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Evaluating the Physical and Chemical Characteristics of Soil from Various Blocks in Sahibganj District, Jharkhand, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This research topic entitled " Evaluating the Physical and Chemical Characteristics of Soil from Various Blocks in Sahibganj District, Jharkhand, India" 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, Uttar Pradesh. During the year 2023-2024. The soil samples were collected at three depths: 0-15 cm, 15-30 cm, and 30-45 cm,

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from nine different villages of three different blocks of Sahibganj areas, summing to 27 samples collected and analyzed for their physical parameters by using standard Laboratory Techniques. The result showed that The Soil Textural class identified were Sandy Loam. The sand, silt and clay percentage varied from 67.00 to 68.64 sand, 14.10 to 19.82 silt and 11.80 to 18.70 clay in Sandy Loam. Bulk Density was varied from the1.17 Mg m^{-3} to 1.44 Mg m^{-3}. The Particle Density varied from 2.22 Mg m^{-3} to 2.48 Mg m^{-3}. The Pore Space (%) ranged from 41.66% to 47.64 The Water Holding Capacity (%) ranged from 33.18 to 45.17. The pH value ranged from 6.15to 6.70 indicating acidity. The Electrical Conductivity ranged from 0.20 to 0.33 dS m^{-1}. The value of total Organic Carbon (%) varied from 0.27 to 0.44%. The available Nitrogen content of soil ranged from 210 to 277.3 kg ha^{-1} and nitrogen content was low in all villages. The available Phosphorus content of soil ranged from 23.62 to 39.32 kg ha^{-1}. Available Potassium content of soil ranged 212.57to 245.7 kg ha^{-1}. To avoid yield losses from nutrient deficiencies, prescribed fertilizer doses should be applied in these locations in accordance with crop response to soil tests.

Keywords: Soil health; Sahibganj district; Jharkhand; physico-chemical properties; texture; etc.

1. INTRODUCTION

"Soil is a vital resource, can be termed as "Soul of infinite life". The essence of life in the soil is its crop producing capacity that is, the soil productivity largely depends on soil fertility, management practices and climate. The word soil represents one of the most active and complex natural systems on the earth's surface. It is essential for the existence of many forms of life and provides medium for plant's growth and also supplies the organisms with most of their nutritional requirements" [1]. "Soil is the base for the existence of many life forms and an indispensable medium for plant growth. It is one of the most active and complex natural systems on the earth's surface. The overarching definition that resonates today is "Soil is a natural independent body which like any other natural body or organism, has a specific origin, history of development, and external appearance" [2]. "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" [3].

2. MATERIALS AND METHODS

2.1 Sampling Site and Collection

Sahibganj is a town on the Ganges River's banks that is situated in northeastern Jharkhand. Its average elevation above mean sea level is 77 meters, and its latitude and longitude are 25°23'81'N and 87°64'54" E, respectively. The district has a total land area of 1599.00 square kilometers. The area for the research study involved 3 blocks of Sahibganj district i.e., Sahibganj, Borio and Mandro. "Soil samples were collected from 9 different villages of 3 blocks of Sahibganj district in 3 different depths i.e., 0-15 cm, 15- 30 cm and 30-45 cm by the help of Augar and Khurpi. Following a v-shaped technique, 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.

Table 1. The methods of analysis for different soil parameters

S. No.	Particulars	Scientist Name	Methods	Unit
PHYSICAL PROPERTIES				
1.	Bulk density	Muthuval et al. (1992)	Graduated measuringcylinder	Mg m^{-3}
2.	Particle density	Muthuval et al. (1992)		Mg m^{-3}
3.	Textural class (Sand, Slit, Clay)	Bouyoucos [4]	Bouyoucos hydrometer	Percentage (%)
4.	Pore space	Black (1965)	-	Percentage (%)
5.	Water Holding capacity	Muthuval et al. (1992)	Graduated measuring cylinder	Percentage (%)

