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Assessment of Physico-Chemical Properties of Soil from Different Villages of Sundar Nagar Block of Mandi District of Himachal Pradesh, 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

One of the most popular phrases in agriculture is the term "Soil Health and Soil Quality." Agricultural sustainability is being dependent on soil health. Soil quality assessment is of paramount importance to know the appropriate management practices to be adopted for sustainable crop production. Soil samples were collected from Sunder Nagar block of Mandi district on Oct. 2022 in three depths viz. 0-15,15-30 and 30-45 cm and analysed for their Physico-chemical parameters by using standard laboratory techniques. Soil health parameters were analyzed and the founding state

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that, texture of soil is sandy loam. Soil reaction was neutral to slightly alkaline with soil EC mostly below <1.0 dS m^{-1} significantly affect for better crop production. In the case of organic carbon, nitrogen and phosphorus content of research area was found to be slightly low to medium while the range of potassium range was medium to high. The concentration levels of certain micronutrients were analyzed and the results indicate that zinc levels were low to slightly medium, copper levels were low to medium, iron levels were medium to high and manganese levels were medium to slightly high. For promoting the soil health and soil quality use of organic manure is recommended for fertilizer management.

Keywords: Soil health; sundar nagar block; physico-chemical properties; texture.

1. INTRODUCTION

Himachal Pradesh is in the western Himalayas. Covering an area of 55,673 square kilometers (21,495 sq m), it is a mountainous state. Most of the state lies on the foothills of the Dhauladhar Range. At 6,816 m, Reo Purgyil is the highest mountain peak in the state of Himachal Pradesh.

Sundar Nagar, Mandi District, Himachal Pradesh – $17^0$5'018'', India ($11^0$0'7.506''$76^0$5'6.552'') Co-ordinates: $31^0$23'2.63'' ^{0}N $76^0$6'06.05'' ^{0}E to $32^0$0'7.604'' ^{0}N $77^0$3'7.726''^{0}E Maximum elevation: 6.405 m, Minimum Elevation:272 m, Average elevation :1.945 m.

Soil is a dynamic, 3-dimensional natural body of the landscape developed from the weathering of rocks through various pedogenic processes, composed of mineral and organic materials, processing a defined set of physical, chemical and biological qualities, having variable depth covering the earth's surface, and providing a medium for terrestrial plant growth. The rate of soil deterioration is influenced by land use patterns, soil types, terrain and climate variables. Inappropriate land use is one of these variables that accelerates the deterioration of soil physico-chemical and biological quality [1].

The physical and chemical characteristics of soil plays a big role in the plants ability to extract water and nutrients. High quality soils not only produce better food and fiber, but also help to establish natural ecosystem and enhance air and water quality. The physical properties of soil depend upon the shape, structure, size, pore space, amount of organic matter and mineral composition of soil. The chemical properties of the soil are the interactions of various chemical constituents among soil particles and soil solution. The physical and chemical properties are soil texture, bulk density, water holding capacity, soil structure, soil colour, pH, electrical conductivity, cation exchange capacity, organic carbon and soil nutrients (macro and micro) (Griffiths et al., 2010).

