Evaluating the physical and chemical characteristics of soil from several blocks in Mirzapur District, Uttar Pradesh, India

ABSTRACT

An evaluation of the physical-chemical characteristics of soil was conducted in 2023–24 in several blocks within the Mirzapur district of Uttar Pradesh. This study's main goals were to assess the physico-chemical characteristics of soil in several blocks in Uttar Pradesh's Mirzapur District in order to ascertain the soil's macronutrient availability. Samples of soil were taken at three different depths: 0–15 cm, 15–30 cm, and 30-45 cm. Sandy loam was the textural class of soil. 1.17 mg m-3 to 1.44 mg m-3 is the bulk density. Density of Particles (2.22 - 2.48 mg m-3). Pore Space Percentage (42.78% to 48.00%). It was evident that the soil had good physical conditions, an alkaline pH range of 7.43 to 8.15, a good water holding capacity (39.92 to 45.76%), and and all crops could benefit from the electrical conductivity (0.21 to 0.34 dSm-1). Organic carbon content in these soils is modest (0.27 to 0.38%). All villages have a medium nitrogen range (250 kg ha-1 to 380 kg ha-1). All villages have a medium phosphorus level (22.53 kg ha-1 to 37.49 kg ha1). (148.43 kg ha-1 to 282.4 kg ha-1) of potassium. is high in one place and medium in eight others.

.

Keywords: Mirzapur District, , Mirzapur, Block, Physico-chemical Properties, Soil Health, Uttar Pradesh

INTRODUCTION

Physical attributes of the soil primarily dictate its potential for agricultural use. The soil's ability to support life, move, hold, and make water and nutrients available to plants, assist root penetration, and permit the passage of heat and air are all directly correlated with its physical properties. Physical characteristics also have an effect on chemical and biological properties. an account of the physical properties of soils and their importance for water and nutrient transport, as well as the development of vegetation cover. **(Phogat *et al.*, (2015).** Numerous life forms depend on soil, which is also an essential medium for plant growth. "Soil is a natural independent body which, like any other natural body or organism, has a specific origin, history of development, and external appearance" is the broad definition that is still relevant today. **(Hartemink *et al.*, 2016**). The process of soil development can be both beneficial and detrimental. Broken rock fragments that have undergone chemical and mechanical changes due to weathering and erosion make up soil. The many functions of soil are advantageous to humans and other living things. A collection of mineral particles does not constitute soil. It has various other components as well as a biological system of living things. The development of soil is greatly influenced by the climate and other factors. (**Tale and Ingole,2015**) Soil science, often known as pedology (pedo meaning soil; logy meaning to study), is the study of soil. Edaphology is another name for this field of study (Edaphos meaning Soil). Another definition of soil is the portion of the earth's crust that contains humus, or the organic portion. (**Das, 2021).**

MATERIALS AND METHODS

Sampling site and collection

The coordinates of Mirzapur are 25.15°N 82.58°E. It is located at an average elevation of 265 feet, or 80 meters. The Mirzapur District is located between the longitudes of 82.7 and 83.33 east and the latitudes of 23.52 and 25.32 north. It is a part of the district of Varanasi. It is bordered by the districts of Varanasi to the north and northeast, Sonbhadra to the south, and Allahabad to the north-west. The north and west have completely regular shapes. Mirzapur has no natural boundaries, with the exception of a 13-kilometer stretch in the northeast where the Ganges divides the Tehsil of Chunar from the Varanasi district. The district of Mirzapur is located in southeast Uttar Pradesh. The district, which has a population of around 20 lac people and an area of 4521 km2, is split into four sub divisions: 12 blocks and 973 gramsabhas, which contain 1698 villages. In terms of agroclimatology, the district is divided into two zones: the Vindhyan Zone encompasses the remaining territory, while the Indo-Gangetic Plains make up just 30–40% of the overall area. While the Vindhyan Zone has limited water resources and primarily degraded land, the Gangetic Plains region is blessed with rich alluvial and lush soil as well as excellent irrigation infrastructure.

