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Evaluation of physico-chemical properties of soil from different blocks of Kanpur Nagar district, Uttar Pradesh

Anshul Saxena, Tarence Thomas and Raghu Nandan Singh Khatana

Abstract

The field experiment was conducted during the year 2020 and 2021 in different blocks of district Kanpur Nagar, Uttar Pradesh. The twenty-seven soil samples were collected from different blocks of district Kanpur Nagar from different depth (0-15, 15-30 and 30-45 cm) at the farmer's fields. Longitude and latitude ($26^{\circ} 34' 12.16''$ and $80^{\circ} 75' 07.61''$) positions of experimental sites were mentioned in abstract. After an analysis of the soil samples the pH value varied from 7.03 to 8.52, 7.08 to 9.23 and 7.24 to 9.75, EC value was ranged from 0.13 to 0.35, 0.10 to 0.30 and 0.07 to 0.15 dS m^{-1} and the Organic Carbon % was ranged from 0.19 to 0.49, 0.16 to 0.36 and 0.10 to 0.21%. Nitrogen was ranged from 148.12 to 234.68, 126.42 to 213.71 and 96.30 to 192.81 kg ha^{-1} . Phosphorus was varied from 4.15 to 21.82, 1.11 to 19.25 and 0.20 to 13.84 kg ha^{-1} . Potassium was ranged from 94.30 to 265.78, 80.83 to 245.50 and 48.23 to 232.09 kg ha^{-1} . Calcium was varied from 1.45 to 2.90, 1.20 to 2.63 and 0.70 to 2.02 $\text{cmol (p}^+) \text{ kg}^{-1}$. Magnesium was ranged from 0.26 to 2.20, 0.20 to 1.80 and 0.20 to 1.42 $\text{cmol (p}^+) \text{ kg}^{-1}$. Sulphur was ranged from 4.73 to 9.35, 3.58 to 7.80 and 2.10 to 6.84 ppm. Dry and wet soil colour (Light yellowish brown, yellowish brown and brownish yellowish) and (dark greyish brown, dark brown and dark yellowish brown). All blocks having the sandy loam soil texture. The bulk density varied from 1.17 to 1.33, 1.23 to 1.42 and 1.29 to 1.48 Mg m^{-3} . Particle density ranged from 2.22 to 2.40, 2.31 to 2.53 and 2.43 to 2.66 Mg m^{-3} . The Water Holding Capacity of the different blocks of the Kanpur Nagar was ranged from 60.65 to 75.00, 55.00 to 73.33, and 65.56 to 83.87% and Pore Space percentage was varied from 42.39 to 50.84, 40.70 to 49.20, and 40.10 to 49.01%. All the above parameters of the physical and chemical soil properties as above mentioned in abstract.

Keywords: longitudes, latitudes, measure macro nutrients, physical and chemical properties, Kanpur Nagar district

Introduction

Land is a basic natural resource on which development of human with other living beings along with water and plants are going on from the beginning of the creation. Inadequate management of natural resource affected bio diversity, agriculture productivity and ecological balance. Soil word has been derived from Latin word *solum* which means earthly material in which all the living things survives on the inside and outside of the periphery. The Edaphology correlate to plants and human beings considered as a soil habitat. The minor difference between pedology and edaphology, Pedology means only study of the soils, its description and its classification. On the other hand, Edaphology means study of plants and humans habitants. Soil is the most vital natural resource, can be termed as 'Soul of infinite life' and it is the exclusive source of infinite living organisms which supports the life of crop plants by acting as a medium for growth along with providing nutrients, air, and water (Rajshri *et al.*, 2021) ^[22]. Soil is one of the most precious natural resources, which provides a medium for plant growth to meet our food and fiber needs (Naphade *et al.*, 2021) ^[19].

Uttar Pradesh is the fourth largest Indian state describes as the "Heartland of India" by an occupying area of about 2,43,286 sq. km or 93,933 sq. miles comprising over 199,581,477 inhabitants as of the 2011 census, becoming the most populous state in the country. It has been divided into 75 districts 350 tehsils and 813 community blocks, situated between North latitudes $23^{\circ} 52' 23.41''$ to $31^{\circ} 28' 76.09''$ and East longitudes $77^{\circ} 03' 16.32''$ to $84^{\circ} 39' 21.23''$ is a part of North-Central of the country India which is situated within the Gangetic plain, which is composed mostly of fertile alluvial soils deposits brought down from the Himalayas to the north by the vast Ganges network. The state occupies 9% area of India in which 16% population of the country resides. The cropping intensity within the state is 153%.

Due to variations in relief, precipitation, vegetation, climate conditions, and parent materials have resulted in various soil varieties due to the different region relief features. The extremely fertile alluvial soils range from sandy to clayey loam. The soils within the southern part of the state are generally mixed red and black or red-to-yellow. The Kanpur Nagar District comes under Central Plain Zone in Agro-climatic zone of Uttar Pradesh. The average annual rainfall is in the district is 939 mm or 37.0 inches with the average annual temperature is 25.3 °C with January (7.75 °C) being the coldest month and May & June being the hottest (38.85 °C) months. This area of the region is rich in alluvial soil deposition in which the older alluvium or Bhangar were deposited mostly during the lower to upper Pleistocene period and the newer alluvium or Khadar were deposited during the upper Pleistocene to a recent period (Tripathi, 2008) [29]. Therefore, the present investigation was undertaken to assess the physico-chemical properties of soils from different blocks of Kanpur Nagar district.