S. No.	Particulars	Scientist Name	Methods	Unit
CHEMICAL PROPERTIES				
1.	Soil pH (1:2.5)	Jackson [5]	Digital pH meter	
2.	Electrical conductivity (1:2.5)	Wilcox [6]	Digital conductivity meter	dS m^{-1}
3.	Organic carbon	Walkley and Black [7]	Wet oxidation method	Percentage (%)
4.	Available nitrogen	Subbiah and Asija [8]	Soil alkaline permanganate method	kg ha^{-1}
5.	Available phosphorus	Olsen et al. [9]	Photometric colorimeter method	kg ha^{-1}
6.	Available potassium	Toth and Prince [10]	Flame photometric method	kg ha^{-1}

The physico-chemical characteristics were examined in the collected samples. The Bouyoucos hydrometer method [4] was used to analyze the textural class of the soil; the Munsell soil color chart (Albert H. Munsell, 1971) was used to determine the color of the soil; the graduated measuring cylinder method [11] was used to determine the bulk density, particle density, % pore space, water holding capacity; the pH meter was used to make a 1:2.5 soil water suspension [5]; the digital EC meter [5] was used to measure the EC; organic carbon was determined by wet-oxidation method [7]; Soil alkaline permanganate method [8] was used to determine the available nitrogen; Photometric Colorimeter method [9] was used to determine the available phosphorous; Flame photometric method [10] was used to determine the available potassium.

3. RESULTS AND DISCUSSION

3.1 Physical Properties of Soil

3.1.1 Soil bulk density (Mg m^{-3})

The Table 2 and Fig. 1 portrayed the Bulk Density of different blocks and depths which was found to be significant at depths in which the highest mean particle density was found at V2 (1.44) from Sahibganj Block, followed by V1 (1.31), V3 (1.34), V4 (1.29), V5 (1.30), V6 (1.25), V7 (1.17), V8 (1.31), and V9(1.29) The least mean value found at V7 (1.17) from the Mandro block. Similar result has been recorded by Singh et al. [12].

3.1.2 Particle density (Mg m^{-3})

The Table 2 and Fig. 1 portrayed the Particle Density of different blocks and depths which was found to be significant at depths in which the highest mean particle density was found at V4 (2.48) from Borio Block, followed by V1 (2.45), V2 (2.41), V3 (2.42), V5 (2.44), V6 (2.29), V8 (2.32) and V9 (2.35). The least mean value found at V7 (2.22) from the Mandro block. Similar result has beenrecorded by Singh et al. [13].

3.1.3 Percent pore space

The Table 2 and Fig. 2 depicted the statistical accumulation on Pore Space in soil from different sampling sites up to various depths in which the highest mean % Pore Space was found at location V6 (47.64) from Borio Block, followed by V1 (45.12), V2 (44.32), V3 (46.13), V4 (46.87), V7 (45.84), V8 (45.12), V9 (45.21). Least mean value was found at location V5 (41.66) from Borio Block. Similar result has been recorded by Singh et al. [14].

3.1.4 WHC (%)

The Table 2 and Fig. 2 portrayed the statistical evaluation on Water Holding in soil from different sampling sites up to various depths in which the highest mean Water Holding Capacity was found at the location V6 (45.17) from the block Borio, followed by V1 (43.83), V2 (42.76), V3 (44.19), V4 (40.30), V7 (43.07), V8 (43.39), and V9 (43.31). The least mean Water Holding Capacity was found at the location V5 (33.18) from Borio Block. Similar result has been recorded by Sharma et al [15].

3.2 Soil Chemical Properties

3.2.1 Soil pH

The Table 3 and Fig. 3 depicted the statistical variation on soil pH in soil from different sampling sites up to various depths in which the Highest mean pH was found at V8 (6.70) from Mandro Block, followed by V1(6.40), V2 (6.35), V3 (6.46), V4 (6.15), V5 (6.28), V6 (6.44), V7 (6.60), V9 (6.65). The least mean for pH was found at location V4 (6.15) from Borio Block. Similar result has been recorded by Singh and Singh [16].