Three separate blocks in the Uttar Pradesh district of Mirzapur provided soil samples. Samples were taken at depths of 0–15, 15–30, and 30-45 cm using a composite sampling approach using a soil auger at random. Only a half-kg sample was taken for the soil analysis using the conning and quartering method after all the samples were divided into four parts and two samples were collected from each of the portions.

Table 1. The methods of analysis for different soil parameters

S. No.	Particulars	Scientist Name	Methods	Unit
		PHYSICAL PROPERTIES		
1.	bulk Density	Muthuvel *et al.* (1992)	graduated Measuring cylinder	Mg m^{-3}
2.	Particle density	Muthuvel *et al.* (1992)	Graduated measuring cylinder	Mg m^{-3}
3.	Textural class (Sand, Slit, Clay)	Bouyoucos (1927)	Bouyoucos hydrometer	Percentage (%)
4.	Pore space	Muthuvel *et al.* (1992)	Graduated measuring cylinder	Percentage (%)
5.	WHC	Muthuvel *et al.* (1992)	Graduated measuring cylinder	Percentage (%)
		CHEMICAL PROPERTIES		
1.	pH (1:2.5)	Jackson (1958)	Digital pH meter	
2.	Ec (1:2.5)	Wilcox (1950)	Digital conductivity meter	ds m^{-1}
3.	Oc	Walkley and Black (1947)	Wet oxidation method	Percentage (%)
4.	nitrogen	Subbiah and Asija (1956)	Soil alkaline permanganate method	Kg ha^{-1}
5.	Phosphorus	Olsen *et al.* (1954)	Photometric colorimeter method	Kg ha^{-1}
6.	potassium	Toth and Prince (1949)	Flame photometric method	Kg ha^{-1}

RESULTS AND DISCUSSION

Physical Properties

The soil textural classification in the Mirzapur block's several villages. All of the villages' soil sample textures were classified as sandy loam.

4.1. Soil Bulk Density (Mg m^{-3})

A soil's bulk density might vary from 1.17 to 1.48 mg m-3. The highest reported bulk density, 1.48 (Mg m-3), was found in V6 - Indi Parwatpur, while the lowest reported bulk density, 1.17 (Mg m-3), was found in V3 - Amirati. Significant findings were noted by **(Ghosh *et al.*, 2021).**

4.2. Particle Density (Mg m^{-3})

The density of soil particles varies from 2.22 to 2.55 mg m-3. The maximum particle density, 2.55 (Mg m-3), was reported for V1 - Aksauli, while the lowest particle density, 2.22 (Mg m-3), was discovered in V3 - Amirati. Comparable outcomes were stated by **(Ghosh *et al.*, 2021)**

4.3. Porespace (%)

A soil sample's soil porosity falls between 40.61 to 48.00%. V6 - Indi Parwatpur reported the lowest porosity of 40.61%, while V1 - Aksauli reported the maximum porosity of 48.00%. Notable outcomes were noted by (**Ghosh *et al.*, 2021)**

4.4. WHC (%)

The range of soil water-holding capacities is 39.37–45.17%. The V6 - Indi Parwatpur had the lowest water holding capacity, measuring 39.37%, while the V1 - Aksauli had the highest capacity, measuring 45.17%. Comparable outcomes were stated by**(Ghosh *et al.*, 2021).**

