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Shobhit Yadav
Research Scholar, Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute (NAI), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Narendra Swaroop
Associate Professor, Research Scholar, Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute (NAI), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Arun A David
Associate Professor, Research Scholar, Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute (NAI), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Tarence Thomas
Associate Professor, Research Scholar, Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute (NAI), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Tarun Kumar
Research Scholar, Research Scholar, Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute (NAI), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Himanshu Harit
Research Scholar, Research Scholar, Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute (NAI), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Shobhit Yadav
Research Scholar, Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute (NAI), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Assessment of physico-chemical properties of soil from different blocks of Kanpur Dehat district, Uttar Pradesh

Shobhit Yadav, Narendra Swaroop, Arun A David, Tarence Thomas, Tarun Kumar and Himanshu Harit

Abstract
An experiment was conducted in Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, SHUATS, Prayagraj during 2020-21 to assess the physico-chemical properties of Soil in different blocks of Kanpur Dehat district, U.P., India. Depth wise soil samples were collected from nine villages at 0-15, 15-30 and 30-45 cm. Total 27 samples were selected for analysis. The results revealed that soil colour varied from grey colour to olive yellow in dry condition while from greyish brown to yellow brown in wet condition. The texture was dominantly sandy loam. The bulk density ranged from1.05 to 1.33 (Mg m^{-3}), particle density from2.35 to 2.66 (Mg m^{-3}), pore space from 42.52 to 55.19 (%), water holding capacity from 55.12 to 73.09 (%), specific gravity from 2.01 to 2.40. The pH ranged from 7.17 to 8.84, Electrical conductivity ranged from 0.15 to 0.51(dS m^{-1}). The soil organic carbon ranged from 0.58 to 1.30 (%). Available nitrogen ranged from 142.16 to 440.52 (kg ha^{-1}), available phosphorous ranged from 20.67 to 47.64 (kg ha^{-1}) and available potassium ranged from 62.88 to 109.32 (kg ha^{-1}), all of which showed decrease in value with increase in depth. Exchangeable calcium ranged from 0.7 to 2.57 (cmol (p^{+}) kg^{-1}), exchangeable magnesium ranged from 0.20 to 0.82 (cmol (p^{+}) kg^{-1}) and available sulphur ranged from 20.02 to 42.52 (kg ha^{-1}) all of which varied significantly with site and depth. The results indicated that soils are good for cultivation of various crops. Farmers are required to maintain Soil Health Card which helps them to adopt suitable management practices and provide proper nutrition to soil.

Keywords: Soil pH, EC, Soil Health Card, Kanpur Dehat district

Introduction
Soil is one of the important and valuable resources of the nature. It is composed of particles of broken rock that have been altered by chemical and mechanical processes that include weathering and erosion (Addis, 2014) [1]. The formation of the soil in a particular climate is so perfect that each climate type and its own soil (Balasubramanian, 2017) [2]. Soil health is the "state of the soil being in sound physical, chemical, and biological condition, having the capability to sustain the growth and development of land plants" (Idowu *et al.*, 2019). Healthy soils constitute the foundation of thriving ecosystems and societies and are directly tied to food and nutritional security, water quality, human health, climate change mitigation/adaptation, and biodiversity (Manter *et al.*, 2017) [11]. The inherent ability of soils to supply nutrients for crop growth and maintenance of soil physical conditions to optimize crop yields is the most important component of soil that virtually determines the productivity of agricultural system. A thorough and proper understanding of morphological, physical and chemical characteristics of the soils gives greater insight of the dynamics of the soil (Khanday *et al.*, 2017) [10]. Soil physicochemical properties are basic indicators for estimating the level of soil nutrient contents and characteristics (Meena *et al.*, 2020) [12]. The Kanpur Dehat district occupies the central part of Uttar Pradesh on eastern bank of Yamuna river and encompasses a total geographical area of 3021 sq. km., lying between latitude 26° 31' to 35° 75.94' N and longitude 79^0 49' to 84^0 46.92' E. The total population of the district as per 2001 census is 1563336 souls having 844331 male and 718997 female populations. The district is divided into five tehsils having ten blocks i.e. Rasoolabad, Maitha, Akbarpur, Sarwarh Khera, Jinjhak, Derapur, Sandalpur, Rajpur, Malasa and Amrodha. The land use pattern of the district in (2010-11) shows forest cover of 5797 hectare. The net sown area is 221999 hectare (Tripathi, 2013) [21].

