International Journal of Research in Agronomy 2024; 7(4): 366-372

E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; 7(4): 366-372
Received: 22-01-2024
Accepted: 28-02-2024

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Assessment of physico-chemical properties of soil from different blocks of Katihar district, Bihar

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i4e.590

Abstract
The present research topic entitled "Assessment of Physical Properties of Soil from Different Blocks of Katihar District, Bihar" was carried out at the Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj. Department of Soil Science and Agricultural Chemistry formerly called Naini Agricultural Institute, (U.P.). During the year 2023-2024. The soil samples were collected at three depths: 0-15 cm, 15-30 cm, and 30-45 cm, from nine different villages of three different blocks of Katihar areas, a total of 27 samples collected and analyzed for their physical parameter by using standard Laboratory Technique. The result showed that the Soil Texture of Pranpur, Azamnagar, and Sameli block is Sandy loam. The Bulk Density reported 1.00 -1.42 Mg m^{-3}, Particle Density reported 2.20 to 2.56 Mg m^{-3}, Percent of Pore Space varied 41.08 to 54.08%, Water Retaining Capacity ranged 39.38 to 51.89%. Results suggest that farmers should adopt appropriate soil management techniques, such as crop rotation and conservation tillage, which will contribute to maintain the soil physical characteristics to ensure the sustainability of agricultural practices and the long-term health of the soil.

Keywords: Physical, parameters, Katihar, Bihar

1. Introduction

Soil is the soul of infinity life and is generally refer to the loose material composed of weathered rock and other materials including partly decayed organic matter. It is a reservoir of nutrients and place a pivotal role in supporting the growth of crops and other vegetation maintaining the earth's environment clean. It also acts as a source and sinks for atmospheric gases (Ratan *et al*., 2011) [12]. Soil provides food, fodder and fuel for meeting the basic needs of human and animal, with the growth in human and animal population, demand for more food production is on the Increase. However, the capacity of soil to produce is limited and limits to production are set by Intrinsic characteristics, Agro-ecological setting, use and management. This demands systematic appraisal of soil resources with respect to their extent, distribution, characteristics, behaviors and use potential' which is very important for developing an effective land use system for augmenting agricultural production on sustainable basis **(**FAO, 1993) [3]. Soil testing makes complete nutrient control a possibility; fertilizer experiments are being patterned to determine economically optimum rates of nutrients application high yields with low production costs per unit area must in modern farming. Farmers of today are different in the failure is more certain and sooner unless they are obtaining reasonably high yields, improved drainage, many improved cultural practices, better varieties, and control of insects and disease have helped to set the stage for high yields. As a result, the demand on the soil has gradually increased. Soil testing lets farmers know how much and what kind of fertilizer they must apply to be sure of returns from their investments in other improved practices (Joshi *et al*., 2013) [6]. Soil is formed by the weathering of rocks, and it can take up to 100 years to develop one centimeter of soil. Soil is differentiated into horizons of mineral and organic constituents of variable depth, which differ from the parent material in morphology, physical properties, chemical properties, composition, and biological characteristics. The study of soil's formation, classification, survey, and geological distribution is known as pedology, while the study of soil in relation to higher plants is known as edaphology.