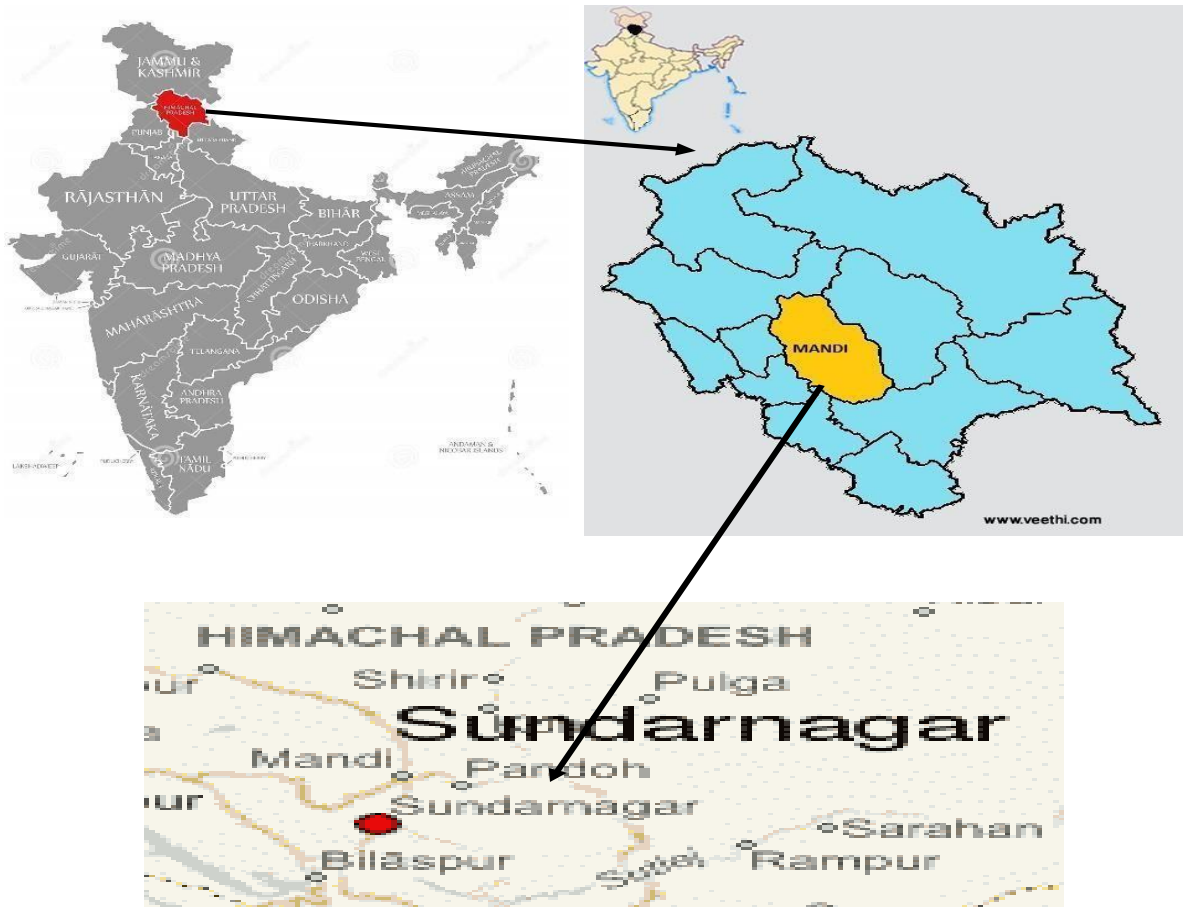
1.1 Agroclimatic Zones of Himachal Pradesh

Himachal is in the western Himalayas. Covering an area of 55,673 square kilometres (21,495 sqm), it is a mountainous state. Most of the state lies on the foothills of the Dhauladhar Range. At 6,816 m, Reo Purgyil is the highest mountain peak in the state of Himachal Pradesh. Sundar Nagar, Mandi District, Himachal Pradesh – 175018, India (11.07506 76.56552) Co-ordinates: 31.23263 76.60605 32.07604 77.37726, Maximum elevation: 6.405 m, Minimum Elevation:272 m, Average elevation: 1.945 m.

2. MATERIALS AND METHODS

Table 1. Sampling sites

S. No.	Village	Latitude (°N)	Longitude (°E)
1	**JUGAHAN**	11°3'41.947"	76°36'12.401"
2		11°3'27.392"	76°35'39.627"
3		11°0'3.791"	76°35'31.246"
4	**JARAL**	11°5'39.462"	76°37'16.399"
5		11°5'27.892"	76°37'8.677"
6		11°5'5095"	76°37'19.459"
7	**DHANOTU**	11°9'20.75"	76°39'50.745"
8		11°9'9.605"	76°39'20.937"
9		11°9'4.147"	76°38'55.266"



Central Survey of India

Map 1. Study area

2.1 Study Area

Soil samples were collected from three different villages *i.e.,* Jugahan, Jaral, Dhanotu blockof Sunder Nagar in Mandi district. From each village of soil samples were taken from three different area. Soil samples were collected from the highland, middle land and lowland fields thatare used for crop production.

2.2 Soil Sampling

Soil samples were collected from three different depths i.e., 0-15, 15-30 and 30-45 cm. Most root activity and fertilizer applications are generally restricted to 30-45 cm depth. Total number of soil sample were collected 27. First the surface area of the sampling spot was cleared out. Weeds, leaves, stones were removed. A 'V' shaped pit of 15 cm depth was dug out with the help of garden *hoe/spade*, depth was measured by a meter scale and 1 to 2 cm slice of soils were collected using garden *hoe/ spade/khurpi*. The soil was put in a clean white paper and was evenly spread out. Foreign materials like roots, stones, pebbles and gravels were removed. Then the soils were mixed thoroughly and quartered into four equal parts. Two opposite soil quarters were discarded and the remaining two were mixed up.