Materials and Methods

The Kanpur Nagar district is located on the right bank of river Ganga and lies in the centre part of Uttar Pradesh state. It lies between 25° 26' 12.34" to 26° 58' 34.56" North latitude and 79° 31' 12.11" to 80° 34' 25.43" East longitude with the total geographical area is 3155 sq. km having with an elevation of about a 127 m above the mean sea level. The entire study area was divided into three different blocks from the district were taken under study, viz., Bilhaur (Block I), Shivrajpur (Block II) and Chaubepur (Block III) 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

locations of the samples were recorded by using the handheld mobile app GIS system. The collected soil samples were processed and analysed for physico-chemical properties of soil by standard analytical methods.

The data was recorded during the course of investigation were subjected to statistical analysis by analysis of Completely Randomized Design (CRD) as per the method of "Analysis of Variance" (ANOVA) technique (Fischer, 1927) [8]. The type of ANOVA adopted for the experiment was two-way factor analysis without replication.

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) [17], bulk density, particle density, percent pore space and water holding capacity was determined by 100 ml graduated measuring cylinder method (Muthuvel *et al.*, 1992) [18]. 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) [10] whereas EC was measured by digital EC meter (Wilcox, 1950) [31], Organic carbon was determined by wet-oxidation method (Walkley, 1947) [30], available nitrogen was determined by alkaline potassium permanganate method by 800 ml kjeldhal flask (Subbiah and Asija, 1956) [27], available potassium was determined by flame photometer using 1 N NH₄OAC (pH 7.0) (Toth and Prince, 1949) [28], available phosphorus was determined by colorimetric method by using spectrophotometer (Olsen *et al.*, 1954) [21], 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) [6].