The thin layer on the earth's surface where soils develop is called the pedosphere. The physical properties of the soil, including soil texture, bulk density, particle density, water retaining capacity, soil structure, soil color, and organic matter, depend on the amount, shape, structure, size, pore spaces, and mineral composition of the soil. High-quality soils not only produce better food and fiber but also help establish natural ecosystems and enhance air and water quality. Soil forms the intermediate zone between the atmosphere and the rock cover of the earth, the lithosphere, and forms the interface between water bodies and the lithosphere, forming a part of the biosphere. Soil is a complex organization made up of inorganic matter, organic matter, soil organisms, soil moisture, soil solution, and soil air. Soil typically contains 50-60% mineral matter, 25-35% water, 15-25% air, and a small percentage of organic matter (Nisha *et al.*, 2017The GPS coordinates for the Katihar district in Bihar are 25° 46' 15.9708" N and 87° 28' 55.8660" E. The monsoonic sub-humid to humid climate of the Katihar district has an average yearly rainfall of about 1300 mm. It is located in Bihar's agroclimatic zone II. Over the past fifty years or so, the Kosi River has had an impact on the soils of the entire district. The Kosi directly affected the areas with deposits of sandy to loamy sand. On the other hand, areas that are not directly affected by it have heavier-textured soils. Since they are all very recent sedimentary deposits, none of these soils have yet to develop my genetic horizons. Compared to the top soil, which was produced when the Kosi's influence was diminishing and the channels were significantly moving, the lower substratum, which was deposited during the earlier stages of the Kosi inundation, is more homogeneous in nature. The consistent patterns of deposition aid in the mapping of these soils as soil associations because they are not random. The monsoonic sub-humid to humid climate of the Katihar district has an average yearly rainfall of about 1300 mm. With the exception of years with extreme weather brought on by heavy rain or draught, the climate is often favorable for the regular production of paddy, maize, jute, wheat, barley, and other crops. In much of the region, the air temperature is pleasant even in the summer, especially at night. Peak precipitation from June to September. In order to do this, a research was carried out to compile detailed data on the soil properties of nine chosen villages in the Bihar district of Katihar. The goal was to create efficient soil management plans that would maintain the health of the soil and increase agricultural yield over the long run. To ascertain the physical characteristics of the soil, samples were taken from the study area and subjected to standard laboratory analysis techniques. The state's distinct topography offers a wide variety of soil types, all of which need to be properly managed to guarantee their long-term productivity. The research carried out in the Katihar district is a crucial first step in creating efficient soil management plans for the area and can act as a template for other Indian regions dealing with comparable problems.

2. Materials and Methods
2.1 Study Area
The GPS coordinates for the Katihar district in Bihar are 25° 46' 15.9708" N and 87° 28' 55.8660" E. The monsoonic sub-humid to humid climate of the Katihar district has an average yearly rainfall of about 1300 mm. It is located in Bihar's agroclimatic zone II. The monsoonic sub-humid to humid climate of the Katihar district has an average yearly rainfall of about 1300 mm. The majority of the year is ideal for the typical cultivation of paddy, maize, jute, wheat, barley, and other crops, with the exception of years when the weather is unfavorable due to an excessive amount of rain or drought. The overall environment is usually favorable for agricultural activities due to the combined impact of sandy to loamy soils, a relatively highwater table, several natural vegetation types, a network of river channels, and the region's closeness to the Himalayan foothills. In much of the region, the air temperature is pleasant even in the summer, especially at night. highest amount of precipitation from June to September.

Twenty-seven soil samples in total, from three distinct blocks and three villages in each block of the Katihar district in Bihar, were taken at various depths of 0–15, 15–30, and 30-45 cm. Following a v-shaped technique, soils were collected from agriculture fields using a garden hoe, spade, and khurpi. Large clods were crushed using a wooden mallet after the samples were dried in the shade. The powdered soils were sieved using a 2 mm sieve, collected in a polythene bag, and appropriately labeled for laboratory analysis. The physico-chemical characteristics were examined in the collected samples. The Bouyoucos hydrometer method (Bouyoucos, 1927) [2] was used to analyze the textural class of the soil; the Munsell soil color chart (Albert H. Munsell, 1954) [7] was used to determine the color of the soil; the graduated measuring cylinder method (Muthuvel *et al*., 1992) [8] was used to determine the bulk density and particle density; the pH meter was used to make a 1:2 soil water suspension (Jackson, 1958) [5]; the digital EC meter (Wilcox, 1950) [22] was used to measure the EC; organic carbon was determined by wet-oxidation method (Walkley, 1947) [21]; the 800 ml kjeldhal flask method (Subbiah and Asija, 1956) [15] was used to determine the available nitrogen; the colorimetric method (Olson *et al*., 1954) [10] was used to determine the available phosphorous; the flame photometer was used to determine the available potassium.

