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Assessment of physio-chemical properties of soils of different villages of Aurangabad district Bihar

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Abstract

The experiment was carried out to assess the physical and chemical properties of soil of Aurangabad District under different cropping pattern during 2023-24. The soil sample were collected from the 10 selected villages of Aurangabad block viz., Nabinagar (V_1), Akohra (V_2), Son Nagar (V_3), Chanda (V_4), Obra (V_5), Rafiganj (V_6), Jakhim (V_7), Amba (V_8), Kutumba (V_9), and Deo (V_{10}) at depth 0- 15 and 15-30 cm with the help of khurpi following standard procedure. The analysis of physical and chemical properties of soil was carried out in the laboratory of Department of Soil Science & Agricultural Chemistry, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj 211007 (U.P.), India. Soil samples are analyzed by using standard laboratory protocols. The predominant soil Texture of soil was found majorly Clayey Loam and colour of soil in dry condition varies from light reddish brown to dark grayish brown and in wet varies from reddish brown to gray. The bulk density of the soils varied between 1.05 to 1.32 Mg m^{-3}, while the particle density ranged from 2.34 to 2.67 Mg m^{-3}. The percentage of pore space in soils ranged from 48.10 to 63.66% and water holding capacity ranged from 45.14 to 58.76. Soil pH levels were slightly acidic to neutral ranging from 6.40 to 7.89 and Electrical conductivity of the soil ranged from 0.14 to 0.38 dS m^{-1}, which belongs to non-saline group. The percent of organic carbon content was found to be medium to high, ranging from 0.42% to 0.67%. The range of available nitrogen content is from 228.38 to 312.40 Kg ha^{-1}. The available phosphorus ranges from 8.42 to 19.43 Kg ha^{-1}, while the available potassium ranges from 138.52 to 284.76 Kg ha^{-1}. Exchangeable calcium ranges from 3.2 to 8.4 meq 100 g^{-1} while Exchangeable magnesium was found to be in range of 0.14 to 1.52 meq^{-1} 100 g is found in soil.

Keywords: Soil health, Aurangabad district, physico-chemical properties, texture, etc.

1. Introduction

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 requirement. Soil analysis is a process that involves testing soil samples to determine their physical, chemical, and biological properties. The results of a soil analysis can help farmers and gardeners make informed decisions about how to manage their soil for optimal crop yields and also used to make recommendations for fertilization. The State of Bihar covers an area of 1,73,866 sq.km. and is stretched between 85'20' and 88032, E longitudes and between 21058' and 27031 ' N latitudes. This state has got both alluvial plains and hilly plateau regions, roughly equal in extension. The alluvial plains both in the north and south of Ganga, occupy 54.8 per cent of the total area while hills and plateau regions occupy 46.2 per cent of the total area of the State. In Bihar, Black and heavy soils have been found both in sedentary as well as alluvial regions. In sedentary region, they had developed mostly on basalt and Shale. These soils have been developed from internal seepage as well as back water during recurrent floods, and were further subjected to submergence for a longer period over the year. Despite the predominant evidence of reduction and segregation of Fe stretches to temporarily permanent saturation of pores water, and its further cause prolonged deficiency of oxygen. Natural factors and human activity both contribute to the degradation of soil. India is now reaping the benefits of its decades of sowing (Supriya, 2021) [14]. Because food productivity and environmental quality are dependent on soil physico- chemical properties, it is critical to have a fundamental understanding of soil physico- chemical properties (Tale *et al.*, 2015) [16].

Traditionally, the farmers in south Bihar, cultivate rabi season oilseeds such as linseed and pulses such as lathyrus, chickpea and lentil and usually go for rice crop establishment as puddled transplanted rice. In some regions of eastern India, farmers grow lentil as second crop by broadcasting the seeds within the standing rice crop in well-moistened soils without any tillage 15–20 days prior to the harvest of rice (relay cropping) and obtain much less yield from lentil (Bandyopadhyay *et al.*, 2016) [3].