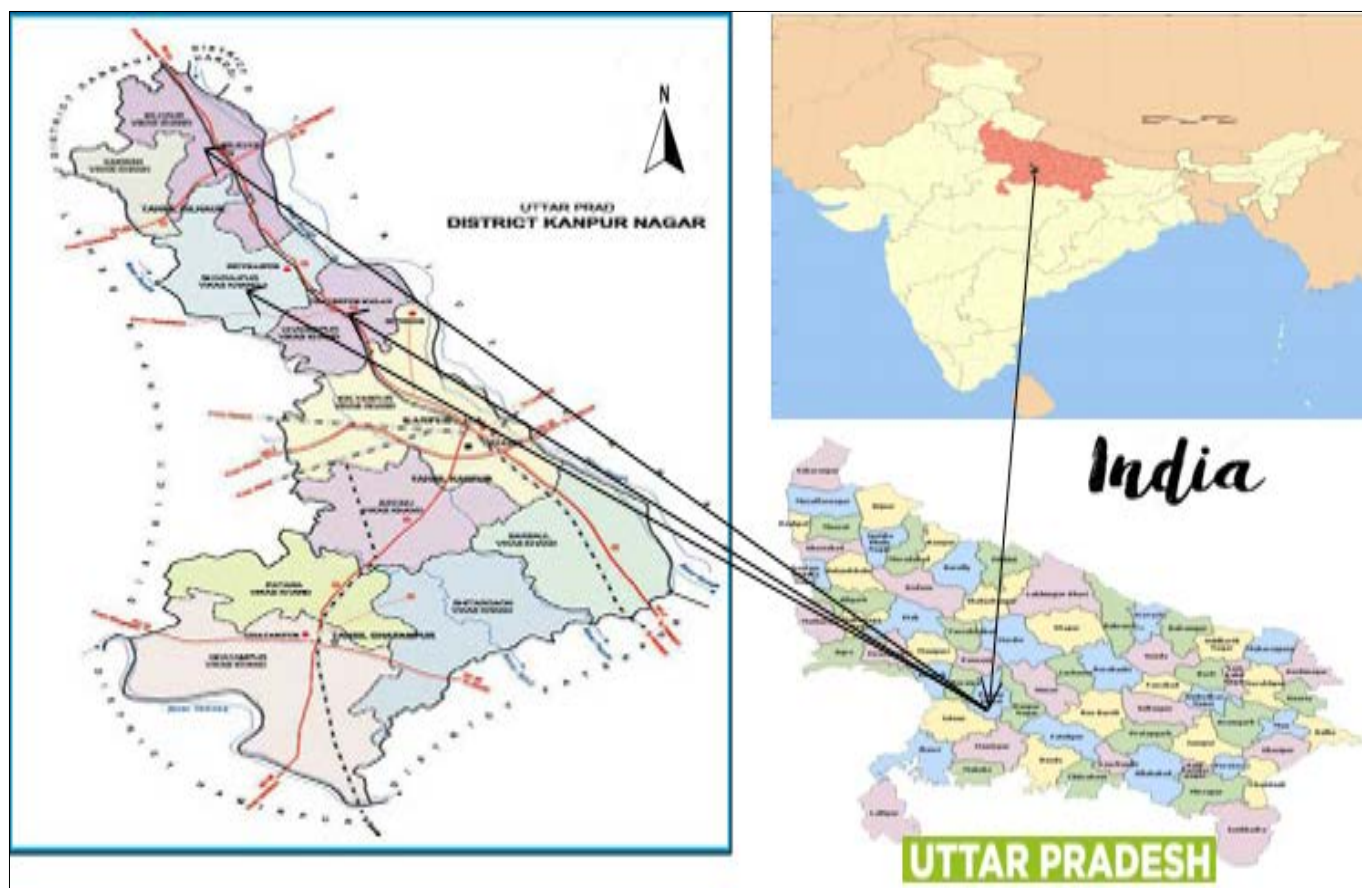


Fig 1: Locating sampling sites on map of Kanpur Nagar district, Uttar Pradesh

Results and Discussion

A. Physical properties

The results revealed that most of the soils of Kanpur Nagar district in dry condition, reflected yellowish brown (2.5YR 5/4) to brownish yellow (2.5YR 6/6) colour and in wet condition, reflected dark greyish brown (10YR 4/2) to dark yellowish brown (10YR 4/4) colour mentioned in Table 1. Soil texture of soil samples was fall under sandy loam (Table 2). The bulk density in soils from different villages varied from 1.17 to 1.48 Mg m⁻³. The bulk density increases with the increase in soil depth (Table 2). The bulk density decreased due to high organic matter content or vice versa. A similar result has also been identified by Bhuyan *et al.*, (2013) [2]. The particle density of soil varied from 2.22 to 2.66 Mg m⁻³. The particle density increased due to increase in soil depth (Table 2). The increased in the particle density is due to soil depth,

water quality and their interaction. Same analysis has been done by Kumar *et al.*, (2018) [15]. The water holding capacity (%) of soil varied from 55% to 83.87% (Table 3). These variations were due to clay, silt and organic carbon content and low WHC in sandy soils due to high sand and less clay content. The WHC increased with an increase in the clay content at the sites. The Irregular trend of this WHC with depth was also due to the illuviation and eluviation of finer fractions in different horizons. Same analysis results have been reported by Sahu *et al.*, (2014) [24] and Sharma *et al.*, (2010) [25]. Percent Pore Space of different soil depths varied from 40.10% to 50.84%. (Table 3) Soil containing high organic matter possesses high porosity. The percent pore space decreases with increase in depth of soil. Same analysis result has been reported by Choudhary *et al.*, (2020) [7].

Table 1: Soil Colour of villages from different blocks of Kanpur Nagar district, Uttar Pradesh

Blocks	Villages	Soil Colour					
		Dry condition			Wet condition		
		0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Chaubepur	Pachor	Light yellowish brown	Yellowish brown	Brownish yellow	Dark greyish brown	Dark brown	Dark yellowish brown
	Kukradev	Light yellowish brown	Yellowish brown	Brownish yellow	Dark greyish brown	Dark brown	Dark yellowish brown
	Devpalpur	Light yellowish brown	Yellowish brown	Brownish yellow	Dark greyish brown	Dark brown	Dark yellowish brown
Bilhaur	Uttaripura	Light yellowish brown	Yellowish brown	Brownish yellow	Dark greyish brown	Dark brown	Dark yellowish brown
	Madara Rai Guman	Light yellowish brown	Yellowish brown	Brownish yellow	Dark greyish brown	Dark brown	Dark yellowish brown
	Tatarpur	Light yellowish brown	Yellowish brown	Brownish yellow	Dark greyish brown	Dark brown	Dark yellowish brown
Shivrajpur	Jagatpur	Light yellowish brown	Yellowish brown	Brownish yellow	Dark greyish brown	Dark brown	Dark yellowish brown
	Pathakpur	Light yellowish brown	Yellowish brown	Brownish yellow	Dark greyish brown	Dark brown	Dark yellowish brown
	Jagdishpur	Light yellowish brown	Yellowish brown	Brownish yellow	Dark greyish brown	Dark brown	Dark yellowish brown

Table 2: Soil texture, Bulk Density and Particle Density at different depths (cm) of villages from different blocks of Kanpur Nagar district, Uttar Pradesh

Blocks	Villages	Soil Texture	Bulk Density (Mg m ⁻³)			Particle Density (Mg m ⁻³)		
			0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Chaubepur	Pachor	Sandy loam	1.25	1.29	1.33	2.35	2.50	2.56
	Kukradev	Sandy loam	1.33	1.42	1.48	2.38	2.53	2.66
	Devpalpur	Sandy loam	1.25	1.33	1.37	2.40	2.50	2.53
Bilhaur	Uttaripura	Sandy loam	1.25	1.33	1.42	2.32	2.43	2.50
	Madara Rai Guman	Sandy loam	1.33	1.37	1.42	2.22	2.35	2.50
	Tatarpur	Sandy loam	1.33	1.37	1.40	2.22	2.31	2.43
Shivrajpur	Jagatpur	Sandy loam	1.17	1.25	1.33	2.35	2.43	2.50
	Pathakpur	Sandy loam	1.17	1.23	1.29	2.38	2.46	2.53
	Jagdishpur	Sandy loam	1.25	1.23	1.42	2.32	2.40	2.50