3. Result and Discussion
3.1 Soil Physical Properties
The experimental results of the present investigation entitled "Assessment of Physical Properties of Soil from Different Blocks of Katihar District, Bihar." The Soil Texture of different soil samples are Sandy loam, sand content varied from 62.60 to 70.10%, silt 14.90 to 19.80% and clay 14.30 to 17.60% as shown in the Table 1 similar results reported by Behera *et al.*, (2016) [23]. As shown in Table 2 the Bulk density of soils from different villages was varied from 1.00 to 1.42 Mg m^{-3}. (V_3) Aathare village reported lowest Bulk density and (V_4) Shitalpur village reported highest Bulk density as reported by Singh *et al.*, (2022) [24]. The range of Particle density of soils was varied from 2.20 to 2.56 Mg m^{-3}. (V_8) dumar village reported lowest and (V_7) Chandpur village reported highest Particle density as reported by Jena *et al.*, (2021) [25]. The range of Pore space was varied from 41.08 to 54.08%. (V_3) Aathare village reported lowest and (V_9) khaira village reported highest porosity similar findings also reported by Jena *et al.*, (2021) [25] and the range of Water Retaining Capacity varies from 39.38 to 51.89%. The lowest Water Retaining Capacity was observed in (V_3) Aathare village and highest observed in (V_9) Khaira village similar results showed.

Table 1: Physical Properties

Block	Village	Sand	Silt	Clay	Textural Class
Pranpur (B1)	V_1	64.40	18.80	16.80	Sandy loam
	V_2	68.90	16.60	14.50	Sandy loam
	V_3	70.10	15.60	14.30	Sandy loam
Azamnagar (B2)	V_4	62.60	19.80	17.60	Sandy loam
	V_5	66.60	17.80	15.60	Sandy loam
	V_6	65.50	18.80	15.70	Sandy loam
Sameli (B3)	V_7	66.20	15.40	14.30	Sandy loam
	V_8	66.60	17.80	15.60	Sandy loam
	V_9	63.50	14.90	15.50	Sandy loam

Table 2: Physical Properties

Block	BD (Mg m^{-3})		PD (Mg m^{-3})		Pore space (%)		WHC (%)	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
B1V$_1$	1.08-1.20	1.14	2.33-2.45	2.39	47.32-43.62	45.47	45.32-41.92	43.62
B1V$_2$	1.02-1.14	1.08	2.30-2.39	2.34	45.80-41.89	43.84	43.84-40.00	41.92
B1V$_3$	1.00-1.18	1.09	2.22-2.29	2.25	49.30-41.08	45.19	48.09-39.38	43.73
B2V$_4$	1.34-1.42	1.38	2.22-2.36	2.29	47.08-44.19	45.63	45.01-42.76	43.88
B2V$_5$	1.29-1.32	1.30	2.28-2.33	2.30	49.23-45.78	47.50	47.88-44.55	46.21
B2V$_6$	1.10-1.32	1.21	2.48-2.55	2.51	44-73-42.10	43.41	41.03-40.88	40.95
B3V$_7$	1.05-1.11	1.08	2.48-2.56	2.52	48.28-53.34	50.81	47.92-51.89	49.90
B3V$_8$	1.00-1.21	1.10	2.20-2.33	2.26	47.67-50.98	49.32	46.30-48.03	47.16
B3V$_9$	1.11-1.29	1.20	2.38-2.52	2.45	49.32-54.08	51.7	45.73-53.18	49.45