2. Materials and Methods

The samples were taken from 10 villages of Aurangabad district which is at at 0-15 and 15-30cm depth. Aurangabad which is at 24.7487° N, 84.3807° E. The villages are Nabinagar (V_1), Akorha (V_2), Son Nagar (V_3), Chanda(V_4), Obra (V_5), Rafiganj (V_6), Jakhim(V_7), Amba (V_8), Kutumba (V_9), and Deo (V_{10}). Total 20 samples were collected from these villages to analyse physical and chemical properties. These samples were air dried in shade for one week to obtain constant weight then crushed with wooden hammer, after that it was sieved with 0.2 mm sieve to obtain composite samples of each site and each depth. The physical properties of soils, soil colour, texture, bulk density (Mg m-3), particle density (Mg m-3), percent pore space and percent water holding capacity were analysed with the following standard procedures: Bouyoucos (1927) [2], Muthuvel *et al* (1992) [9] and chemical properties pH, EC (dSm^{-1}) at 25 °C, percent organic carbon, available nitrogen, phosphorus and potassium (kg ha-1), Ca+3 C mol(p+) kg-1 and Mg+3 C mol(p+) kg-1 were analysed by following Jackson(1958) [6], Wilcox (1950) [17], Walkley and Black (1947) [18], Subbiah and Asija (1956) [12], Olsen *et al*. (1954) [11], Toth and Prince(1949) and Jackson (1973) [6] at 0-15 and 15-30 cm depths. The data recorded during the course of investigation was subjected to statistical analysis by the method of analysis of Completely Randomized Design (CRD) as per the method of "Analysis of Variance technique" (ANOVA) given by (Fisher 1960) [4].

Table 1: Geographical locations of experimental site

Village	Latitude (°N)	Longitude (°E)
Nabinagar (V_1)	24° 37' 12.00”	84° 07' 12.00”
Akorha (V_2)	25°01'38.2”	83°51'49.2”
Son Nagar (V_3)	24°52’60”	84°13'60”
Chanda (V_4)	26°21'08.4”	87°08'39.4”
Obra (V_5)	24° 52' 12.00”	84° 20' 24.00”
Rafiganj (V_6)	24° 49' 3.25"	84° 38' 4.02"
Jakhim (V_7)	24° 50' 00"	84° 33' 00"
Amba (V_8)	24° 48' 48"	84° 10' 45"
Kutumba (V_9)	24° 36’ 0”	84° 17' 60”
Deo (V_{10})	24° 39' 21.80”	84° 26' 8.32”