Table 3: Water holding capacity and Percentage Pore Space at different depths (cm) of villages from different blocks of Kanpur Nagar district, Uttar Pradesh

Blocks	Villages	Water Holding Capacity (%)			Pore Space (%)		
		0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Chaubepur	Pachor	65.56	61.29	65.56	48.40	48.05	46.80
	Kukradev	60.65	55.00	66.66	44.12	43.88	42.37
	Devpalpur	66.66	59.67	66.12	47.92	46.80	45.85
Bilhaur	Uttaripura	62.90	70.31	70.96	46.13	45.27	43.20
	Madara Rai Guman	62.90	68.33	74.20	43.20	41.71	40.10
	Tatarpur	72.41	73.33	76.66	42.39	40.70	40.10
Shivrajpur	Jagatpur	75.00	72.41	83.87	50.20	48.56	46.80
	Pathakpur	62.90	61.29	73.33	50.84	49.20	49.01
	Jagdishpur	68.33	62.50	63.33	46.13	44.59	43.20

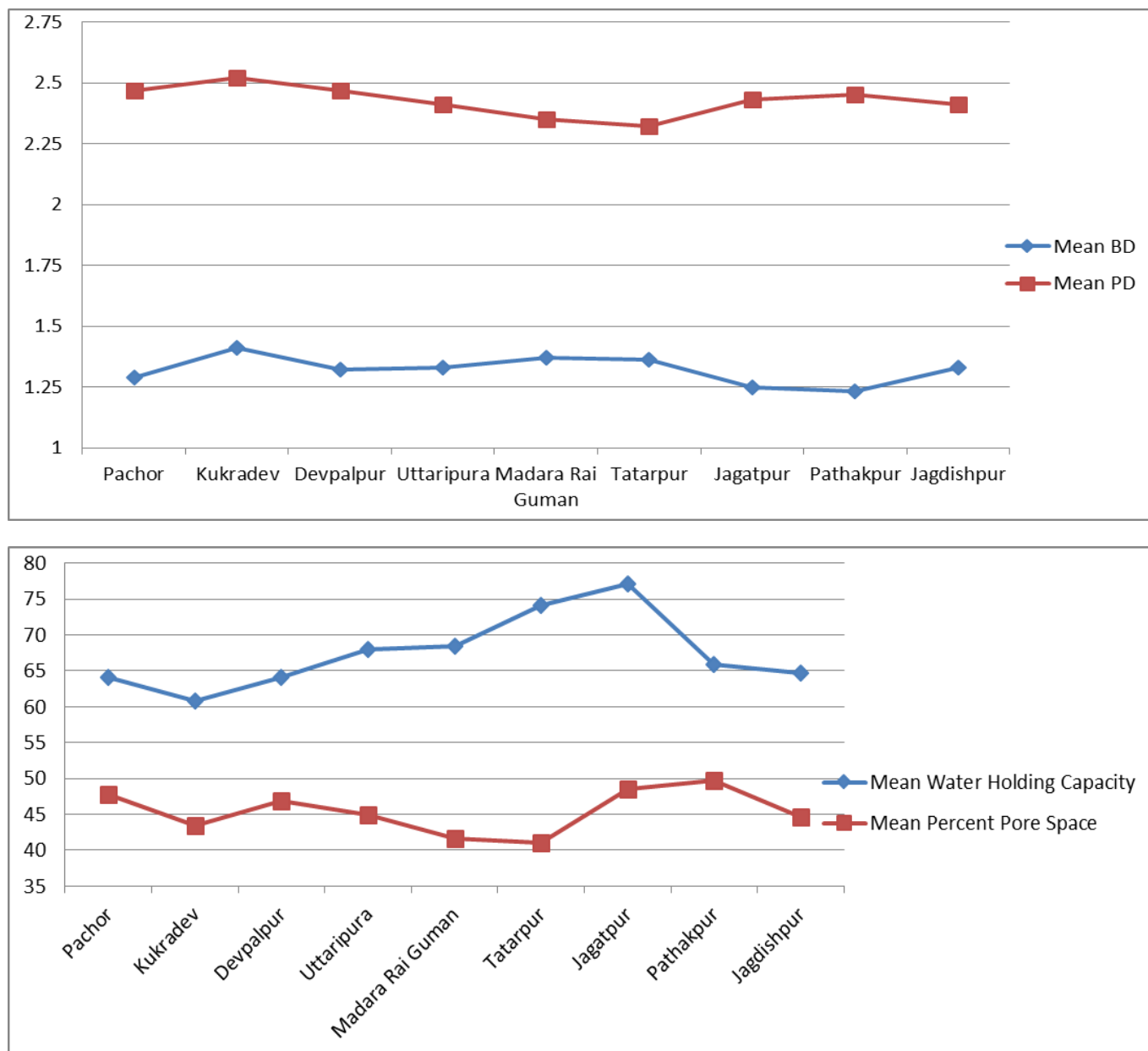


Fig 2: Show the mean BD, PD, Water Holding Capacity and Percent Pore space of different villages