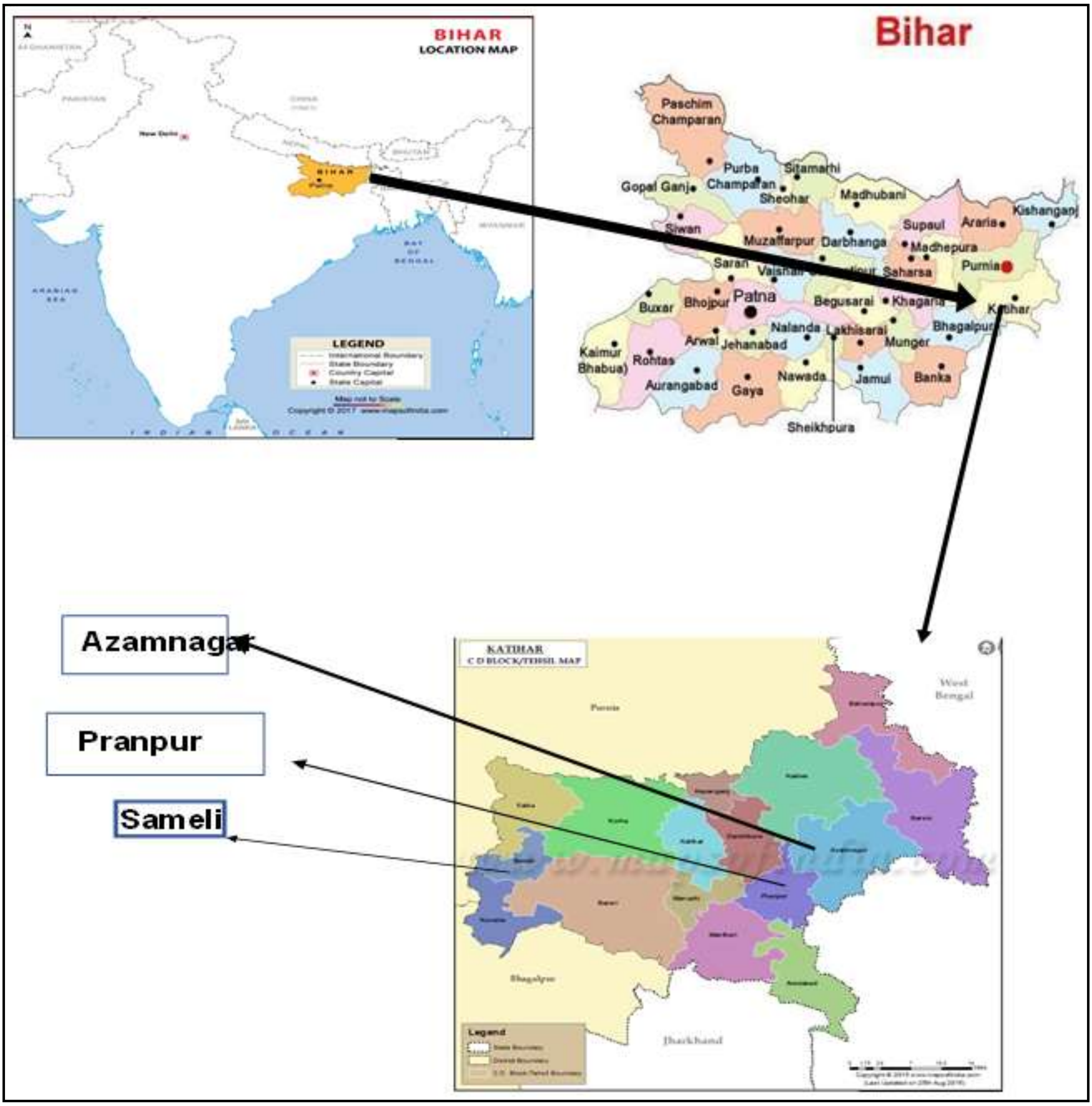

Fig 1: Location Map of Study Area

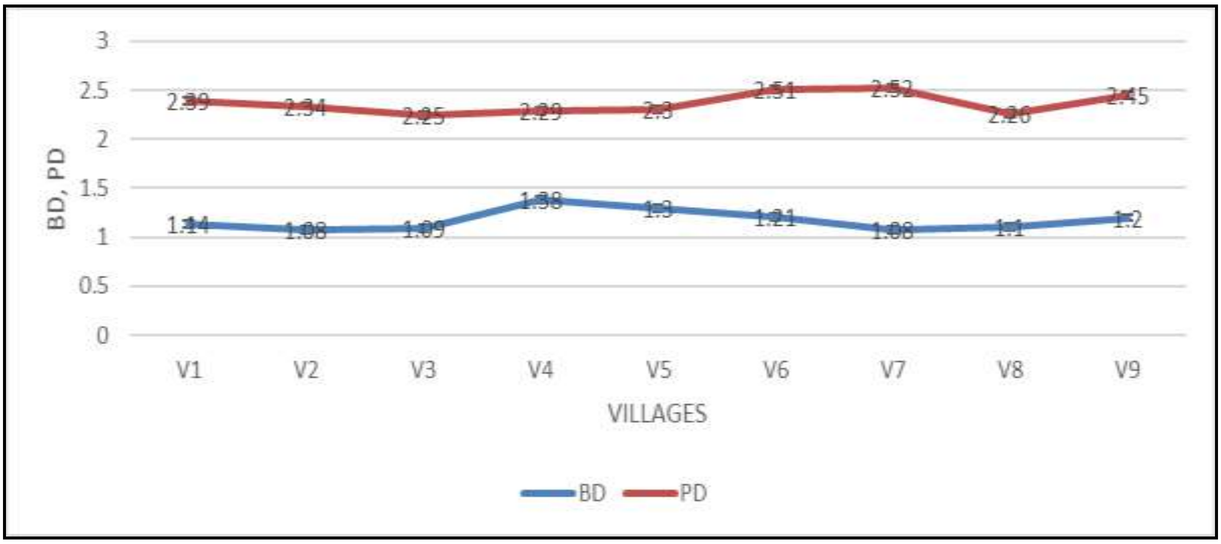