Materials and Methods

The Kanpur Dehat district lies in the center of Uttar Pradesh. It lies between 26° 31' to 35^0 75.94' N latitude and 79^0 49' to 84^0 46.9'' E longitude with total geographical area 3021 sq. km having elevation of about 126 m above the mean sea level. The entire study area was divided into three different blocks from the district under study, *viz.* Rasulabad (B_1), Jhinjhak (B_2) and Akbarpur (B_3) with three different sites taken from each village (Fig. 1). Total twenty seven soil samples were collected at different depths of 0- 15 cm, 15-30 cm and 30-45 cm respectively at the site. The collected soil samples were processed and analyzed for physico-chemical properties of soil by standard analytical methods.

Sieved soil samples were determined for physical properties of soil like its soil textural class by Bouyoucos hydrometer method (Bouyoucos, 1927) [4], soil colour by using Munsell soil colour chart (Munsell, 1954) [13], bulk density, particle density, percent pore space and water holding capacity was determined by 100 ml graduated measuring cylinder method (Muthuvel *et al.,* 1992). For determined the chemical properties of soil like its pH was determined by digital pH meter by making 1:2 soil-water suspension (Jackson, 1958) whereas EC was measured by digital EC meter (Wilcox, 1950), Organic carbon was determined by wet-oxidation method (Walkley, 1947) [24], available nitrogen was determined by alkaline potassium permanganate method by 800 ml kjeldahl flask (Subbiah and Asija, 1956) [18], available potassium was determined by flame photometer using 1 N NH_4OAC (pH 7.0) (Toth and Prince, 1949) [20], available phosphorus was determined by colorimetric method by using spectrophotometer (Olsen *et al.,* 1954) [15], exchangeable calcium and magnesium were estimated by EDTA titration method (Cheng and Bray, 1951) [5], available sulphur was determined by turbidimetric method (Chesnin and Yien, 1950).