B. Chemical properties

Soil reaction

Soil pH (1:2) of Kanpur Nagar district of different villages was found to be varied from 7.03 to 9.75 i.e. neutral to alkali in nature. The soil pH was increased with depth. The range of pH with different depth-wise of villages are given in Table 4. The low pH value is due to low level of organic matter and the reduction in the pH value is due to productions of acids by bacterial action in nitrification processes in the soil. A similar result has been identified by Kiran *et al.*, (2012) [13].

Electrical Conductivity (dS m⁻¹)

EC (1:2) of surface soil samples of the study area was found to be less than 1dS m⁻¹(Table 4). The EC range varied from 0.07 to 0.35. Hence, all the soils under the study area are safe

for all types of crop production w.r.t. the soluble salt content. The low EC may be due to a good drainage conditions which favored the removal of released bases by percolating. Similar analysis has been recorded by Rathi *et al.*, (2018) [23] and Singaravel *et al.*, (2000) [26].

Organic Carbon (%)

The soil organic carbon percentage of various farmer’s field and depths which was found to be significant. The Organic Carbon percentages ranged from 0.10% to 0.49% are mentioned in table 4. The soil organic carbon content decreased with increased in soil depth and this is due to the addition of plant residues and FYM to surface soil than in the sub-surface soil. Similar results have been reported by Gautam *et al.*, (2018) [9].

Table 4: Soil pH, EC and OC % at different depths (cm) of villages from different blocks of Kanpur Nagar district, Uttar Pradesh

Blocks	Villages	pH (1:2)			EC (1:2) (dS m ⁻¹)			OC (%)		
		0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Chaubepur	Pachor	7.03	7.08	7.24	0.18	0.13	0.10	0.24	0.21	0.18
	Kukradev	7.50	8.77	9.16	0.25	0.20	0.15	0.43	0.18	0.13
	Devpalpur	8.52	8.60	8.67	0.15	0.10	0.08	0.28	0.16	0.10
Bilhaur	Uttaripura	7.72	7.76	7.90	0.30	0.20	0.15	0.33	0.22	0.18
	Madara Rai Guman	7.86	9.23	9.75	0.35	0.30	0.15	0.40	0.19	0.16
	Tatarpur	8.31	8.43	8.72	0.20	0.15	0.10	0.34	0.16	0.13
Shivrajpur	Jagatpur	7.45	7.80	7.91	0.15	0.13	0.10	0.49	0.36	0.21
	Pathakpur	7.80	8.17	8.27	0.13	0.10	0.08	0.19	0.16	0.13
	Jagdishpur	7.75	7.87	7.89	0.15	0.11	0.07	0.22	0.19	0.16