Fig 2: Bulk density (Mg m^{-3}) & Particle density (Mg m^{-3})

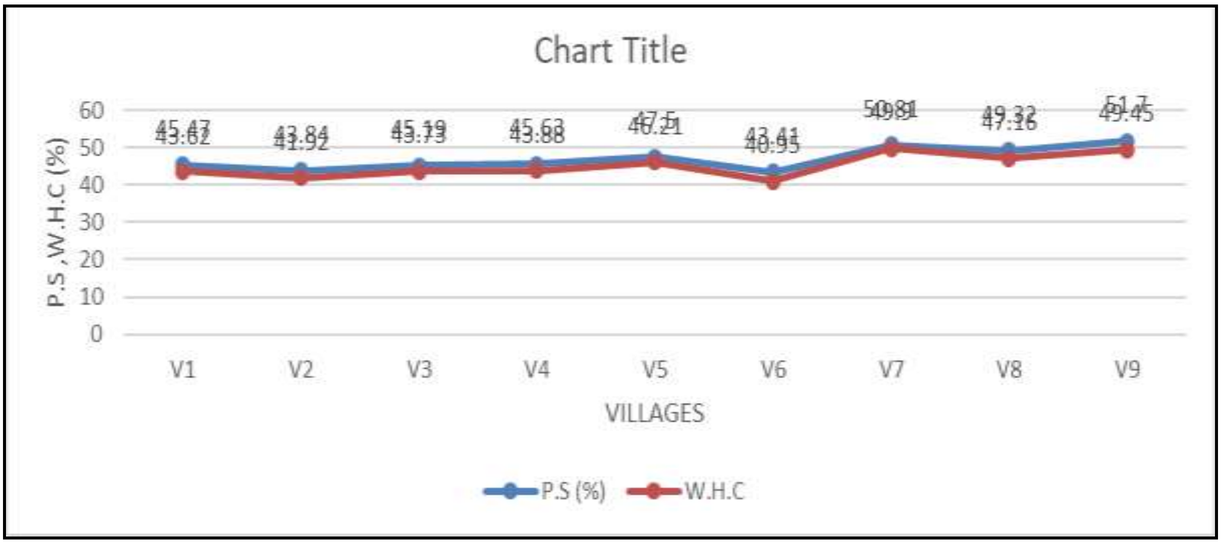

Fig 3: Pore Space (%) & Water Retaining Capacity (%)