Table 2. Soil physical properties

	Bulk density(Mg m^{-3})			Particle density(Mg m^{-3})			Pore space(%)			Water holding capacity(%)		
	0-15 cm	15-30 cm	15-45 cm	0-15 cm	15-30 cm	15-45 cm	0-15 cm	15-30 cm	15-45 cm	0-15 cm	15-30 cm	15-45 cm
V_1	1.29	1.31	1.35	2.48	2.52	2.55	48.00	47.82	46.45	45.17	43.19	41.78
V_2	1.31	1.33	1.35	2.32	2.35	2.38	43.51	43.00	42.80	42.76	40.78	39.37
V_3	1.17	1.25	1.29	2.22	2.25	2.27	47.33	44.50	42.70	44.19	42.81	40.18
V_4	1.34	1.39	1.44	2.42	2.47	2.50	44.63	43.74	42.36	43.39	41.78	40.17
V_5	1.30	1.35	1.39	2.44	2.48	2.52	46.74	45.54	44.85	44.15	42.03	40.35
V_6	1.44	1.48	1.48	2.41	2.44	2.44	42.78	40.61	40.61	40.18	39.37	39.37
V_7	1.25	1.29	1.33	2.29	2.33	2.35	45.62	44.64	43.37	43.07	41.35	39.75
V_8	1.29	1.33	1.36	2.35	2.38	2.40	45.09	44.11	43.26	43.31	41.17	49.17
V_9	1.31	1.35	1.42	2.45	2.46	2.50	46.52	45.03	43.18	44.13	42.30	40.39
f- test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
S.Em. (±)	**0.023**	**0.020**	**0.020**	**0.037**	**0.382**	**0.323**	**0.656**	**0.767**	**0.645**	**0.610**	**0.610**	**0.683**
c. d. @ 5 %	**0.070**	**0.061**	**0.060**	**0.118**	**0.113**	**0.096**	**1.949**	**2.280**	**1.919**	**1.814**	**1.813**	**2.030**

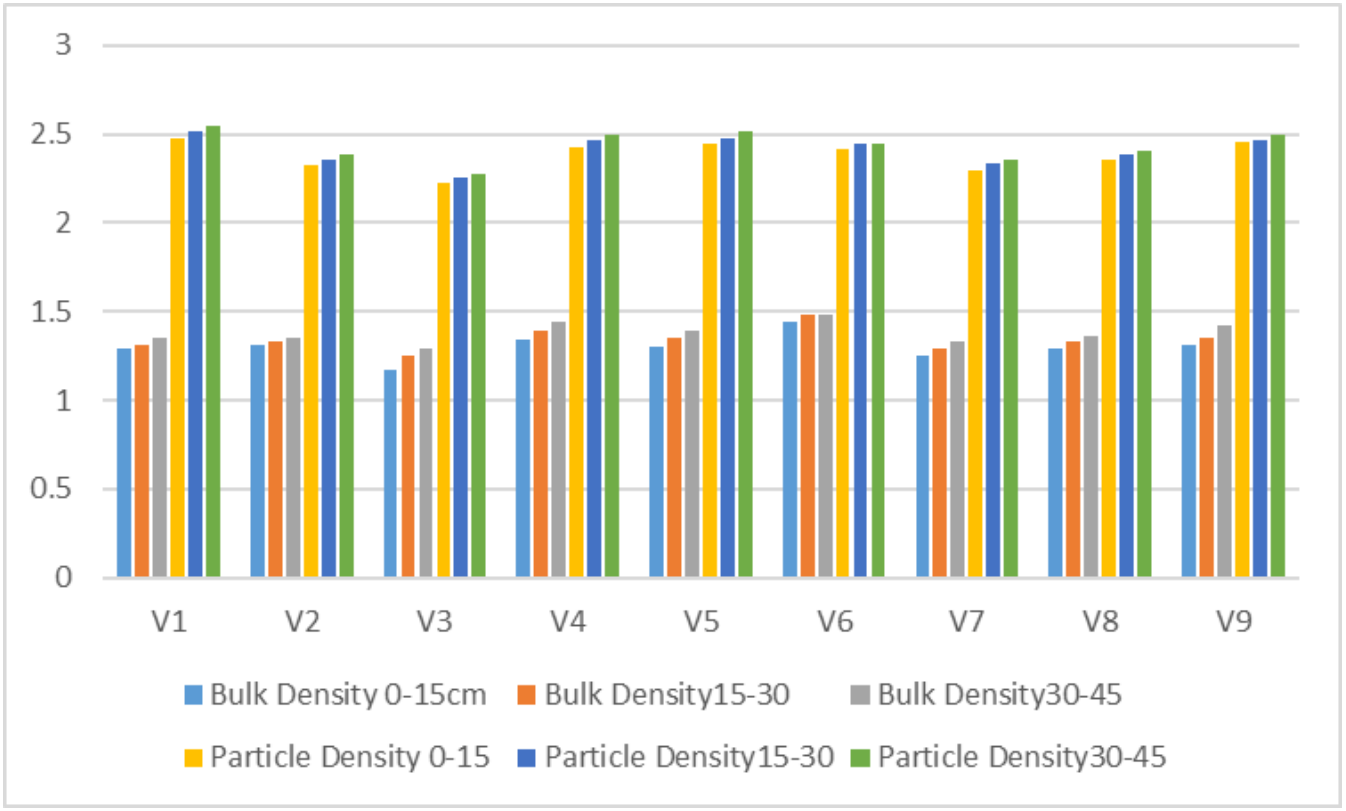

Fig. 1. Bulk density and particle density (Mg m^{-3})