3. Results and Discussion

3.1 Soil Parameters

The results depicted in Table 2 show that the soil texture of Aurangabad villages which is clayey loam in V_1- Nabinagar V_2-Akohra V_3-Son Nagar V_4-Chanda V_6-Rafiganj V_7-Jakhim V_8-Amba V_{10}- Deo, sandy loam in V_9 -Kutumba and sandy clay loam in V_5 -Obra; Similar results were observed in Narwal *et al.* (2006) [10]. The bulk density of soil at 0-15, 15-30 cm depths respectively, was found to be significant at 5% critical difference. The maximum bulk density 1.26 and 1.32 Mg m-3 was recorded in Kutumba (V_9) is at 0-15 and 15-30 cm depth and minimum bulk density was 1.05and 1.08 Mg m-3 recorded in Rafiganj (V_6). The bulk density of the soil is increases with increase in soil depth. Generally, decreases in bulk density is due to high organic matter or wise versa. The bulk density is found varied from 1.05-1.32 Mg m^{-3} low to moderate, similarly result reported by Singh *et al.* (2016) [3] Low bulk density in soil is often an indicator of healthy soil with good structure and pore space because of high organic matter. However, Compaction can increase bulk density, as it reduces pore space and increases the mass of soil per unit volume. The results graphically presented in Fig. 1 also shows the particle density of the soils at 0- 15, 15-30 cm depths respectively and was found to be significant at 5% critical difference. The maximum particle density 2.65 and 2.67 Mg m^{-3} was found in Kutumba (V_9) at 0-15 and 15-30 cm depth and minimum particle density was recorded 2.34 and 2.36 Mg m^{-3} found in Rafiganj (V_6) maize-wheat. Particle density increase with depth same as bulk density. The particle density was decreases is due to high organic matter or vice versa. Particle density is basically bulk density without pore space The particle density found varied from 2.34-2.67 Mg m^{-3} which low to slightly high, similarly result reported by Singh *et al.* (2017) [19]. The results mentioned in Table 3 shows that the percent pore space of the soil at 0-15, 15-30 cm depths was found to be significant at 5% critical difference. The maximum percent pore space was 63.66 and 61.22 in village Rafiganj (V_6). The minimum percent pore space was recorded 48.10 and 46.22% found in village Kutumba (V_9). Pore space decreases down the depth due to the compaction and consolidation of the soil at greater depths. Soil containing high organic matter possesses high porosity. The pore space (%) found varied from 46.22-63.66% similarly result reported by Singh *et al.* (2014) [13]. The water holding capacity of soil at 0-15, 15-30 cm depths respectively was found to be significant at 5% critical difference. The maximum water holding capacity (%) found in Rafiganj (V_6) is 58.76 and 54.24% at depth 0-15 and 15-30 cm. The minimum value of water holding capacity (%) found in Kutumba (V_9) is 45.22 and 45.14% at depth 0-15 and 15-30 cm. Water holding capacity of soil can decrease with increasing depth due to increase in soil density with depth. As the weight of the soil above increases, the pressure on the underlying soil particles increases, causing them to become more tightly packed. This results in a decrease in the size and number of pore spaces between soil particles, which in turn reduces the soil's ability to hold water. As a result, the water holding capacity of soil tends to decrease with increasing depth similarly result reported by Sharma *et al.* (2013) [7]. The results mentioned in Fig. 2 show the soil pH and EC dSm^{-1} at 25 °C at 0-15, 15-30 cm depths respectively were found to be non- significant at 5% critical difference. The maximum pH was 7.82 and 7.89 values with recorded in Rafiganj (V_6) maize-wheat is at 0-15 and 15-30 cm depth and minimum pH was found in Akohra (V_2) rice-gram is 6.40 and 6.71. The increase in pH with depth of soil is possibly due to leaching down of salts from upper soil depth to lower soil depth, which is accumulation of salts in lower depth of soil and increase in soil pH. The value of is found varied from 6.40- 7.89 it is neutral to slightly alkaline in nature, similarly result reported by Singh and Singh (2018). The soils in Aurangabad district are derived from alluvial deposits and contain a high proportion of calcium carbonate, which can help to neutralize acidity and maintain a slightly alkaline pH. The groundwater in the region is often naturally alkaline due to the presence of dissolved minerals such as calcium and magnesium. When this water is used for irrigation, it can contribute to a more alkaline pH