Table 2. Bulk density (Mg m^{-3}), particle density (Mg m^{-3}), pore Space (%) and water holdingcapacity (%) of soil at different depth

S. No.	Soil bulk density			Soil particle density			Soil porosity			Soil water holding capacity		
	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	0-15 cm	15-30 cm	30-45 cm
V1	1.31	1.35	1.42	2.45	2.46	2.50	45.12	43.31	41.93	43.83	41.34	39.27
V2	1.44	1.48	1.48	2.41	2.44	2.44	44.32	43.04	41.85	42.76	40.78	39.37
V3	1.34	1.39	1.44	2.42	2.47	2.50	46.13	44.61	42.11	44.19	42.81	40.18
V4	1.29	1.31	1.35	2.48	2.52	2.55	46.87	46.30	46.30	40.30	39.28	39.03
V5	1.30	1.35	1.37	2.44	2.48	2.52	41.66	41.10	40.71	33.18	32.22	32.08
V6	1.25	1.29	1.33	2.29	2.33	2.35	47.64	45.54	43.93	45.17	43.19	41.78
V7	1.17	1.25	1.29	2.22	2.25	2.27	45.84	43.07	41.13	43.07	41.35	39.73
V8	1.31	1.33	1.35	2.32	2.35	2.38	45.12	43.20	41.51	43.39	41.78	40.19
V9	1.29	1.33	1.36	2.35	2.46	2.50	45.21	43.63	41.11	43.31	41.17	39.17
F- test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
S.Em. (±)	**0.021**	**0.018**	**0.015**	**0.035**	**0.031**	**0.026**	**0.627**	**0.538**	**0.596**	**0.711**	**0.523**	**0.593**
C. D. @ 5 %	**0.065**	**0.054**	**0.045**	**0.106**	**0.093**	**0.079**	**1.864**	**1.598**	**1.773**	**2.113**	**1.556**	**1.762**

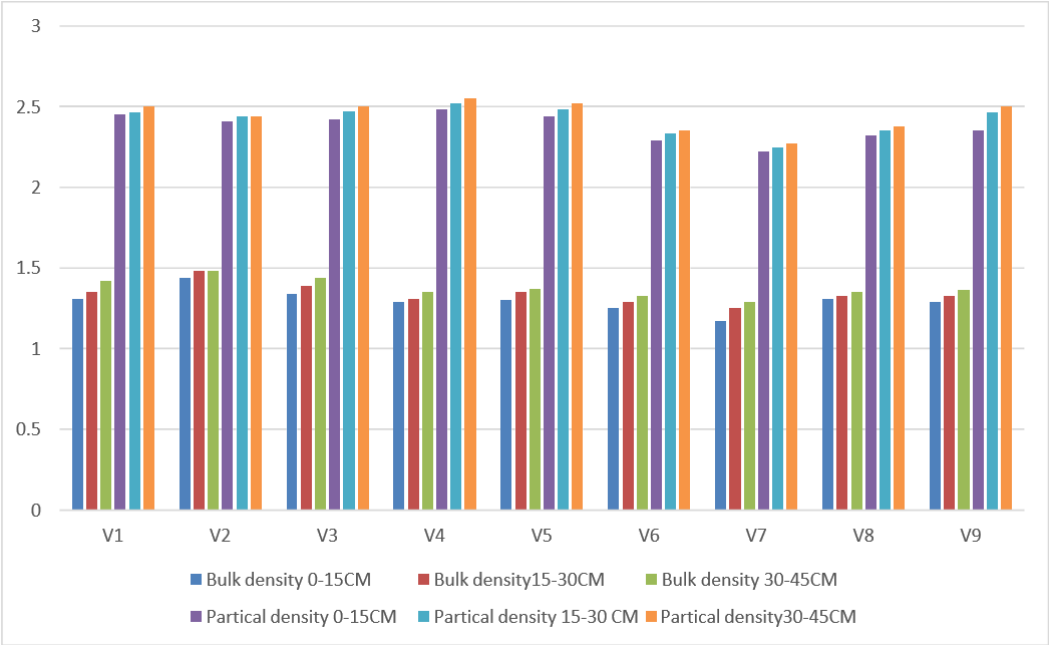

Fig. 1. Bulk density (Mg m^{-3}), particle density (Mg m^{-3}) of soil at 0-15, 15-30 and 30-45 cm depth