3.2 Soil chemical Properties

The pH scale runs from 5.52 to 7.50, with (V3) Khaira recording the highest pH value and (V7) Chandpur recording the lowest. The low levels of organic matter and nutrient leaching could be the cause of the low pH readings. Upadhyay and Chawla (2014) [18] reported similar outcomes. The soil was found to have a low electrical conductivity (EC), with the highest and lowest EC being reported in (V1) Patharwar and (V7) Chandpur, respectively. The electrical conductivity ranged from 0.031 to 0.47 dS m-1. For soil, an EC value of 0.5 dS m-1 is ideal. Almost all crops would have significant germination problems and significantly lower yields when the EC value exceeded this threshold. Belwal and Mehta (2014) [1] reported similar outcomes. The percentage of soil organic carbon ranged from 0.15 to 0.44, with (V4) Shitalpur and (V3) Aathare having the highest and lowest percentages, respectively. It was discovered that these soils had a low to medium amount of organic carbon. Due to the accumulation of plant residues and farmyard manures to surface layers rather than lower horizons, the organic carbon content decreases with depth. Upreti *et al*. (2016) [20] reported similar outcomes. The range of accessible nitrogen is 153.52 to 290.80 kg ha-1, with the maximum nitrogen reported in(V4) Shitalpur, The available nitrogen content is found to be highest in the surface layer and to decrease steadily with depth. This is primarily because the trend of organic carbon decreases with depth, and crop cultivation is confided to the rhizosphere only occasionally when the depleted nitrogen content is supplemented by external fertilizer application during crop cultivation. Upadhyay *et al*. reported the Simila results (2014) [18]. The range of accessible phosphorus is 10.36 to 32.28 kg ha-1, with (V5) Gadhbaina having the maximum amount. The surface layer has been shown to have the highest accessible phosphorous concentration, which fluctuates randomly with depth. It could be the result of the crop being confined within the rhizosphere during cultivation, as well as the addition of external sources such as fertilizers to replenish the depleted "P" and the availability of exchangeable Al+3 and free iron oxide in trace levels. Similar outcomes were documented by Manjunath and Sannappa (2013) [13]. The range of accessible potassium is 77.82 to 177.20 kg ha-1, with (V8) Dumar having the maximum potassium available.

More extreme weathering, the release of relevant K from organic residues, the use of K fertilizers, and the upward translocation of K from deeper levels along the ground water's capillary rise could all be contributing factors. Patel (2015) [11] reported the Simila results. The maximum amount of available calcium was discovered in (V5) Gadhbaina, with available calcium ranging from 2.8 to 4.8 meq 100g-1 of soil. The maximum amount of available magnesium was discovered in (V9) Khaira. The available magnesium ranged from 0.75 to 1.10 meq 100g-1 of soil. When their availability in the soil increases, calcium and magnesium both raise the pH of the soil. Joshi *et al.* (2013) [6] reported similar outcomes.

Table 3: Chemical Properties

Village	pH		EC (dS m^{-1})		OC (%)	
	Range	Mean	Range	Mean	Range	Mean
Patharwar	6.30-6.46	6.38	0.46-0.47	0.46	0.32-0.24	0.28
Teliyabad	7.20-7.46	7.33	0.34-0.37	0.35	0.34-0.27	0.30
Aathare	7.03-7.50	7.26	0.38-0.45	0.41	0.21-0.15	0.18
Shitalpur	5.58-6.10	5.84	0.40-0.44	0.42	0.44-0.40	0.42
Mohharampur	6.08-6.67	6.37	0.38-0.40	0.39	0.27-0.24	0.25
Gadhbaina	6.34-6.50	6.42	0.36-0.38	0.37	0.31-0.28	0.29
Chandpur	5.52-5.81	5.66	0.31-0.37	0.34	0.23-0.20	0.21
Dumar	5.89-6.48	6.18	0.42-0.45	0.43	0.25-0.19	0.22
Khaira	6.30-6.82	6.56	0.40-0.42	0.41	0.23-0.20	0.21