Each soil samples were spread on a clean white paper sheet in the shade and air dried at room temperature. The large lumps/clods were crushed/broken to its ultimate soil particle using awooden mallet. The powdered soil was sieved through 2 mm sieve. The soil material was collected in a clean cloth or polythene bag and was labelled properly for laboratory analysis.

Table 2. Analysis of physico-chemical properties of soil

Sr. No.	Particulars	Scientist name	Methods	Unit
I.	**Physical properties**			
1.	Bulk density	Muthuvel et al.,[2]	Measuring cylinder	Mg m^{-3}
2.	Particle density			Mg m^{-3}
3.	Pore space			%
4.	Water holding capacity			%
5.	Colour	Munsell, [3]	Munsell colour charts	Colour
6.	Texture (Sand, Slit, Clay %)	Bouyoucous, [4]	Bouyoucous hydrometer	Texture (Sand, Slit, Clay %)
II	**Chemical properties**			
1.	Soil pH (1:2.5)	Jackson, [5]	pH meter	
2.	Electrical conductivity (1:2.5)	Wilcox, [6]	digital conductivity meter	dS m^{-1}
3.	Organic carbon	Walkley and Black, [7]	Walkley and Black Wet oxidation method	kg ha^{-1}
4.	Available nitrogen	Subbiah and Asija, [8]	Modified alkaline permanganate oxidation method	kg ha^{-1}
5.	Available phosphorus	Olsen et al., [9].	Olsen's extraction followed by Spectrophotometric method	kg ha^{-1}
6.	Available potassium	Toth and Prince, [10]	Neutral normal ammonium acetate extraction fallowed by Flame photometric method	kg ha^{-1}

3. RESULTS AND DISCUSSION

3.1 Bulk Density

The highest bulk density was recorded in Dhanotu (V_3F_2) is 1.38, 1.40 and 1.43 (Mgm^{-3}) and lowest value of bulk density recorded in Jugahan (V_1F_1) 1.16, 1.19 and Dhanotu (V_3F_3) 1.22 ($Mg\ m^{-3}$) at depth 0-15, 15-30 and 30-45 cm. Similar results were earlier reported by Kumari et al*.,* 2013 and Pravin et al*.,* 2013.

3.2 Particle Density

The highest particle density was found in Dhanotu (V_3F_1) 2.49, 2.496 and 2.498 ($Mg\ m^{-3}$) and lowest value of particle density found in Jaral (V_1F_1) 2.261, 2.265 and 2.267 ($Mg\ m^{-3}$) at depth 0-15, 15-30 and 30-45 cm. Similar results were reported by Kumari et al*.,* 2013 and Pravin et al*.,* 2013.

3.3 Pore Space

The highest pore space was recorded in Dhanotu (V_3F_1) was 49.2, 48.9 and 47.5% and lowest value of pore space recorded in Dhanotu (V_3F_2) is 41.7, 41.2 and (V_3F_3) 40.2% at depth 0- 15, 15-30 and 30-45 cm. These results were similar with the findings of Ratnam et al*.,* 2001.

3.4 Water Holding Capacity

The highest water holding capacity (%) was recorded in Dhanotu (V_3F_1) 47.2, 46.9 and 45.5% and lowest value of water holding capacity (%) found in Dhanotu (V_3F_2) 39.7, 39.2 and 38.2% at depth 0-15,15-30 and 30-45 cm. Similar trends were observed by Venkateswarlu et al*.,* 1995 and Pulakeshi et al*.,* 2014.

3.5 pH

The highest pH values was recorded in Jugahan (V_1F_2) 7.63, 7.66 and 7.68 and lowest value of pH Dhanotu (V_3F_2) 6.94 ,7.02 and 7.24 at depth 0-15,15-30 and 30-45 cm. similar trend was observed by Kekane [11]; Patel [12] and Kumari et al*.,* 2005.

3.6 EC

The highest values was recorded in EC Dhanotu (V_3F_3) 0.325, Jugahan (V_1F_1) 0.217 and (V_1F_3) 0.490 ($dS\ m^{-1}$) and lowest value of EC Dhanout (V_3F_1) 159, (V_3F_3) 0.140 and 0.308 ($dS\ m^{-1}$) at depth 0-15, 15-30 and 30-45 cm. These results were in accordance with the findings of Krishnamurthy et al*.,* 2007.

3.7 Organic Carbon

The highest value of organic carbon percent was found in soil of Jaral (V_2F_2) 0.381, 0.377 and 0.372% and lowest value of OC Jaral (V_2F_3) 0.314, 0.308 and 0.305% at depth 0-15, 15- 30 and 30-45 cm. These results were similar with the findings of Ratnam et al. (2001).