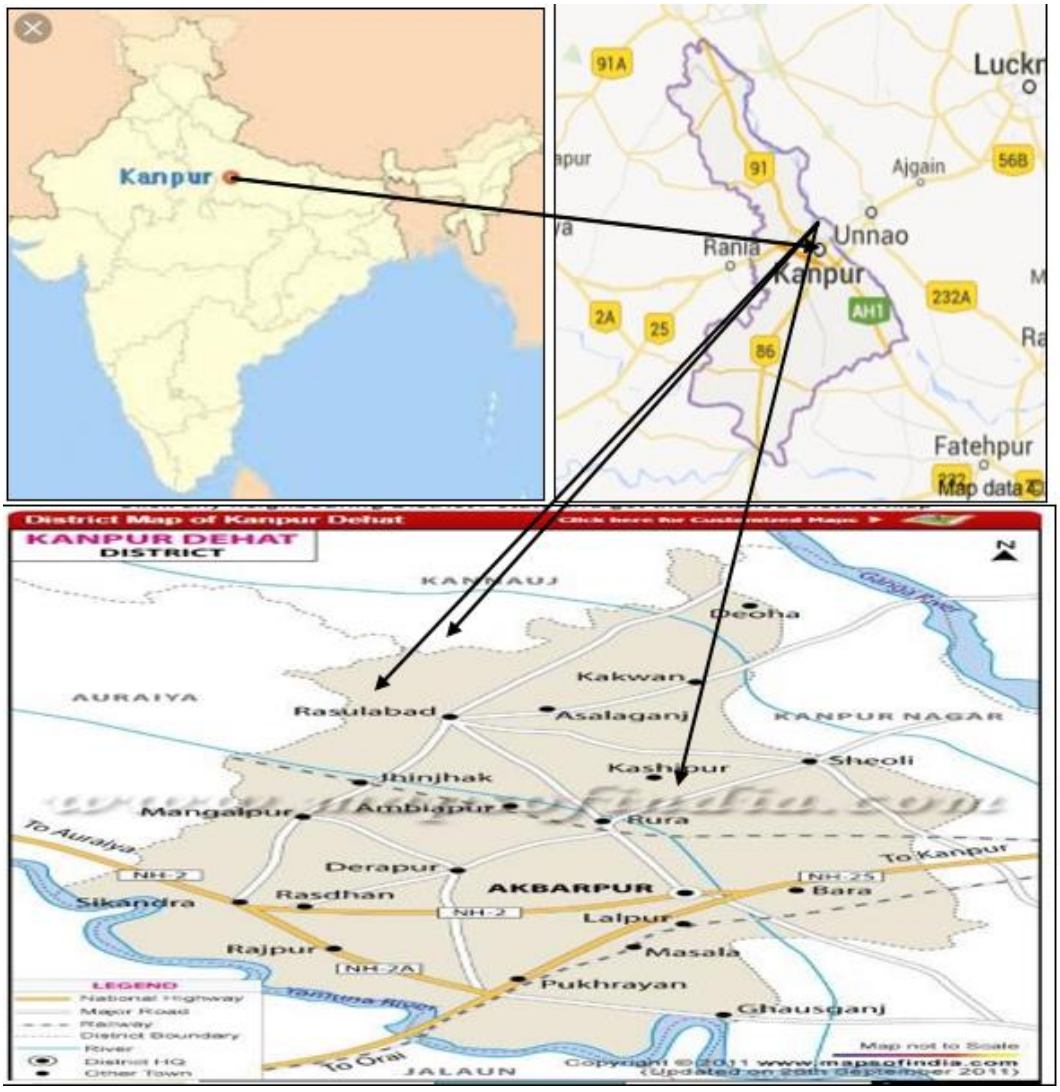

Fig 1: Geographical map of study area

Results and Discussion:

A. Physical properties

The results depicted that the soil color of Kanpur Nagar district in dry condition varies from Grey colour (10YR 6/1) to Olive yellow (2.5Y 6/6) in 0-15 cm depth, from Light brownish grey (10YR 6/2) to Olive yellow (2.5Y 6/6) in 15-30 cm depth and from Light yellowish brown (2.5Y 6/4) to Olive yellow (2.5Y 6/8) in 30-45 cm depth. The colour in wet condition varies from Very dark greyish brown (2.5Y 3/2) to Pale brown (10YR 6/3) in 0-15 cm depth, from Greyish brown (2.5Y 5/2) to Olive yellow (2.5Y 6/6) in 15- 30 cm depth and from Greyish brown (2.5Y 5/2) to Light yellowish brown (2.5Y 6/4) in 30-45 cm depth. Wet soils are darker than dry soils due to similarity in refractive properties of water and soil Pradhan *et al.,* (2020) [16]. The texture in village is dominantly sandy loam. Most of the crops are grown in

these soils because they retain more water and nutrients (Khadka *et al.*, 2017) [9]. Table. 1 represents the entire mean and range value of BD, PD, WHC and Pore space (%). The bulk density varied from 1.05 to 1.33 Mg m^{-3}. The bulk density increases with the increase in soil depth. The reason is soil compactness, which will be more at high depth Iram *et al.*, (2018) [8]. The particle density varied from 2.35 to 2.66 Mg m^{-3}. Particle density varies according to the mineral content of the soil particles Verma *et al.*, (2019) [23]. The pore space (%) varied from 42.52 to 55.19 (%). Pore space was found to decrease with increase in depth attributed to increase in compaction in the sub surface Verma *et al.*, (2019) [23]. The water holding capacity (%) varied from 55.12 to 73.09 (%). WHC value increases with the increasing depth because increase in depth there is decrease in % pore space, hence macro pores will get decreased and micro pores will increase where the water is held Vengadaramana *et al.*, (2012) [22].