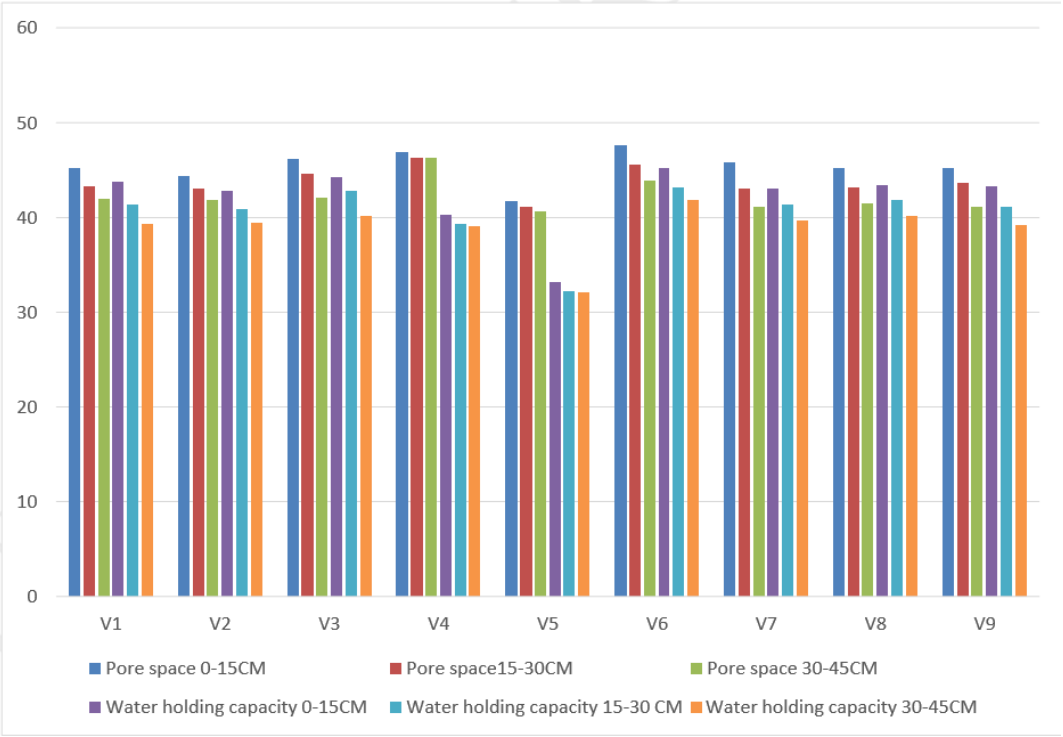

Fig. 2. Pore Space (%) and water holding capacity (%) of soil at 0-15, 15-30 and 30-45 cm depth

3.2.2 EC (dS m^{-1})

The Table 3 and Fig. 3 portrayed the statistical evaluation on Electrical Conductivity in soil from different sampling sites up to various depths in which the highest mean of EC was found at the location V3 (0.33) from Sahibganj Block, followed by V1 (0.32), V2 (0.26), V4 (0.31), V5 (0.24), V6 (0.21), V7 (0.24), V8 (0.22), V9 (0.20). The least mean value was found at V9 (0.20) from Mandro Block. Similar result has been recorded by Singh and Singh [16].

3.2.3 Organic carbon

The Table 3 and Fig. 3 depicted the statistical evaluation on Organic Carbon of blocks from different sampling sites up to various depths in which the highest mean of Organic Carbon was found at location V4 (0.44) from Borio Block, followed by V1 (0.42), V2 (0.35), V3 (0.41), V5 (0.42), V6 (0.41), V7 (0.33) V8 (0.29) and V9 (0.27). The least mean Organic Carbon was found at the location V8 (0.29) from Mandro Block. Similar result has been recorded by Yadav et al. [17].

3.2.4 Available nitrogen

The Table 4 and Fig. 4 depicted the statistical evaluation on available Nitrogen in soil from different sampling sites up to various depths, which the highest mean of available Nitrogen was found at the location V5 (299) from Borio Block, followed by V1 (256.34), V2 (245.45), V3 (220), V4 (210), V6 (277.3), V7 (252.71), V8 (246.25) and V9 (263.47). Least mean value was found at V4 (210) from Borio Block. Similar result has been recorded by Arya et al. [18].