Table 4: Chemical Properties

Village	N (Kg ha^{-1})		P (Kg ha^{-1})		K (Kg ha^{-1})	
	Range	Mean	Range	Mean	Range	Mean
Patharwar	234.52-203.30	218.91	18-13.72	15.86	168-97-118.55	143.76
Teliyabad	270.38-242.14	256.26	22.56-13.52	18.04	183.27-134.43	158.85
Aathare	254.41-162.02	208.21	18.25-10.36	14.30	170.56-126.53	148.54
Shitalpur	290.80-223.56	257.18	22.32-15.67	18.99	160.32-109.74	135.03
Mohharampur	245.85-189.63	217.74	32.28-24.63	28.45	152.32-98.20	125.26
Gadhbaina	285.54-201.58	243.56	20.65-15.26	17.95	120.51-77.82	99.16
Chandpur	232.00-143.65	187.82	19.00-13.39	16.19	160.23-101.32	130.77
Dumar	240.58-188.12	214.35	21.20-14.98	18.09	177.20-101.20	139.20
Khaira	222.14-153.52	187.83	19.00-14.89	16.94	154.32-84.62	119.47

Table 5: Chemical Properties

Village	Ex. Ca (meq 100g^{-1})		Ex. Mg (meq 100g^{-1})	
	Range	Mean	Range	Mean
Patharwar	4.2-4.7	4.45	0.85-1.00	0.92
Teliyabad	3.8-4.1	3.95	0.80-1.00	0.90
Aathare	2.8-3.5	3.15	0.75-0.90	0.82
Shitalpur	3.5-3.7	3.60	0.85-1.08	0.96
Mohharampur	4.0-4.8	4.40	0.98-1.08	1.03
Gadhbaina	3.5-3.9	3.70	0.75-0.95	0.85
Chandpur	3.8-4.6	4.20	0.87-1.05	0.96
Dumar	4.4-4.8	4.60	0.78-1.04	0.91
Khaira	4.0-4.7	4.35	0.97-1.10	1.03