in the soil. The soil sample from Kutumba (V_9) had the highest EC values which was is 0.35 and 0.38 ds m-1 at 0-15 and 15-30 cm depth and the soil sample from Amba (V_8) had the lowest EC values which was 0.14 and 0.17 ds m-1 of 0-15 and 15-30 cm at depth Water percolating through the soil can carry dissolved salts down into the deeper layers of the soil. As a result, the concentration of dissolved salts and leaching, EC can decrease with depth. The EC ranges 0.14-0.38 ds m^{-1} and it is normal, similarly results found by Singh and Singh (2017). The per cent organic carbon of soil at 0-15, 15-30 cm depths was found to be significant at 5% critical difference. The maximum organic carbon is 0.67 and 0.62% was found in soil of of Rafiganj (V_6) at depth 0-15 and 15-30 cm and minimum value 0.44 and 0.42% of soil of Kutumba (V_9). The decrease in organic carbon content with increasing soil depth because the input of organic matter is generally greater near the soil surface due to the accumulation of plant residues and the activities of soil organisms. Microbial activity is higher in the surface layers of the soil where there is more oxygen available, which stimulates the decomposition of organic matter. The value of organic carbon percent is found in varied from 0.42-0.67% and this is low to medium level, similarly result reported by Yadav *et al.* (2017) [19]. The Aurangabad district is characterized by predominantly clayey loam soils, which tend to have lower organic matter content compared to soils with higher clay content. Table 4 shows the available nitrogen in kg ha-1 of soil at 0-15, 15-30 cm depth respectively where it was found to be significant at 5% critical difference. The maximum Available nitrogen was 312.40 and 284.48 kg ha-1 found in soil of Rafiganj (V_6) at 0-15 and 15-30 cm depth and minimum value 236.45-228.38 kg ha^{-1} in soil of (V_9) kutumba with depth 0-15 and 15-30 cm. Biological activity plays an important role in the cycling of nitrogen in soil. Microorganisms in the upper layers of soil consume and decompose organic matter, releasing nitrogen in forms that can be taken up by plants. However, as the soil depth increases, the amount of organic matter decreases, and microbial activity slows down, leading to a decrease in the availability of nitrogen. Leaching is another factor for decreasing nitrogen in lower depth The value of available nitrogen (kg ha^{-1}) is found in varied from 132.42-242.60 kg ha-1 is low to medium level similarly result reported by Arya *et al.* (2012) [22]. The available phosphorus of soil at 0-15, 15-30 cm depths respectively, was found to be significant at 5% critical difference. The maximum value of phosphorus 19.43 and 15.42 kg ha^{-1} was found in soil of Rafiganj(V_6) at depth 0-15 and 15-30 cm respectively and minimum value 10.85 and 8.42 kg ha-1 in soil of Chanda (V_4) at 0-15 and 15-30 cm. The value of available phosphorus (kg ha^{-1}) is found in varied from 8.42- 19.43 kg ha^{-1} is low to medium level similarly result reported by Gyawali *et al.* (2016) [5]. Table 4 also shows the available potassium of soil at 0-15, 15-30 cm depths respectively was found to be significant at 5% critical difference. The maximum value 284.76 and 264.71 kg ha^{-1} of potassium was found in soil of Nabinagar (V_1) at depth 0-15 and 15-30 cm and minimum value 145.54 and 138.52 kg ha^{-1} in soil of Jakhim (V_7) rice-rai at depth 0-15 and 15-30 cm. The value of available potassium kg ha^{-1} is found in varied from 138.52-284.76 kg ha^{-1}. Similarly result reported by Arya *et al.* (2012) [22]. The results in Fig. 3 show that the exchangeable calcium of soil at 0-15, 15-30 depths was found significant at 5% critical difference, The maximum value of Calcium 8.2 and 8.4 meq 100 g^{-1} was found in soil of Jakhim (V_7) at depth 0-15 and 15-30 cm and minimum value 3.2 and 3.6 meq 100 g^{-1} in soil of Akohra (V_2) at depth 0-15 and 15-30 cm. The value of Exchangeable Calcium (meq 100 g^{-1}) is found in varied from 2.08-8.77. Similarly result reported by Kukal *et al.* (2013) [7]. The exchangeable magnesium of soil at 0-15, 15-30 cm depths was found significant at 5% critical difference, The maximum value 1.43 and 1.52 meq 100 g^{-1} of Magnesium was found in soil of Amba (V_8) at depth 0-15 and 15-30 cm and minimum value 0.14 and 0.25 meq 100 g^{-1} in soil of Son Nagar (V_3) at depth 0-15 and 15-30 cm. The value of Exchangeable Magnesium (meq 100 g^{-1}) is found in varied from 0.14-1.43. Similarly result reported by Kumar *et al.* (2016) [3]