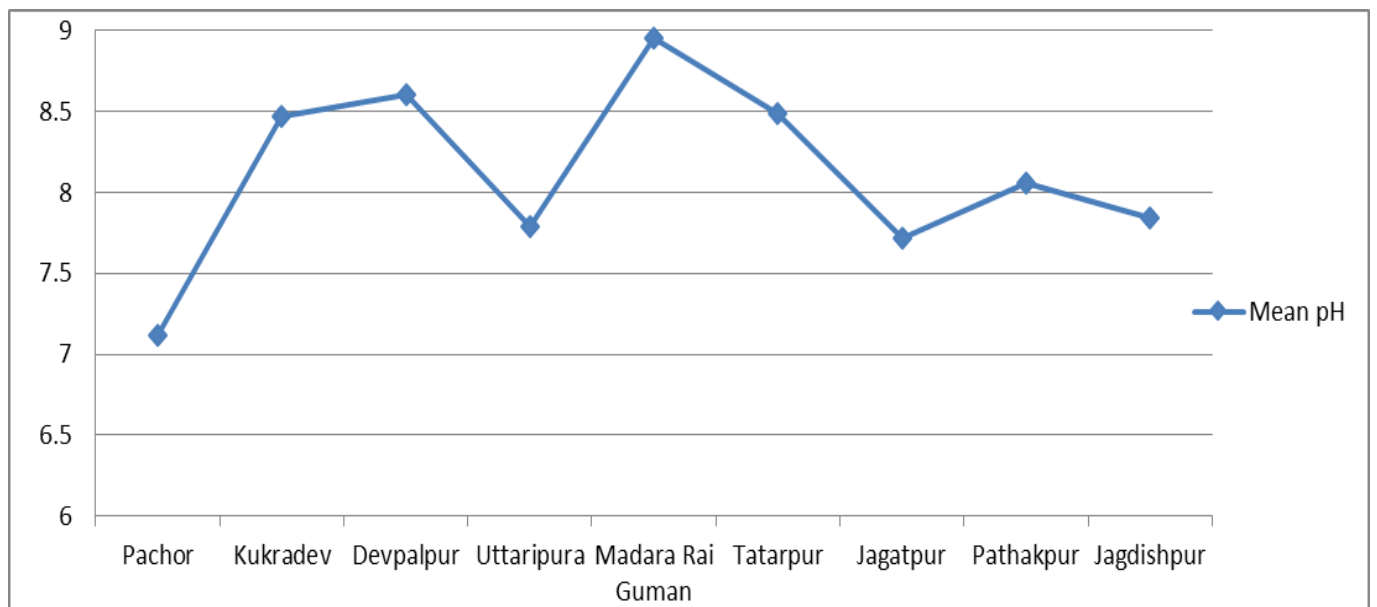
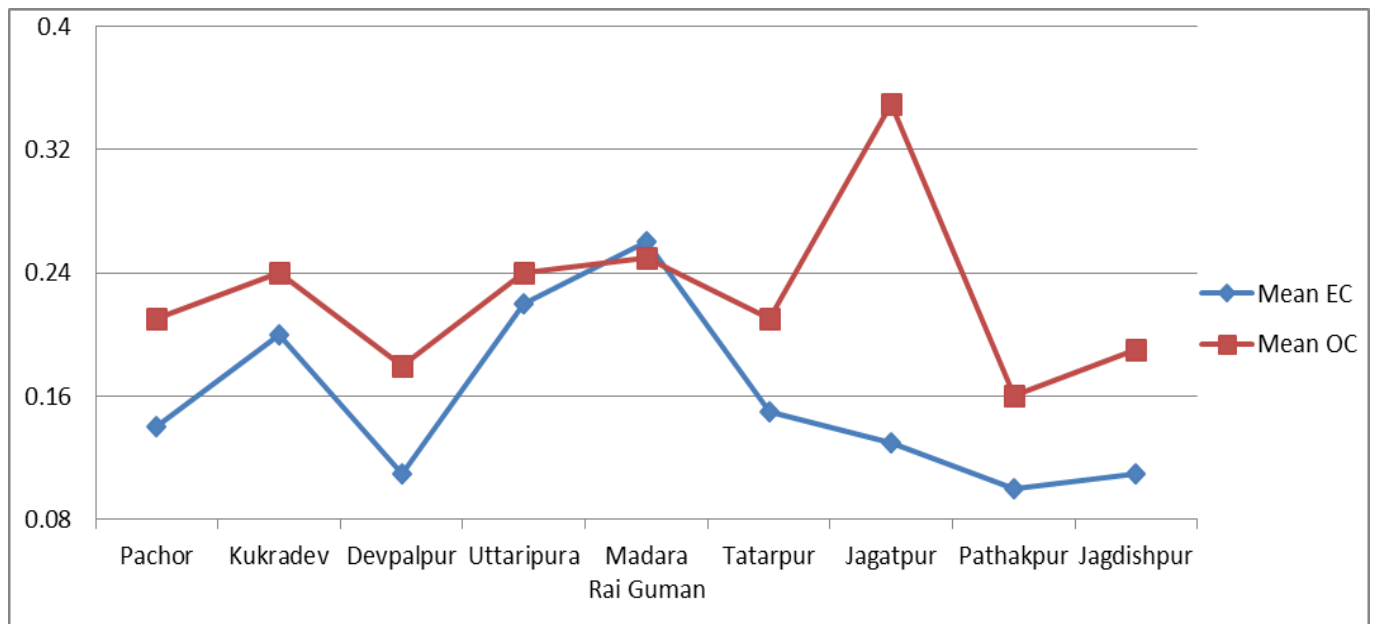


Fig 3: Show the mean EC, OC and pH of different villages

Available Nitrogen in soil (kg ha⁻¹)

The available nitrogen content of soil samples varied from 96.30 to 234.68 kg ha⁻¹ is mentioned in table 5. Based on the permissible limits suggested by Jaiswal (2014) [11], the soil samples of the villages were found to be low in nitrogen content. The available nitrogen decreased with the increased in soil depth. Similar finding analysis has been noticed earlier by Bhavya *et al.*, (2018) [11].

Available Phosphorus in soil (kg ha⁻¹)

The available P in soils ranged from 3.18 to 21.82 kg ha⁻¹ in different soil depth and farmer fields are mentioned in table 5. Based on the interpreted limit suggested by Jaiswal (2014) [11], the available phosphorus status was found to be very low to low in content which enables the soil for higher crop production. However, the highest phosphorus content was noticed in the surface horizon and decreased with soil depth.

Similar result analysis has been identified by Kumar *et al.*, (2013)^[16].

Available Potassium in soil (kg ha⁻¹)

The available K in soils range from 48.23 to 265.78 kg ha⁻¹ are mentioned in table 5. The amount of available potassium

status in the entire study area was found to be low to medium at three different depths. The highest available of K content was observed in the surface horizons and showed a less decreasing trend with depth. Similar finding analysis has been observed by Khanday *et al.*, (2018)^[12].