Table 1: Assessment of BD, PD, WHC and Porosity of soils from different blocks of Kanpur Dehat district

Villages	Bulk Density		Particle Density		Water Holding Capacity (%)		Pore Space (%)	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Ajeemabad (V1)	1.12-1.31	1.22	2.50-2.66	2.60	55.12-60.71	58.21	43.43-53.50	48.05
Jot(V2)	1.07-1.21	1.14	2.50-2.66	2.55	61.42-64.51	63.04	45.22-51.32	47.63
Malgaon (V3)	1.23-1.33	1.28	2.50-2.66	2.66	62.50-72.39	68.36	42.56-52.75	46.28
Bhogipur (V4)	1.11-1.27	1.22	2.45-2.65	2.65	69.67-73.09	71.34	47.63-55.19	51.40
Shivnathapur (V5)	1.13-1.25	1.19	2.41-2.57	2.49	59.07-65.71	62.50	50.00-54.33	52.32
Kariyajhaala (V6)	1.23-1.32	1.28	2.43-.262	2.53	62.16-67.94	64.91	45.27-52.68	49.44
Aama (V7)	1.05-1.11	1.07	2.50-2.66	2.58	64.83-70.45	67.91	42.77-50.52	47.06
Adhupur (V8)	1.10-1.23	1.17	2.35-2.66	2.50	56.34-62.83	59.46	42.52-47.89	45.39
Anavakhas (V9)	1.11-1.28	1.20	2.53-2.59	2.55	64.75-71.21	68.09	52.77-54.23	53.25

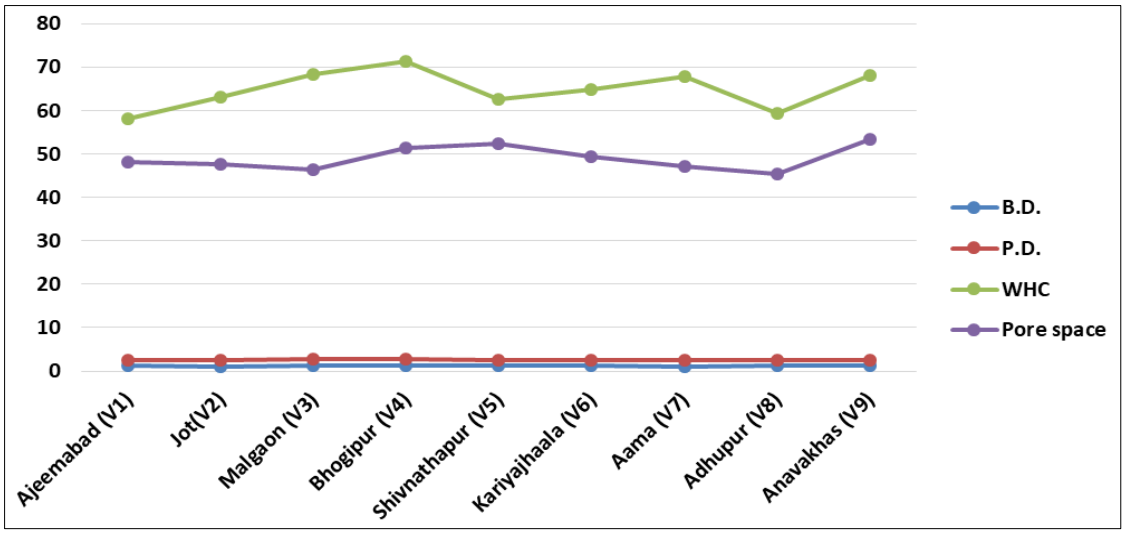

Fig 1: BD, PD, WHC and Porosity of soils from different blocks of Kanpur Dehat district

B. Chemical properties

Table. 2 represents the entire mean and range value of soil pH, EC and OC (%). The soil pH varied from 7.15 to 8.84, thereby indicating the soils are moderately alkaline Okolo *et al.*, (2016) [14]. The electrical conductivity varied from 0.15 to 0.51 dS m^{-1}. It indicates that the soils are non- saline and salinity effect is mostly negligible for the crops Tale *et al.*, (2015). The soil organic carbon (%) varied from 0.58 to 1.30 (%). The organic carbon decreases with increasing depth due to the fact that surface soil contains undecomposed and partial decomposed organic matter while subsoil contains decomposed organic matter Singh *et al.*, (2012) [17].