Table 2: Soil texture (sand, silt and clay %) of soil samples collected from different villages of Aurangabad district, Bihar at 0-15 and 15- 30 cm depth

Village	Soil texture			Textural classes name
	Sand (%)	Silt (%)	Clay (%)	
Nabinagar (V1)	43.80	20.0	36.20	Clay loam
Akohra (V2)	54.20	17.0	28.80	Clay loam
Son Nagar (V3)	52.60	18.70	28.70	Clay loam
Chanda (V4)	48.34	12.53	39.13	Clay loam
Obra (V5)	56.31	16.44	27.25	Sandy Clay loam
Rafiganj (V6)	46.75	19.45	33.80	Clay loam
Jakhim (V7)	39.82	27.24	32.94	Clay loam
Amba (V8)	45.29	23.67	31.04	Clay loam
Kutumba (V9)	68.55	19.90	11.55	Sandy loam
Deo(V10)	44.25	22.30	33.45	Clay loam

Table 3: Bulk density, particle density, Pore space%, Water holding capacity% of different villages of Aurangabad district.

Villages	Bulk density (Mg m-3)		Particle density (Mg m-3)		Pore space (%)		Water holding capacity (%)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
V_1	1.11	1.14	2.36	2.39	56.14	55.27	55.20	54.28
V_2	1.12	1.18	2.50	2.54	58.60	56.22	56.40	54.10
V_3	1.18	1.22	2.62	2.64	57.80	56.24	56.12	55.30
V_4	1.14	1.18	2.35	2.37	60.05	57.21	58.44	53.35
V_5	1.20	1.24	2.55	2.58	54.24	52.33	53.21	51.20
V_6	1.05	1.08	2.34	2.36	63.66	61.22	58.76	54.24
V_7	1.17	1.26	2.41	2.44	61.12	59.20	54.50	52.53
V_8	1.11	1.18	2.44	2.48	59.22	57.33	56.43	55.20
V_9	1.26	1.32	2.65	2.67	48.10	46.22	45.22	45.14
V_{10}	1.18	1.20	2.56	2.58	56.20	54.16	54.62	52.11
F-test	S	S	S	S	S	S	S	S
S. Em. (±)	0.018	0.016	0.016	0.023	0.817	0.949	0.823	0.814
C.D.@5%	0.055	0.048	0.048	0.068	2.412	2.802	2.430	2.402

Table 4: pH, EC, Organic carbon of different villages of Aurangabad district at 0-15 and 15-30 cm depth

Treatments	pH		EC (dS m-1)		Organic Carbon (%)	
	0-15 cm	15-30 cm	0-15 cm	15- 30 cm	0-15 cm	15-30 cm
V_1	7.45	7.60	0.14	0.16	0.62	0.60
V_2	6.4	6.71	0.21	0.24	0.64	0.61
V_3	5.02	5.56	0.18	0.06	0.61	0.58
V_4	7.61	7.84	0.14	0.20	0.65	0.64
V_5	7.42	7.83	0.13	0.16	0.56	0.53
V_6	7.82	7.89	0.18	0.20	0.67	0.62
V_7	7.65	7.80	0.23	0.26	0.63	0.58
V_8	6.55	6.78	0.14	0.17	0.64	0.61
V_9	8.0	8.16	0.35	0.38	0.44	0.42
V_{10}	7.15	7.98	0.16	0.18	0.64	0.60
F-test	S	S	S	S	S	S
S. Em. (±)	0.118	0.123	0.003	0.002	0.009	0.011
C.D.@ 5%	0.350	0.363	0.009	0.008	0.026	0.033

Table 5: Nitrogen, Phosphorus and potassium of different villages of Aurangabad district at 0-15 and 15-30 cm depth

Treatment	Nitrogen (kg ha-1)		Phosphorus (kg ha-1)		Potassium (kg ha-1)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
V_1	282.32	272.45	16.66	12.84	284.76	264.71
V_2	278.42	272.42	15.22	11.66	276.52	252.82
V_3	254.55	238.40	13.42	10.11	221.72	208.52
V_4	282.60	276.22	10.85	8.42	190.76	181.42
V_5	310.47	280.42	12.23	9.41	207.69	186.57
V_6	312.40	284.48	19.43	15.42	228.57	207.72
V_7	286.41	238.40	14.21	11.66	145.54	138.52
V_8	273.44	242.44	12.76	9.54	182.52	164.50
V_9	236.45	228.38	13.30	10.24	172.52	155.20
T_{10}	286.42	250.52	14.22	11.77	188.72	178.88
F-test	S	S	S	S	S	S
S. Em. (±)	4.310	3.661	0.199	0.140	3.165	2.422
C.D.@ 5%	12.715	10.800	0.589	0.414	9.338	7.146