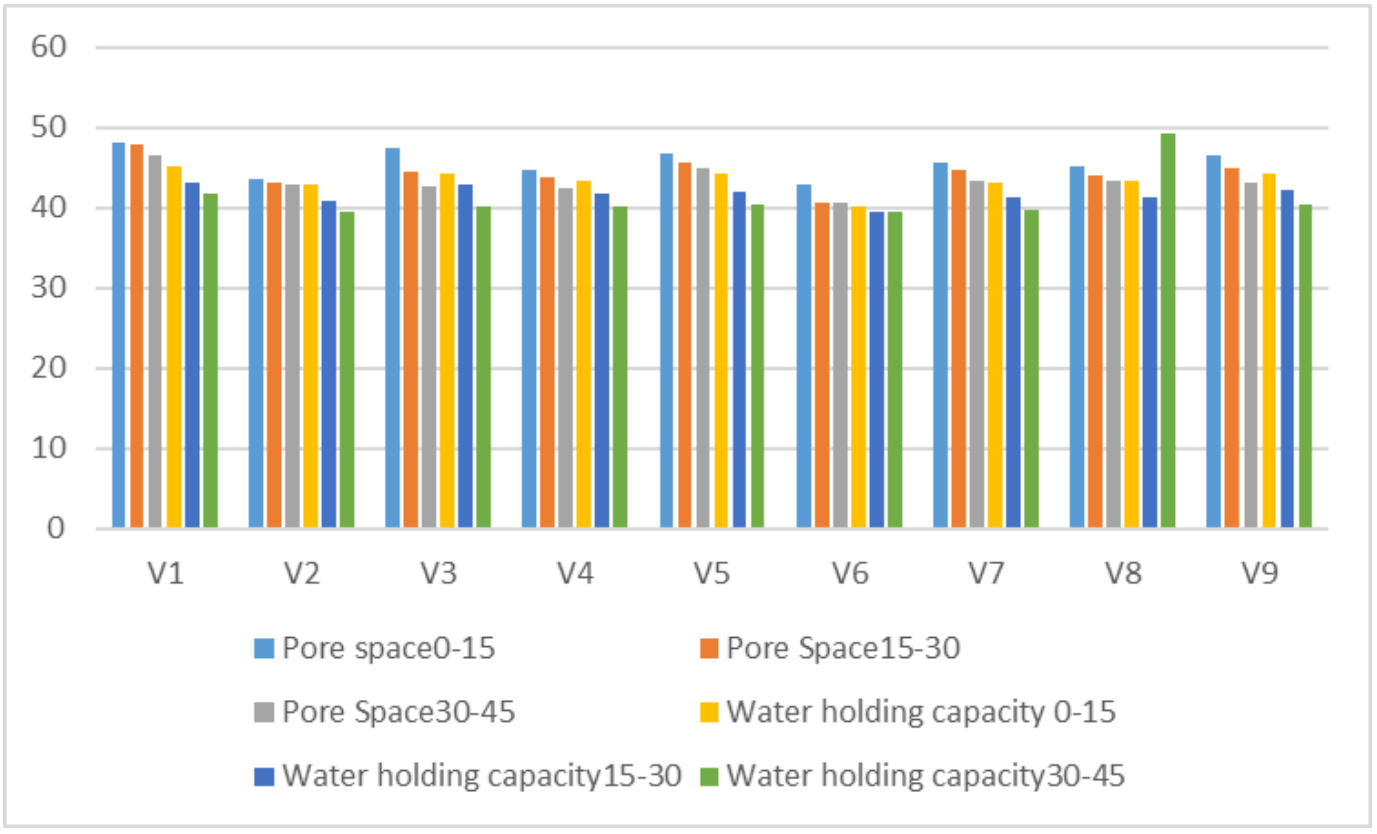

Fig. 2. Pore space and Water holding capacity (%)