Table 2: Assessment of soil pH, EC and Organic Carbon (%) of soils from different blocks of Kanpur Dehat district

Villages	Soil pH		Electrical Conductivity		Organic Carbon (%)	
	Range	Mean	Range	Mean	Range	Mean
Ajeemabad (V1)	7.17-8.65	8.34	0.25-0.51	0.34	0.71-1.04	0.90
Jot(V2)	7.24-7.97	7.62	0.29-0.34	0.31	0.91-1.20	1.04
Malgaon (V3)	7.89-8.23	8.20	0.29-0.35	0.32	0.58-1.10	0.85
Bhogipur (V4)	8.18-8.25	8.21	0.35-0.43	0.39	0.71-0.97	0.84
Shivnathapur (V5)	8.21-8.54	8.38	0.28-0.30	0.29	1.01-1.30	1.17
Kariyajhaala (V6)	7.15-8.05	7.51	0.29-0.38	0.33	0.79-1.14	0.98
Aama (V7)	7.72-8.84	8.73	0.15-0.17	0.16	0.65-1.03	0.80
Adhupur (V8)	8.03-8.58	8.41	0.24-0.32	0.28	0.83-1.10	0.93
Anavakhas (V9)	8.32-8.79	8.61	0.20-0.24	0.22	0.82-1.11	0.99

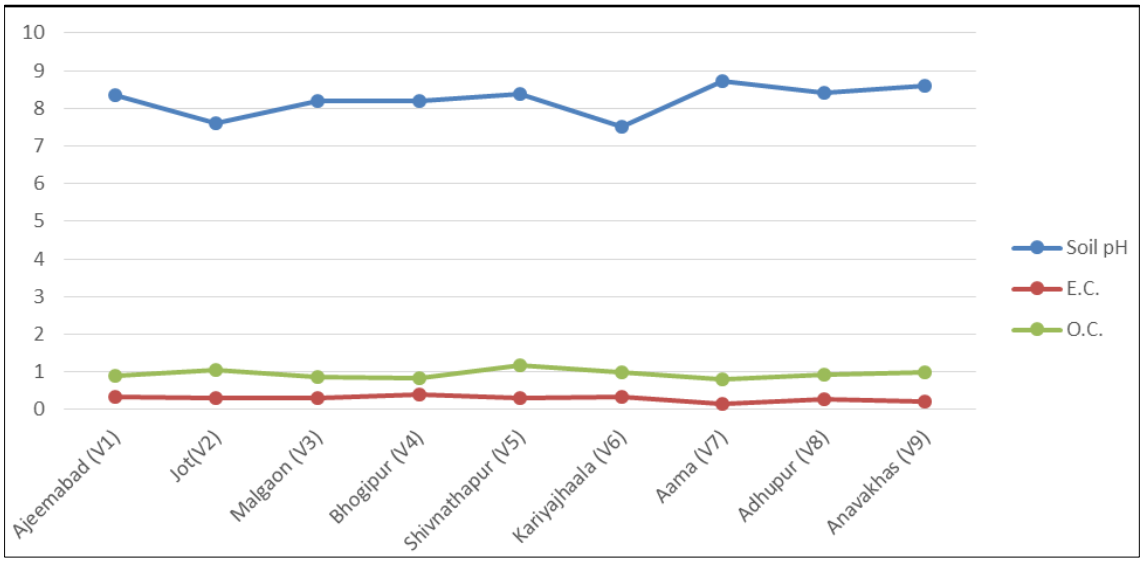

Fig 2: pH, EC and OC of soils from different blocks of Kanpur Dehat district

Table. 3 represents the entire mean and range value of available N, P and K. The available nitrogen (kg ha^{-1}) varied from 142.16 to 440.52 (kg ha^{-1}). The available nitrogen decreases with the increasing depth due to the fact organic matter decreases with depth Ghodke *et al.*, (2016). The available phosphorous varied from 6.73 to 29.56 (kg ha^{-1}). The available phosphorous decreases with the increasing depth. Higher level of available phosphorous in surface soil could be attributing of favorable soil pH Ghodke *et al.*, (2016) [7]. The available potassium varied from 62.88 to 109.32 (kg ha^{-1}). The available potassium decreases with the increasing depth. The high content of available potassium on surface soil may be attributed to application of potassium fertilizers Wani *et al.*, (2017) [25].