Table 6: Exchangeable calcium, exchangeable magnesium of different villages of Aurangabad district at 0-15 and 15-30 cm depth

Treatment	Exchangeable calcium (meq 100 g^{-1})		Exchangeable magnesium (meq 100 g^{-1})	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm
V_1	4.5	4.8	0.33	0.43
V_2	3.2	3.6	0.25	0.34
V_3	5.5	5.7	0.14	0.25
V_4	3.2	3.4	0.57	0.65
V_5	5.6	5.6	0.96	1.10
V_6	3.3	3.6	1.26	1.34
V_7	8.2	8.4	0.22	0.32
V_8	4.4	4.5	1.43	1.52
V_9	5.4	5.7	1.23	1.32
T_{10}	5.0	5.4	1.05	1.14
F-test	S	S	S	S
S. Em. (±)	0.099	0.085	0.014	0.017
C.D.@ 5%	0.294	0.253	0.043	0.051

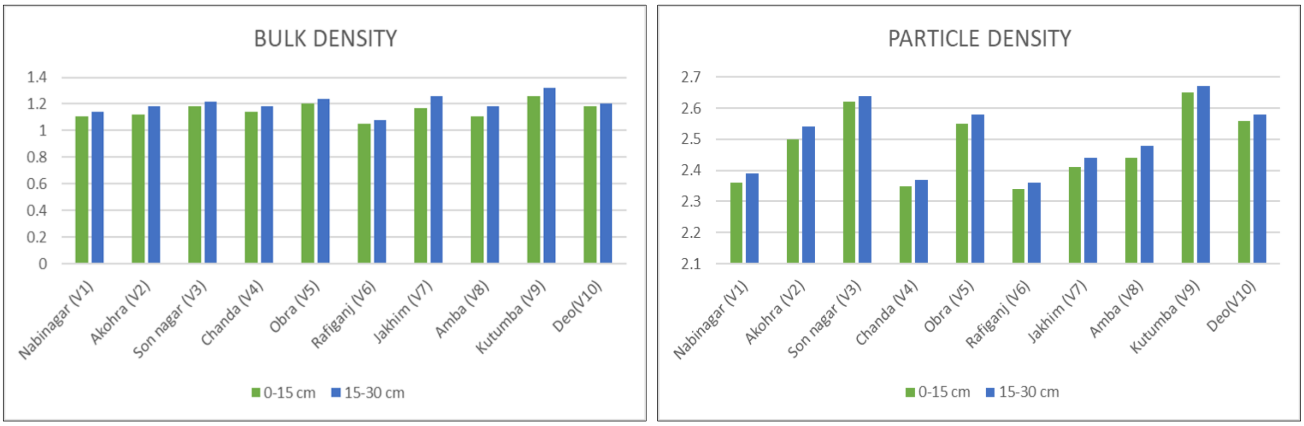

Fig 1: Graphical representation of bulk density (Mg m-3) and particle density (Mg m-3) of soil in different villages of Aurangabad district at 0-15 cm, 15-30 cm and 30-45 cm depths respectively