Soil Chemical Properties

4.5. Soil pH

A soil sample's pH falls between 7.43 to 8.20. The pH value of 8.20 was recorded in the V8 - Leduki. At 7.43, the pH was lowest in V2-Dewahi. The pH is naturally alkaline, according to the data. The pH is important and suitable given the availability of nutrients. Similar noteworthy outcomes were published by **(Ghosh *et al.*, 2021).**

4.6. Soil EC (dS m^{-1})

The range of EC in soil samples was 0.21–0.39 dS m–1. The findings were judged to be noteworthy. The highest recorded EC value, 0.39 dS m-1, was found in V9 - Sirsi, while the lowest EC content, 0.21 dS m-1, was found in V3 - Amirati. Comparable outcomes were stated by **(Ghosh *et al.*, 2021).**

4.7 Soil Organic Carbon (%)

Samples of soil with organic carbon have values between 0.21 and 0.38 percent. Significance was determined by the results. Dewahi had the highest recorded organic carbon content (0.38%), while Amirati (0.21%) had the lowest. Due to the minimal amount of vegetation used as waste and the rapid block-wide degradation brought on by the tropical climate, the amount of organic carbon is low. Comparable outcomes were noted by **(Ghosh *et al.*, 2021).**

Table 3. Variation in Soil pH, electric conductivity and organic carbon

S. No.	Soil pH			Soil EC (dS m^{-1})			Soil Organic Carbon (%)		
	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45
V_1	7.45	7.50	7.88	0.24	0.28	0.31	0.34	0.30	0.28
V_2	7.43	7.63	7.76	0.26	0.29	0.32	0.38	0.36	0.33
V_3	7.83	7.95	7.95	0.21	0.24	0.26	0.27	0.25	0.22
V_4	8.03	8.15	8.19	0.33	0.35	0.37	0.28	0.26	0.21
V_5	8.06	8.10	8.12	0.33	0.37	0.39	0.29	0.27	0.24
V_6	8.07	8.13	8.16	0.31	0.35	0.35	0.32	0.30	0.28
V_7	8.04	8.10	8.12	0.34	0.35	0.37	0.38	0.36	0.32
V_8	8.15	8.18	8.20	0.22	0.25	0.27	0.33	0.30	0.27
V_9	8.10	8.15	8.15	0.33	0.35	0.39	0.31	0.27	0.24
f- test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
S.Em.	**0.134**	**0.108**	**0.083**	**0.006**	**0.004**	**0.004**	**0.002**	**0.004**	**0.004**
c. d. @ 5 %	**0.399**	**0.322**	**0.234**	**0.018**	**0.014**	**0.14**	**0.008**	**0.013**	**0.012**