Table 3: Assessment of N-P-K (kg ha^{-1}) of soils from different blocks of Kanpur Dehat district

Villages	Available Nitrogen (kg ha-1)		Available Potassium (kg ha-1)		Available Phosphorus (kg ha-1)	
	Range	Mean	Range	Mean	Range	Mean
Ajeemabad (V1)	157.18-440.52	284.85	16.33-27.67	21.80	78.07-109.32	94.97
Jot(V2)	166.36-411.21	294.63	15.18-29.56	23.60	70.86-101.91	84.97
Malgaon (V3)	173.47-406.45	299.26	14.51-22.87	18.60	67.32-112.00	85.51
Bhogipur (V4)	154.65-378.74	257.01	10.35-19.28	15.31	81.29-108.29	94.26
Shivnathapur (V5)	142.16-279.77	214.41	8.75-14.42	11.49	72.81-103.25	88.19
Kariyajhaala (V6)	157.18-290.64	222.62	6.73-12.52	9.60	65.22-101.10	79.74
Aama (V7)	185.43-323.76	265.61	6.78-17.87	12.33	63.22-103.15	82.84
Adhupur (V8)	179.18-304.93	280.36	8.65-15.09	11.66	62.88-105.33	80.50
Anavakhas (V9)	164.65-395.94	248.34	19.25-21.82	20.30	64.39-104.45	82.30

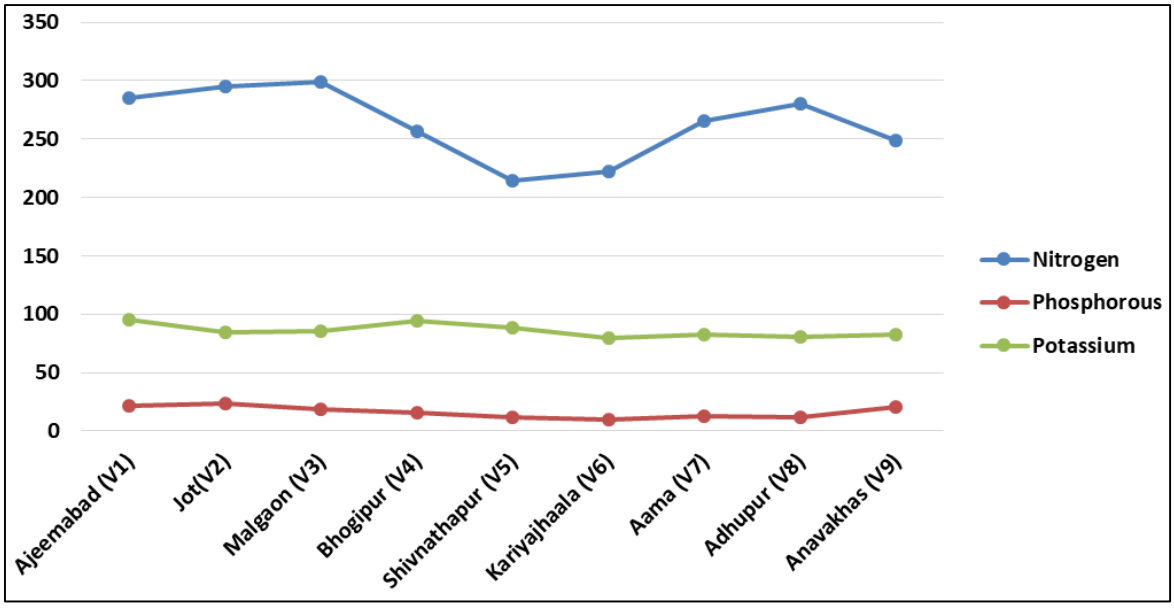

Fig 3: N, P and K of soils from different blocks of Kanpur Dehat district

Table. 4 represents the entire mean and range value of available Ca, Mg and S. The exchangeable calcium varied from 0.72 to 2.57 (cmol (p^+) kg^{-1}). The exchangeable calcium decreases with the increasing depth Deshmukh, (2012) [6]. The exchangeable magnesium varied from 0.20 to 0.82 (cmol (p^+) kg^{-1}). The exchangeable magnesium decreases with the increasing depth Deshmukh, (2012) [6]. The available sulphur varied from 20.02 to 42.52 (kg ha^{-1}). The available sulphur decreases with the increasing depth might be due to greater plant and microbial activities in surface soil Ghodke *et al.*, (2016) [7].