Table 5: Available N-P-K (kg ha⁻¹) at different depths (cm) of villages from different blocks of Kanpur Nagar district, Uttar Pradesh

Blocks	Villages	N (kg ha ⁻¹)			P (kg ha ⁻¹)			K (kg ha ⁻¹)		
		0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Chaubepur	Pachor	221.27	208.54	188.96	16.88	14.56	9.62	98.33	80.83	53.89
	Kukradev	234.68	213.71	192.81	21.82	14.95	8.89	109.05	96.71	48.23
	Devpalpur	224.64	206.10	172.82	9.58	6.78	3.18	94.30	81.27	67.36
Bilhour	Uttaripura	188.16	164.50	110.08	19.28	16.35	10.20	170.00	163.36	140.10
	Madara Rai Guman	154.86	135.57	104.80	4.15	1.11	0.20	142.26	128.57	103.66
	Tatarpur	148.12	126.42	96.30	7.58	2.48	0.74	131.42	117.69	97.81
Shivrajpur	Jagatpur	216.43	192.13	163.70	21.82	19.25	13.84	170.70	134.72	121.25
	Pathakpur	197.36	154.20	130.50	17.87	12.36	6.78	242.50	202.09	182.21
	Jagdishpur	188.16	172.00	154.50	15.09	11.25	8.65	265.78	245.50	232.09

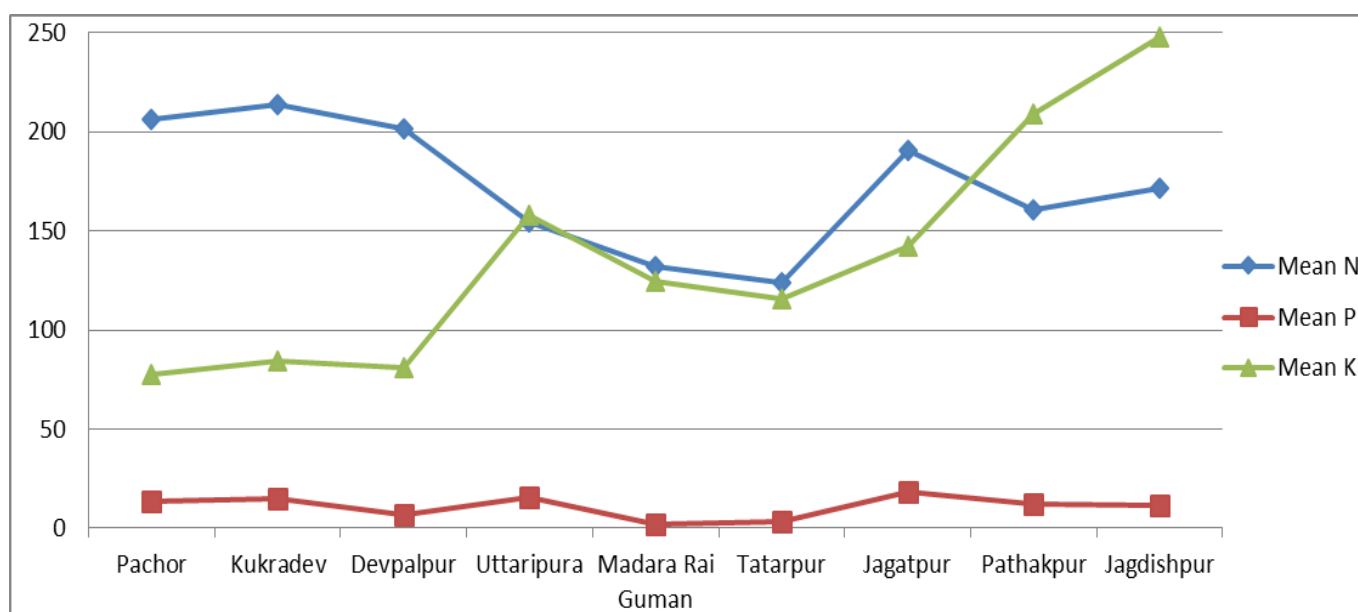


Fig 4: Show the mean N, P and K of different villages

Exchangeable Ca and Mg [cmol (p⁺) kg⁻¹]

The exchangeable Ca and Mg of soils ranged from 0.70 to 2.90 [cmol (p⁺) kg⁻¹] and 0.20 to 2.20 [cmol (p⁺) kg⁻¹] are mentioned in table 6. It signifies that a moderate amount of Ca present on the surface soil. The available Ca is more in surface horizon than sub-surface horizons. The amount of Mg found in low range due to the rainfall. The amount of Mg content decreased with increased in depth. Similar result analyses have been noticed by Ndah, *et al.*, (2020) and

Ololade, I.A. (2010)^[20].

Available Sulphur (ppm)

The available sulphur in soils of various farmers' field and depths which was found to be a significant. The available S in soils found to be ranged from 2.10 to 9.35 ppm is mentioned in table 6. The range signifies that sulphur is deficient in the soil. Similar result findings have also been reported by Kour and Jalali (2008)^[14] and Chaitra *et al.*, (2019).