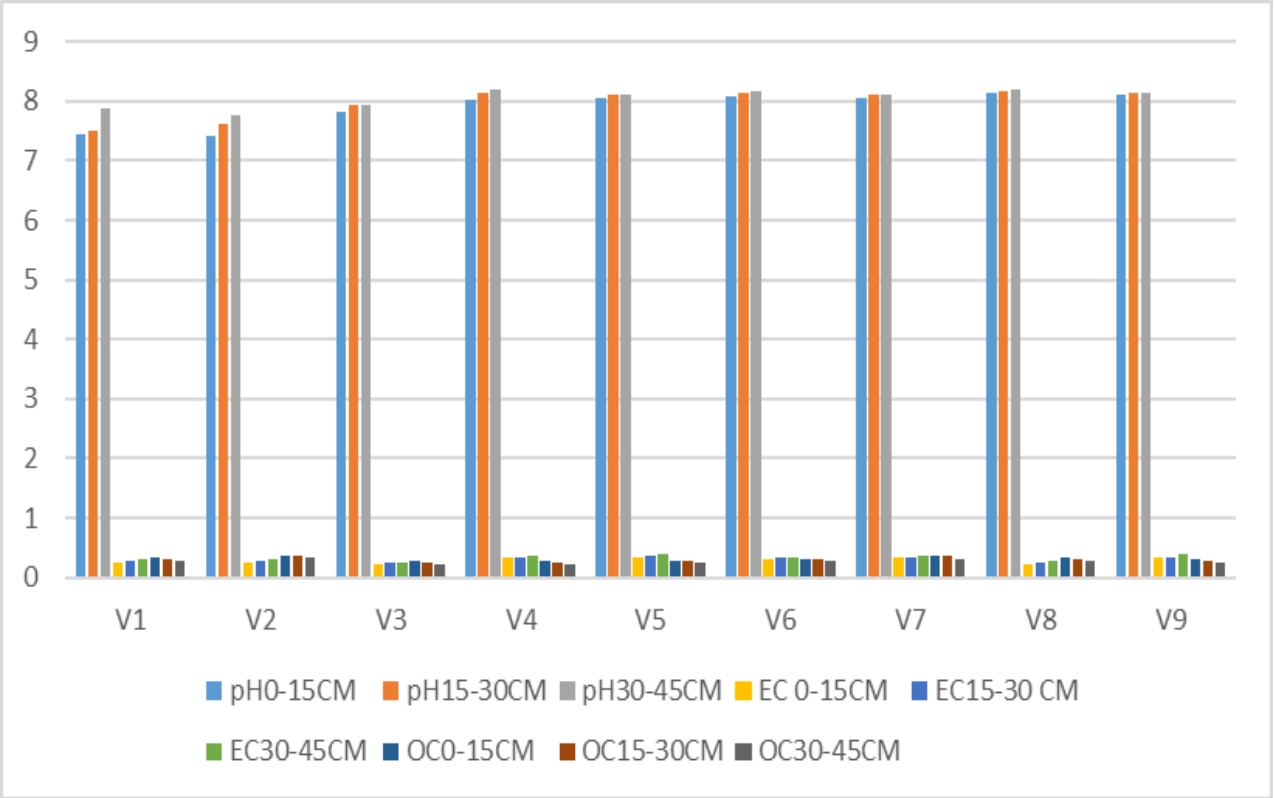

Fig. 3. pH, EC and Organic Carbon

4.8. Soil Nitrogen (kg ha^{-1})

A soil sample's nitrogen concentration varies from 160 to 380 kg ha-1. The findings were judged to be noteworthy. The soil at V5 - Birshahpur had the highest nitrogen level, measuring 380 kg ha-1, whereas V1 - Aksauli had the lowest nitrogen content, measuring 160 kg ha-1. Comparable outcomes were noted. **(Ghosh *et al.*, 2021).**

4.9. Soil Phosphorus (kg ha^{-1})

The range of phosphorus in soil sample was 22.53 – 37.49 kg ha-1. The findings were judged to be noteworthy. V9-Ghori had the highest recorded phosphorus level, measuring 37.49 kg ha-1, while V4-Bhuili had the lowest, measuring 22.53 kg ha-1. Notable outcomes were noted by**(Ghosh *et al.*, 2021).**

4.10. Soil Potassium (kg ha^{-1})

The soil samples' potassium contents range from 105.54 to 282.4 kg ha-1. The findings were judged to be noteworthy. The potassium level of V6 - Indi parwatpur was found to be the highest at 282.4 kg ha-1, whereas V8 - Leduki had the lowest potassium content at 105.54 kg ha-1. Comparable outcomes were noted by **(Ghosh *et al.*, 2021).**

Table 4: Available nitrogen, phosphorous and potassium (kg ha-1)