3.8 Available Nitrogen

The highest value of available nitrogen was found in soil of Jaral (V_2F_2) 246.39, 241.11 and Jughan (V_1F_3) 234.38 kg ha^{-1} and lowest value in soil of Jaral (V_2F_3) 216.18, 209.38 and 200.37 kg ha^{-1} with depth 0-15, 15-30 and 30-45 cm. Similar observations of reported by Bandyopadhyay et al*.,* 2004.

3.9 Available Phosphorus

The highest value of available phosphorus was found in soil of Dhanotu (V_3F_2) 19.26, 17.26 and 14.88 kg ha^{-1} and lowest value in soil of Jugahan (V_1F_2) 10.88, 8.23 and 7.26 kg ha^{-1} with depth 0-15, 15-30 and 30-45 cm. Similar observations of high phosphorus content were reported by Bandyopadhyay et al*.,* 2004.

3.10 Available Potassium

The maximum value of available potassium was found in soil of Dhanotu (V_3F_2) 157.77, 153.48 and 149.38 kg ha^{-1} and minimum value in soil of Jaral (V_2F_3) 125.63, 118.48 and 130.53 kg ha^{-1} with depth 0-15, 15-30 and 30-45 cm. Similar observations of high potassium content were reported by Bandyopadhyay et al*.,* 2004.

3.11 Available Iron

The highest value of Iron is found in soil of Dhanotu (V_3F_1) 22.48, Jugahan (V_1F_3) 21.38 and (V_1F_3) 21.30 ppm and lowest value in soil of Jaral (V_2F_1)17.27, 15.58 and 13.69 ppm with depth 0-15,15-30 and 30-45 cm. The pH range is generally between 7.0 to 8.5, which is considered slightly alkaline. Similarly result reported by Shukla et al*.,* 2015.

3.12 Available Manganese

The highest value of Manganese is found in soil of Dhanotu (V_3F_1) 18.91, (V_3F_2) 16.80 and 15.23 ppm and lowest value in soil of Jaral (V_2F_1) 8.55, 7.39 and 6.01 ppm with depth 0-15, 15-30 and 30-45 cm respectively. Similarly result reported by Shukla et al*.,* 2015.

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

Name of village and Farmer's field		Bulk density (Mg m^{-3})			Particle density (Mg m^{-3})			Pore Space (%)			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
JUGAHAN	V_1F_1	1.16	1.19	1.3	2.273	2.275	2.279	47.10	46.10	45.20	45.1	44.1	43.1
	V_1F_2	1.24	1.26	1.29	2.284	2.288	2.289	48.80	47.10	45.20	46.8	45.1	43.2
	V_1F_3	1.17	1.2	1.23	2.272	2.274	2.276	44.77	43.80	42.20	42.7	41.8	40.2
JARAL	V_2F_1	1.3	1.33	1.35	2.381	2.385	2.389	46.60	47.80	43.50	44.6	42.8	41.5
	V_2F_2	1.37	1.39	1.4	2.363	2.365	2.389	45.60	44.40	43.90	44.6	42.4	41.9
	V_2F_3	1.22	1.25	1.27	2.261	2.265	2.267	47.40	46.10	45.20	45.4	44.1	43.2
DHANOTU	V_3F_1	1.24	1.27	1.3	2.49	2.496	2.498	49.90	48.90	47.50	47.2	46.9	45.5
	V_3F_2	1.38	1.4	1.43	2.452	2.456	2.458	41.70	41.20	40.90	39.7	39.2	38.2
	V_3F_3	1.17	1.2	1.22	2.471	2.473	2.477	42.70	41.70	40.20	40.7	39.7	38.9
F- test		S	S	S	S	S	S	S	S	S	S	S	S
S.Em. (±)		0.01	0.02	0.01	0.03	0.03	0.03	0.64	0.43	0.64	0.59	0.38	0.55
C. D. (P =0.05)		0.04	0.06	0.05	0.10	0.11	0.11	1.92	1.28	1.90	1.75	1.14	1.65

Table 4. pH (w/v), EC (dSm^{-1}) and organic carbon (%) of soil at different depth