Table 4: Assessment of Calcium, Magnesium and Sulphur of soils from different blocks of Kanpur Dehat district

Villages	Exchangeable calcium (kg ha-1)		Exchangeable magnesium (kg ha-1)		Available sulphur (kg ha-1)	
	Range	Mean	Range	Mean	Range	Mean
Ajeemabad (V1)	1.51-2.32	1.93	0.39-0.82	0.57	27.03-37.57	32.18
Jot(V2)	1.23-1.83	1.50	0.47-0.67	0.56	24.18-42.26	32.54
Malgaon (V3)	0.86-1.02	0.92	0.32-0.73	0.53	25.98-34.95	29.27
Bhogipur (V4)	1.01-1.23	1.09	0.23-0.64	0.48	22.16-37.23	29.13
Shivnathapur (V5)	2.10-2.24	2.15	0.37-0.57	0.45	24.82-30.78	27.80
Kariyajhaala (V6)	1.34-1.87	1.56	0.30-0.43	0.36	25.98-32.36	29.04
Aama (V7)	1.24-1.65	1.42	0.20-0.21	0.20	31.23-42.52	36.74
Adhupur (V8)	0.97-2.57	1.84	0.21-0.39	0.28	20.02-34.53	28.45
Anavakhas (V9)	0.72-1.61	1.18	0.29-0.49	0.38	24.11-32.51	27.81

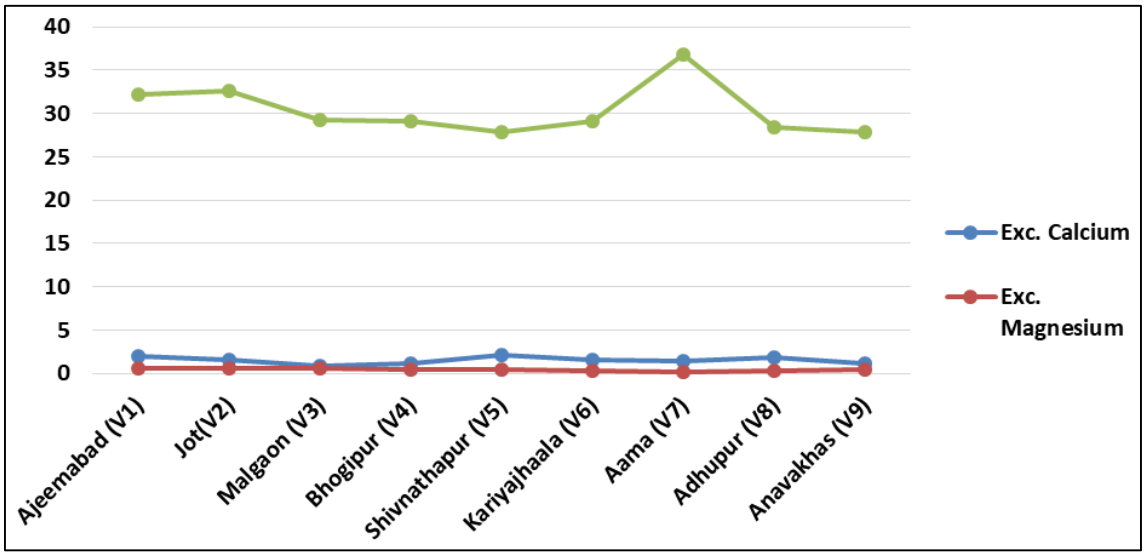

Fig 4: Ca, Mg and S of soils from different blocks of Kanpur Dehat district

Conclusion

It is concluded from the research work that the soils of Kanpur Dehat are found to be significant with medium to high amount of macronutrients *viz.* Nitrogen, Phosphorous, Potassium and some sites showed a deficiency in secondary nutrients *i.e.* Calcium, Magnesium and Sulphur. The deficiency of the nutrients can be enhanced by adopting Integrated Nutrient Management. It shows that the soils are good for cultivation of various crops. Farmers are required to maintain Soil Health Card which helps them to adopt suitable management practices and provide proper nutrition to soil.

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