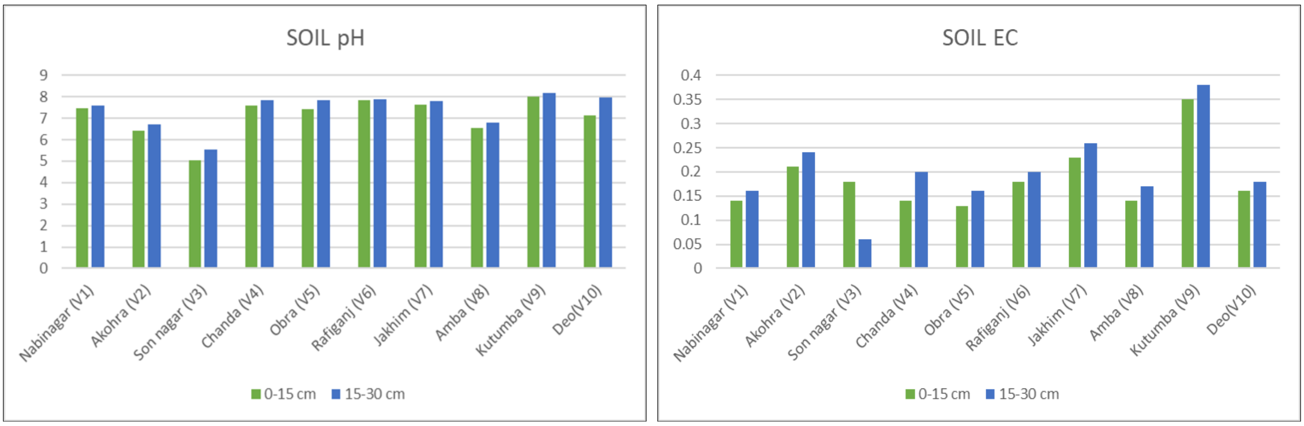

Fig 2: Graphical representation of soil pH and EC (dSm^{-1}) at 25˚C of soil in different villages of Aurangabad district at 0-15cm, 15-30 cm depth

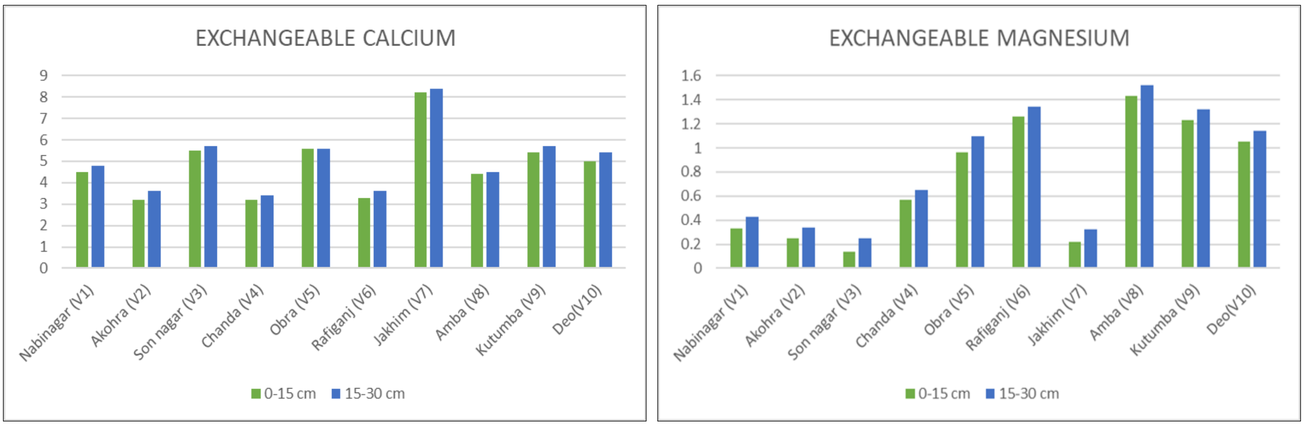

Fig 3: Graphical representation of exchangeable calcium (C mol(p) kg) and exchangeable + -1 magnesium (C mol (p) kg) of soil in different villages of Aurangabad district at 0-15 cm, 15-30 cm depths respectively

4. Conclusion

Soils were slightly alkaline and belong to low salinity class and are neutral in nature. Nitrogen and phosphorous content was Medium in all soils; potassium was medium except in one sample of Nabinagar (V1) 0-15 sample where it was high, organic carbon is medium high except in (V9). Hence these essential elements are to be supplemented through the addition of fertilizers in proper amounts which will bring maximum crop yield avoiding the pollution and saving the soil's health which harbours millions of microorganisms favouring the plant growth. We founded that nitrogen and phosphorus is medium in soil samle and micronutrient. Based on the soil health card analysis, the soil of research area shows variation in fertility with certain area exhibiting excellent nutrient content while some may require specific interventions. The soil health card enables farmers to identify the nutrient deficiencies and take appropriate fertilizer application to improve crop productivity

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6. Competing interests

Authors have declared that no competing interests exist.

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