Table 6: Exchangeable Ca and Mg [cmol (p⁺) kg⁻¹] and S (ppm) at different depths (cm) of villages from different blocks of Kanpur Nagar district, Uttar Pradesh

Blocks	Villages	Exchangeable Ca [cmol (p ⁺) kg ⁻¹]			Exchangeable Mg [cmol (p ⁺) kg ⁻¹]			Sulphur (ppm)		
		0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Chaubepur	Pachor	2.50	2.32	1.98	2.20	1.80	1.42	7.65	6.42	5.23
	Kukradev	2.90	2.63	2.02	2.10	1.15	0.92	6.33	5.82	4.61
	Devpalpur	1.70	1.40	1.30	1.30	1.10	0.85	9.35	7.80	5.86
Bilhour	Uttaripura	1.80	1.50	1.30	1.20	0.90	0.82	8.75	7.63	6.84
	Madara Rai Guman	1.80	1.20	0.70	0.39	0.25	0.21	4.73	3.58	2.10
	Tatarpur	1.65	1.30	0.95	0.26	0.20	0.20	5.64	4.81	2.33
Shivrajpur	Jagatpur	1.60	1.39	1.24	1.21	1.06	0.84	7.89	6.51	5.43
	Pathakpur	1.45	1.30	0.80	1.30	1.02	0.80	5.35	4.31	3.38
	Jagdishpur	1.61	1.24	0.72	1.10	0.72	0.56	5.89	5.13	3.50

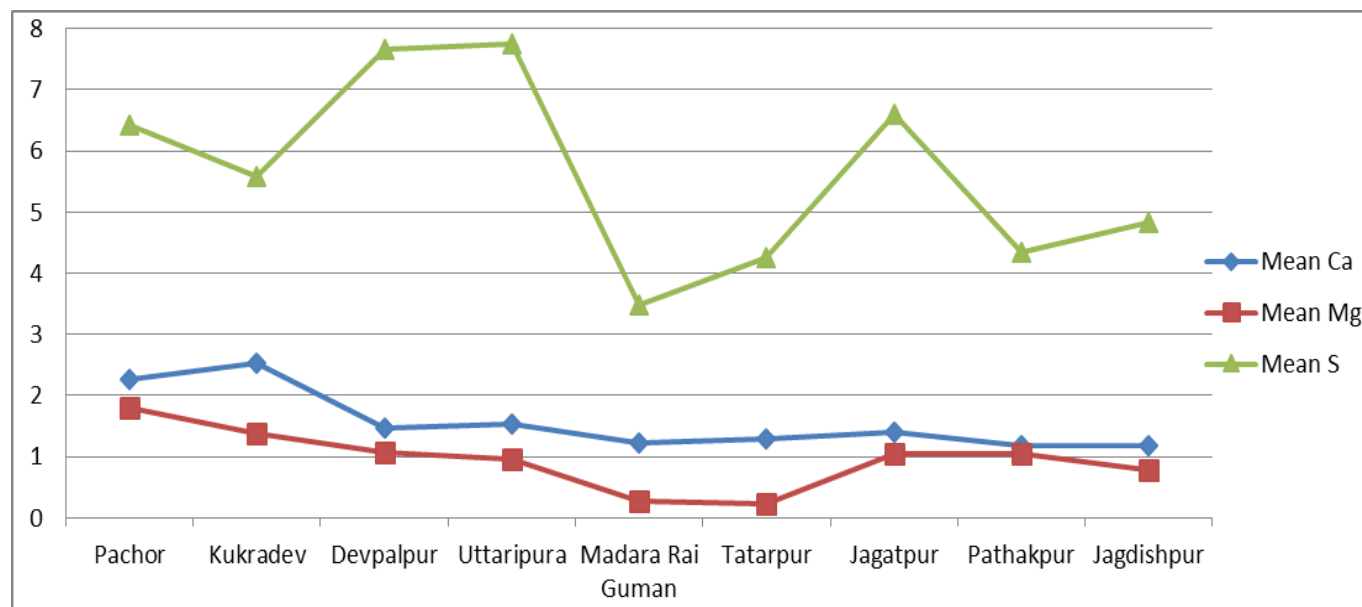


Fig 5: Show the mean Ca, Mg and S of different villages

Conclusion

It was concluded that soil of district Kanpur Nagar, Uttar Pradesh has an appreciated soil health for farmer's crop cultivation. Soil texture showed a sandy loam soil. Soil has pH neutral to alkaline in nature. Electrical Conductivity was found normal in condition. Sulphur was found deficient with an increasing to decreasing in trends. In the upper top most layers of the soil Calcium and Magnesium content were found sufficient in position. The soil has a low level of Organic Carbon, Nitrogen, and soil has Potassium and Phosphorus, medium and very low to low conditions were found in an experimental sites. These studies give information about the nature and present nutrients in soil. Based on this analysis of soil from Kanpur Nagar district of Uttar Pradesh a nutrient addition through organic (FYM) and inorganic sources are essential to maintain the soil fertility in the entire region of the farmer's field.

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Conflict of Interest

As a corresponding Author, I Anshul Saxena, confirm that none of others have any conflicts of interest associated with this publication.

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