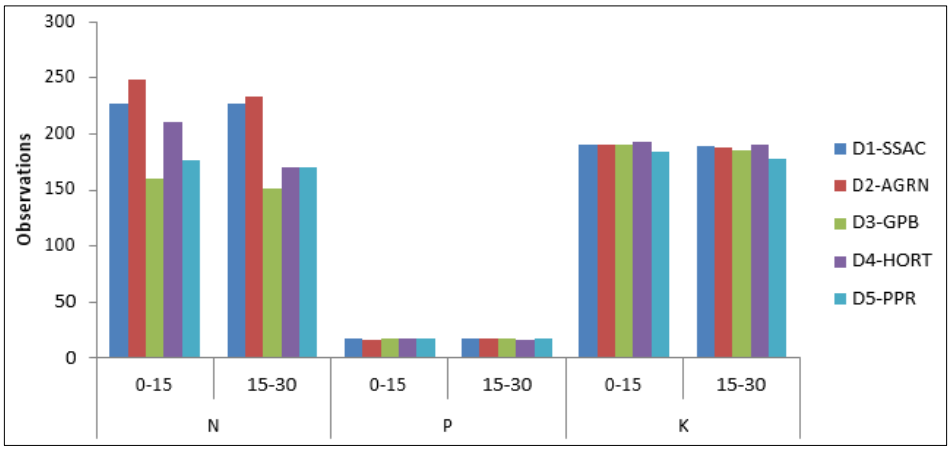

Fig 6: Soil Available Nitrogen, Available Phosphorus and Available Potassium (kg ha-1) of various depths (0-15 and 15-30 cm) of various department of Naini Agricultural Institute, SHUATS, Prayagraj

4. Summary

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 soil Moisture (%) ranged from 11.56 to 24.69 % and the moisture percent 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 7.47pH. The Electrical Conductivity ranged from 0.02 to 0.07 dSm-1and the soil were found to be non-saline. 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.

5. Conclusion

It was concluded that soil has medium level in organic carbon and potassium, low in available nitrogen and phosphorous content. Nutrient additions through organic (FYM) and inorganic sources are essential to maintain the soil fertility of all the department research farms of Naini Agricultural Institute SHUATS, Prayagraj.

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