Table 3. pH(w/v), EC (dS m^{-1}) and organic carbon (%) of soil at different depth

S. No.	SoilpH			Soil EC (dS m^{-1})			Soil organic Carbon (%)		
	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
V1	6.40	6.65	6.85	0.32	0.36	0.38	0.42	0.39	0.35
V2	6.35	6.60	6.73	0.26	0.29	0.34	0.35	0.32	0.30
V3	6.46	6.67	6.70	0.33	0.37	0.41	0.41	0.39	0.37
V4	6.15	6.35	6.45	0.31	0.37	0.39	0.44	0.43	0.40
V5	6.28	6.50	6.60	0.24	0.28	0.31	0.42	0.40	0.40
V6	6.44	6.58	6.65	0.21	0.24	0.26	0.41	0.39	0.37
V7	6.60	6.75	6.88	0.24	0.29	0.31	0.33	0.31	0.29
V8	6.70	6.75	6.75	0.22	0.25	0.27	0.29	0.26	0.23
V9	6.65	6.70	6.75	0.20	0.23	0.28	0.27	0.25	0.22
F- test	S	S	S	S	S	S	S	S	S
S.Em. (±)	0.099	0.070	0.077	0.004	0.005	0.006	0.005	0.004	0.004
C. D.@ 5%	0.296	0.210	0.230	0.014	0.015	0.018	0.017	0.013	0.011

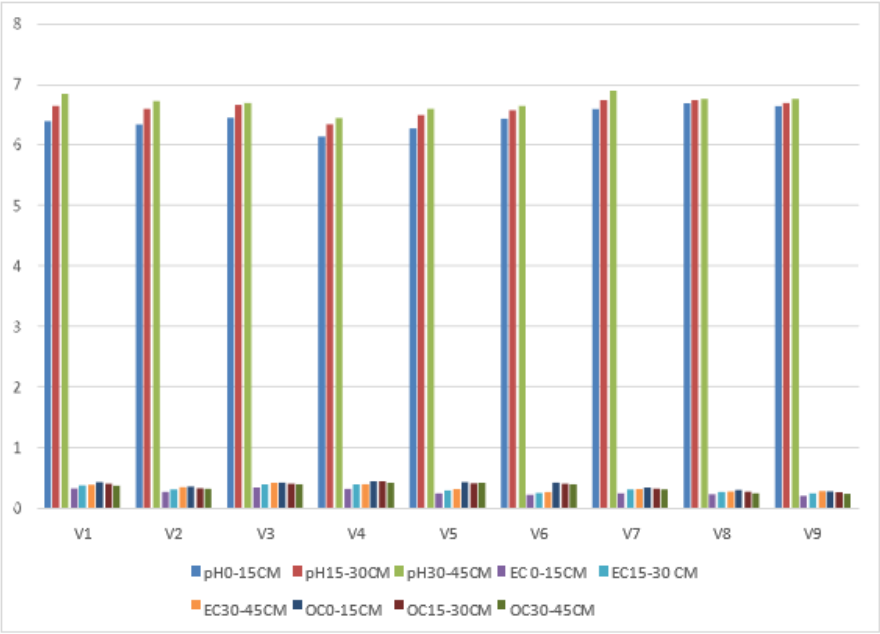

Fig. 3. pH(w/v), EC (dS m^{-1}) and organic carbon (%) of soil at 0 -15, 15-30 and 30-45 cm depth

3.2.5 Available phosphorus

The Table 4 and Fig. 4 portrayed the statistical evaluation on Available Phosphorus in soil from different sampling sites up to various depths was significantly decreasing in which the highest mean of available Phosphorus was found at V3 (39.32) from Sahibganj Block, followed by V1 (37.37), V2 (35.76), V4 (26.70), V5 (24.37) V6 (23.82), V7 (31.17), V8 (26.28), V9(23.62). Least mean value was found at V9 (23.62) from Mandro Block. Similar result has been recorded by Gyawali et al.

3.2.6 Available potassium

The Table 4 and Fig. 4 depicted the statistical evaluation on Available Potassium in soil from different sampling sites up to various depths was significantly decreasing, in which the highest mean of available Potassium was found at location from Sahibganj Block, V3 (245.47).