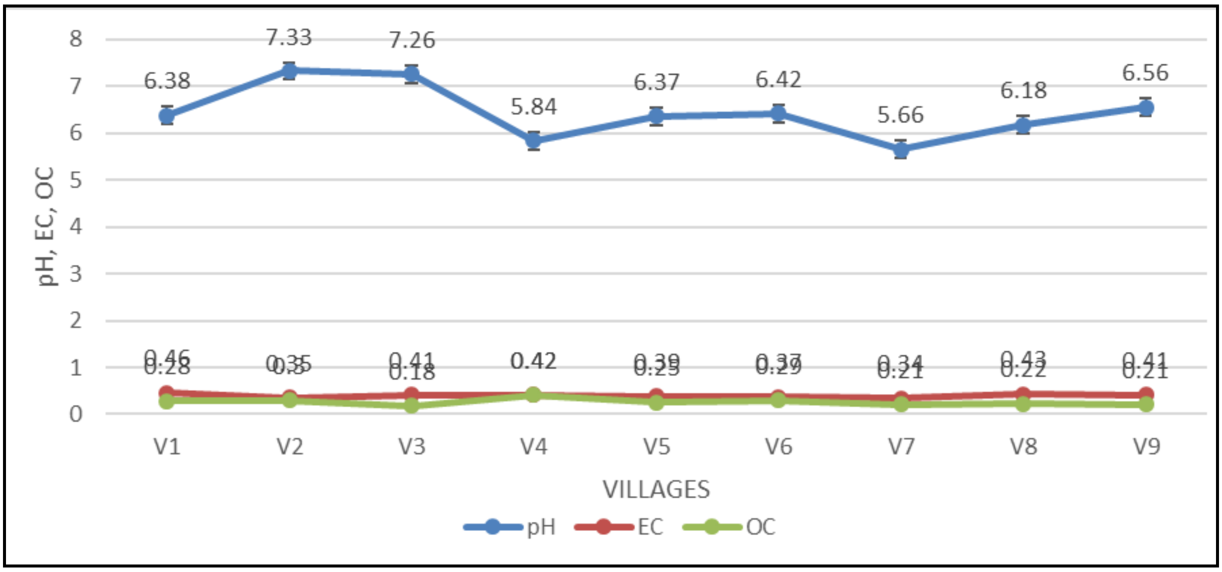

Fig 4: pH, EC (dS m^{-1}) and OC (%)

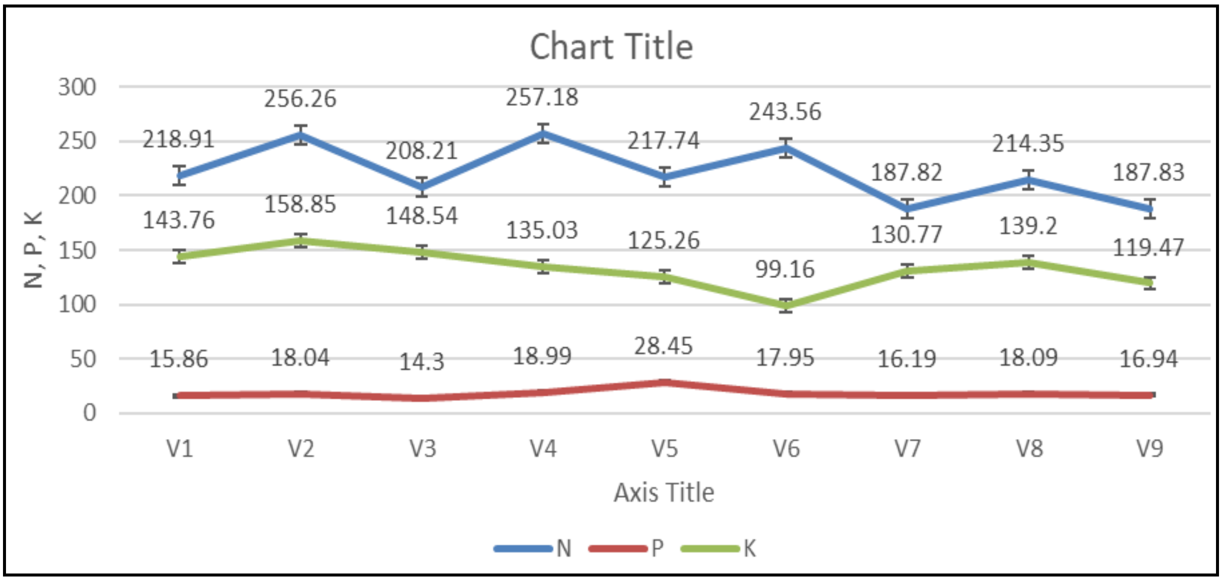

Fig 5: Available Nitrogen, Phosphorus and Potassium (Kg ha^{-1})

Conclusion

In summary, the majority of crops may be grown in the Katihar district due to the moderately to good physical and chemical conditions of the soils. The soil's texture revealed a moderate percentage of clay, a slightly acidic to slightly alkaline soil reaction, low to medium levels of soil organic carbon, low to medium levels of nitrogen, low to moderately fine levels of phosphorus, very low to moderately fine levels of potassium, low to moderate levels of calcium, and very low levels of magnesium. Any external source of nutrients, such as chemical fertilizer, can be used to replenish the lacking nutrient.

Acknowledgement

The Honorable Vice Chancellor, Head of the Department of Soil Science and Agricultural Chemistry at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, is much appreciated by the authors for giving the equipment and support that this research project required.

Prince Kumar Singh, the Corresponding Author, attests that there are no conflicts of interest pertaining to this publication among the other authors.

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