S. No.	Nitrogen			Phosphorus			Potassium		
	0-15 cm	15-30 cm	15-45 cm	0-15 cm	15-30 cm	15-45 cm	0-15 cm	15-30 cm	15-45 cm
V_1	250	205	160	26.22	25.50	24.96	200	180.47	150.32
V_2	344	285	200	24.22	23.33	22.82	156.8	148.32	122.22
V_3	297	232	170	25.95	24.82	24.23	190.4	172.25	140.22
V_4	338	265	195	24.45	23.08	22.53	170	150.45	125.25
V_5	380	320	275	26.76	25.79	24.70	244	222.44	180.44
V_6	350	280	220	26.60	25.64	24.89	282.4	260.22	220
V_7	275	220	160	35.75	34.88	34.33	156.8	140.56	110.55
V_8	280	250	190	36.71	35.20	34.59	148.43	130.44	105.54
V_9	290	210	140	37.49	34.44	32.44	222	185.55	135.52
F- test	**s**	**s**	**s**	**s**	**s**	**s**	**s**	**s**	**s**
S.Em. (±)	**5.295**	**2.823**	**2.622**	**0.403**	**0.401**	**0.534**	**3.540**	**2.743**	**2.082**
C. D. @ 5 %	**15.732**	**8.388**	**7.792**	**1.198**	**1.193**	**1.587**	**10.519**	**8.151**	**6.186**

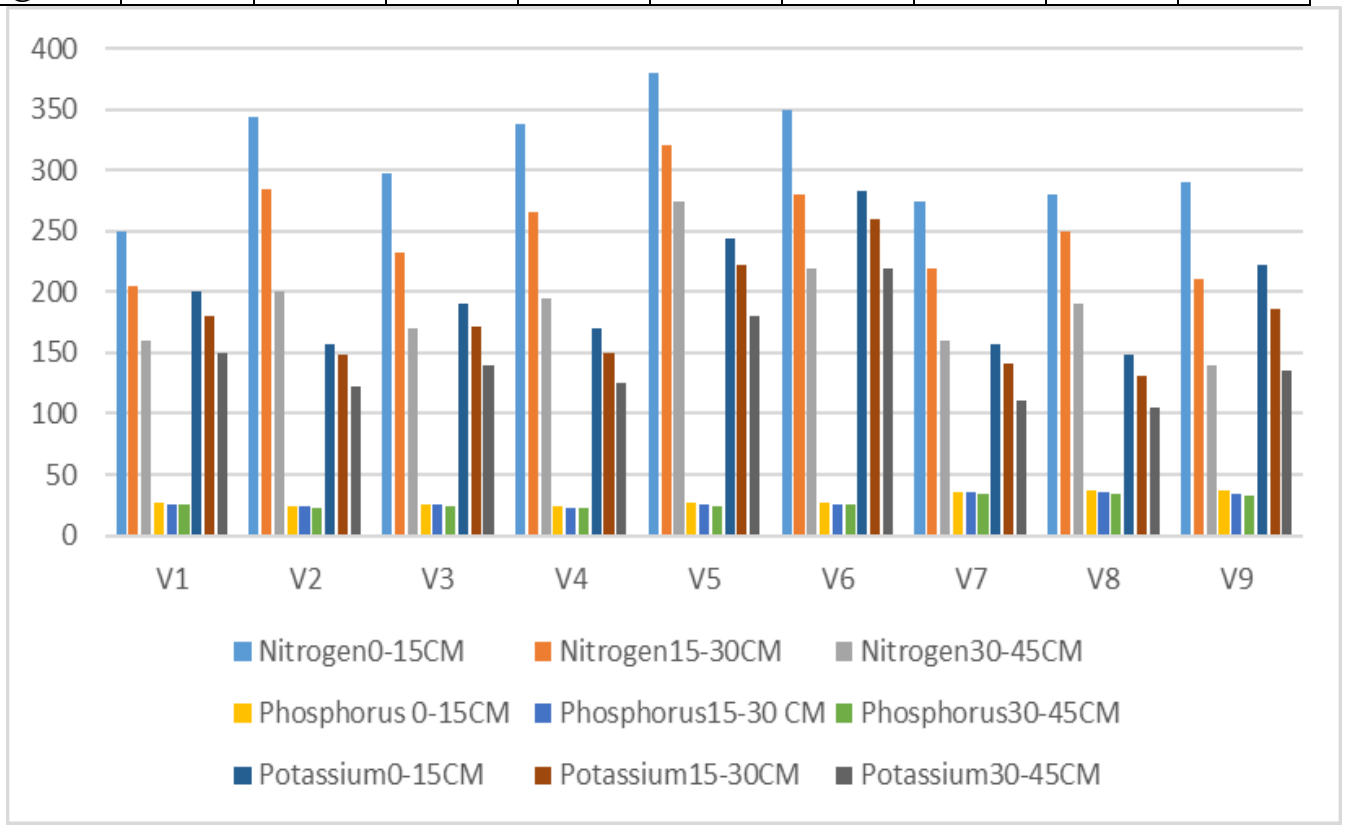

Fig. 4. Graphical presentation of Available nitrogen, phosphorous and potassium (kg ha-1)