Table 4. Available nitrogen (kg h^{-1}), available phosphorus (kg h^{-1}) and availablepotassium (kg h^{-1}) of soil at different depth

S. No.	Soil Nitrogen (kg ha^{-1})			Soil Phosphorus (kg ha^{-1})			Soil Potassium (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
V1	256.34	249.52	244.14	37.37	35.36	31.62	233.45	232.75	229.34
V2	245.45	239.55	235.15	35.76	32.73	31.27	239.63	235.45	232.75
V3	220	196	184	39.32	37.37	35.83	245.47	243.57	239.85
V4	210	181	173	26.70	23.39	23.20	231.80	221.79	214.96
V5	299	272	251	24.37	23.87	21.03	212.57	197.60	185.31
V6	277.3	265.56	259.07	23.82	19.76	16.83	243.87	238.70	231.30
V7	252.71	233.08	229.17	31.17	28.84	26.28	229.16	223.71	204.11
V8	246.25	239.98	237.13	26.28	23.39	21.45	232.75	231.80	221.79
V9	263.47	245.45	237.13	23.62	21.03	19.76	208.13	206.33	204.11
F- test	S	S	S	S	S	S	S	S	S
S.Em. (±)	4.998	3.183	3.811	0.425	0.388	0.439	2.908	3.900	3.002
C. D. @ 5 %	14.851	9.458	11.324	1.265	1.154	1.305	8.642	11.589	8.921

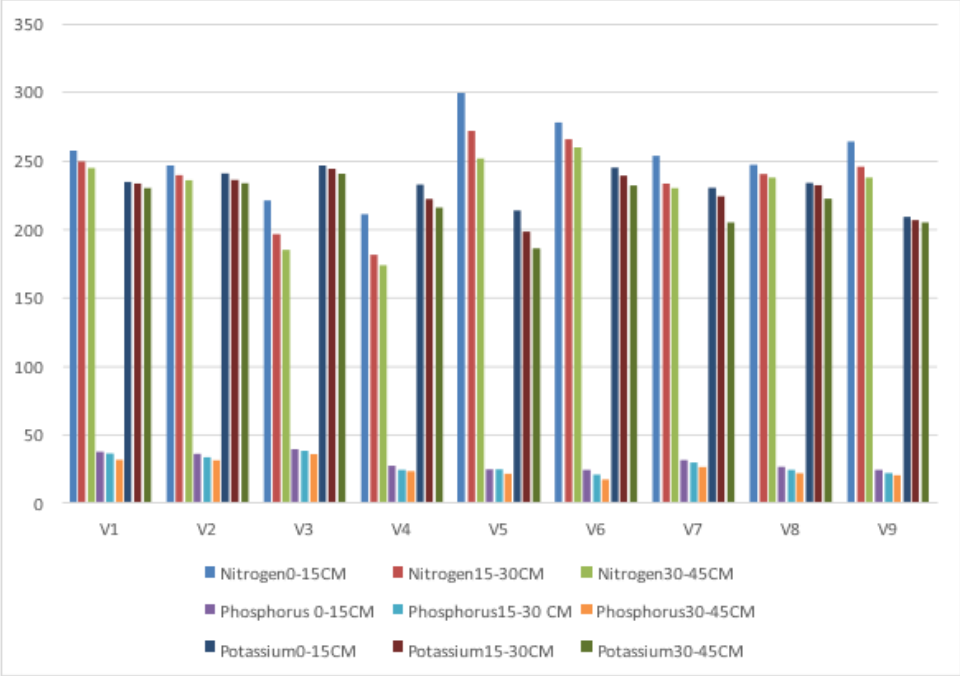

Fig. 4. Available nitrogen (kg h^{-1}), available phosphorus (kg h^{-1}) and available potassium (kg h^{-1}) of soil at 0-15,15-30 and 30-45 cm dept

The value is higher than V1 (233.45), V2 (239.63), V4 (231.80), V5 (212.57), V6 (243.87), V7 (229.16), V8 (232.75), V9 (208.13). The least mean value found at V9 (208.13) from Mandro Block. Similar result has been recorded by Arya et al. [19], [20].

4. CONCLUSION

It was concluded that soil parameters studied during the course of investigation clearly indicated that soil has good water holding capacity and good physical condition. The pH of soil is slightly acidic in nature and the Electrical conductivity was suitable for all crops. Organic carbon ranged from low to medium. These soils have low to medium Nitrogen in all villages. Phosphorus content is medium in all sites. Potassium is medium in all sites. According to soil depths, the nutrients distribution is varying with different depths. Recommendations for fertilizer dosages should be based on crop response and soil test results to prevent yield losses caused by nutrient deficiencies.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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