CONCLUSION

We may conclude that most crops, especially rice and wheat, can be grown in the Mirzapur block of Uttar Pradesh because the soils there are in a reasonably excellent physical state. All of the communities had medium-nitrogen soils, low levels of organic carbon, high percentages of sand in the soil, an alkaline pH, and electrical conductivity that was appropriate for all crops. In every community, the phosphorus concentration was determined to be moderate. In every community, the potassium concentration ranged from modest to high. The application of certain inorganic or organic fertilizers can help to lessen the lack of nutrients. It is possible to employ tolerant cultivars and implement integrated nutrient management.

ACKNOWLEDGEMENT

I would like to express my sincere thanks to my Advisor Prof. (Dr.) Tarence Thomas , Head and Professor, Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, SHUATS, Prayagraj, for his diligent guidance and constructive suggestions at every step during my work. I thank him for his creative follow-up and valuable suggestions for improving the quality of this work. I also extend my gratitude to all the teaching and non- teaching staff of our department because without them I would not be able to complete my work.

REFERENCES

1. **Anonymous**. Munsell colour chart. Munsell colour company inc. 2241 N. calveri street, Baltimore, Marytanel 21212, USA; 1971.

Bouyoucos, G.J. (1927) The hydrometer as new method of mechanical analysis of soil. *Soil Science*.23:343-353.

Das, R., Kumar , M., Singh, S. K., Jha, S., and. Sahoo, S. (2021). Soil Physico-chemical properties as affected by Longterm Application of Organic and Inorganic NPK Fertilisers under Rice-wheat Cropping System in Calcareous Soil of Bihar. International Journal of Environment and Climate Change, 100-107

Ghosh, A. K., Yadav, S., Singh, P., & Thakur, A. (2021). Characterization and Fertility Assessment of Soils of Mirzapur District of Eastern Uttar Pradesh for Sustainable Land Use Planning. *Journal of the Indian Society of Soil Science*, *69*(4), 347-353

Hartemink, A. E., McBratney, A. B. and Mendonça-Santos, M. L. (2016) Digital soil mapping. In Soil mapping and process modeling for sustainable land use management (3- 11). Springer, Cham

Jackson. M. L. (1958). Soil Chemical Analysis. *Prentice Hall, Inc. Englewood.cliffe.N.J.*
Joffe, J. S. (1949). Pedology (Vol. 68, No. 4, p. 346). LWW.

John, M. S, Mohammad, Y., Ullahshah, H. and Bat, J. (2010). Soil health. 42(3): 1909-1922.

Olsen. S.R., Cole. C.V., Watanabe. F.S. and Dean. L.A. (1954). Estimation Of Available Phosphorus in Soils by Extraction with Sodium Bicarbonate. *U. S. Department of Agriculture,* Circular No. 939.

Muthuvel P, Udayasoorian C, Natesan R, Ramaswami PR(1992). Introduction to soil analysis. Tamil Nadu Agricultural University Coimbatore; 1992

Phogat, V. K., Tomar, V. S., and Dahiya, R. I. T. A. (2015). Soil physical properties. *Soil science: An introduction*, 135-171.

Tale, K. S., and Ingole, S. (2015). A review on role of physico-chemical properties in soil quality. Chemical Science Review and Letters, 4(13), 57-66.

Toth, S.J and Prince, A.L. (1949) Estimation of Cation Exchange Capacity and Exchangeable Ca, K, Na Content of Soil by Flame Photometer Technique. *Soil Sci*.67, 439-445.

Walkley, A. and Black, (1947) An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Sci., 37:29-38