Name of village and Farmer's field		pH(w/v)			EC (dS m^{-1})			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
JUGAHAN	V_1F_1	7.34	7.45	7.64	0.25	0.26	0.29	0.367	0.361	0.354
	V_1F_2	7.39	7.40	7.68	0.40	0.43	0.45	0.323	0.317	0.311
	V_1F_3	7.35	7.37	7.38	0.28	0.30	0.31	0.348	0.341	0.337
JARAL	V_2F_1	7.31	7.43	7.58	0.24	0.26	0.29	0.328	0.321	0.316
	V_2F_2	7.42	7.43	7.45	0.29	0.31	0.33	0.381	0.377	0.372
	V_2F_3	7.47	7.49	7.53	0.39	0.38	0.36	0.314	0.308	0.305
DHANOTU	V_3F_1	7.32	7.41	7.28	0.23	0.25	0.26	0.359	0.352	0.348
	V_3F_2	7.28	7.46	7.24	0.20	0.22	0.24	0.339	0.333	0.329
	V_3F_3	7.34	7.45	7.51	0.25	0.26	0.30	0.345	0.340	0.337
F- test		NS	NS	NS	NS	NS	NS	S	S	S
S.Em. (±)		-	-	-	-	-	-	0.005	0.004	0.004
C. D. (P =0.05)		-	-	-	-	-	-	0.017	0.010	0.012

Table 5. Available nitrogen (kg ha^{-1}), available phosphorus (kg ha^{-1}) and available potassium (kg ha^{-1}) of soil at different depth

Name of village and Farmer's field		Available nitrogen (kg ha^{-1})			Available phosphorus (kg ha^{-1})			Available 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
JUGAHAN	V_1F_1	246.36	235.38	231.24	16.91	13.32	10.23	151.08	144.98	142.63
	V_1F_2	220.48	213.36	209.44	10.88	8.23	7.26	132.31	127.56	120.66
	V_1F_3	242.41	238.96	234.38	14.32	12.98	11.22	135.00	130.09	126.21
JARAL	V_2F_1	239.88	234.46	227.31	16.28	12.32	9.68	150.11	145.38	141.27
	V_2F_2	246.39	241.11	233.97	15.32	13.66	11.78	142.22	137.42	132.98
	V_2F_3	216.18	209.23	200.37	14.31	12.76	10.84	125.63	118.48	130.53
DHANOTU	V_3F_1	243.73	237.89	231.23	18.26	16.34	12.98	157.77	153.48	149.38
	V_3F_2	240.01	236.38	232.98	19.26	17.26	14.88	156.63	152.36	148.39
	V_3F_3	241.71	237.86	233.48	17.87	15.58	12.26	152.67	148.23	144.49
F- test		S	S	S	S	S	S	S	S	S
S.Em. (±)		3.13	3.38	3.72	0.26	0.20	0.19	2.47	1.96	1.42
C. D. (P =0.05)		9.30	10.06	11.06	0.79	0.60	0.56	7.36	5.83	4.21

Table 6. Available iron (ppm), available manganese (ppm), available zinc (ppm) and available copper (ppm) of soil at different depth

Name of village and Farmer's field		Available iron (ppm)			Available manganese (ppm)			Available zinc (ppm)			Available copper (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	0-15 cm	15-30 cm	30-45 cm
	V_1F_1	21.62	20.60	19.10	14.25	11.63	10.75	2.46	2.44	2.34	2.7	2.59	2.32
JUGAHAN	V_1F_2	21.38	20.84	19.88	11.26	10.49	9.73	3.71	2.53	2.32	3.56	2.88	2.62
	V_1F_3	21.3	21.38	21.30	9.03	8.71	7.28	3.43	3.18	2.16	3.41	3.23	2.75
JARAL	V_2F_1	17.27	15.58	13.69	8.55	7.39	6.01	2.44	1.7	1.55	2.3	2.2	1.79
	V_2F_2	20.84	19.15	17.00	10.67	9.31	8.54	2.71	2.49	2.23	2.7	2.32	2.32
	V_2F_3	17.87	16.72	13.84	9.24	9.17	7.02	2.5	2.35	2.01	2.48	2.17	2.03
DHANOTU	V_3F_1	22.48	19.01	15.12	18.91	15.43	10.92	2.4	2.32	1.79	1.85	1.63	1.29
	V_3F_2	19.79	19.79	19.56	17.58	16.8	15.23	1.58	1.52	1.49	1.53	1.51	1.02
	V_3F_3	19.01	18.64	16.95	17.9	12.510	12.3	3.05	2.72	2.55	3.05	2.72	2.55
F- test		S	S	S	S	S	S	S	S	S	S	S	S
S.Em. (±)		0.27	0.33	0.29	0.20	0.17	0.13	0.03	0.04	0.02	0.02	0.02	0.04
C. D. (P =0.05)		0.81	0.98	0.87	0.60	0.52	0.40	0.10	0.12	0.08	0.08	0.06	0.11

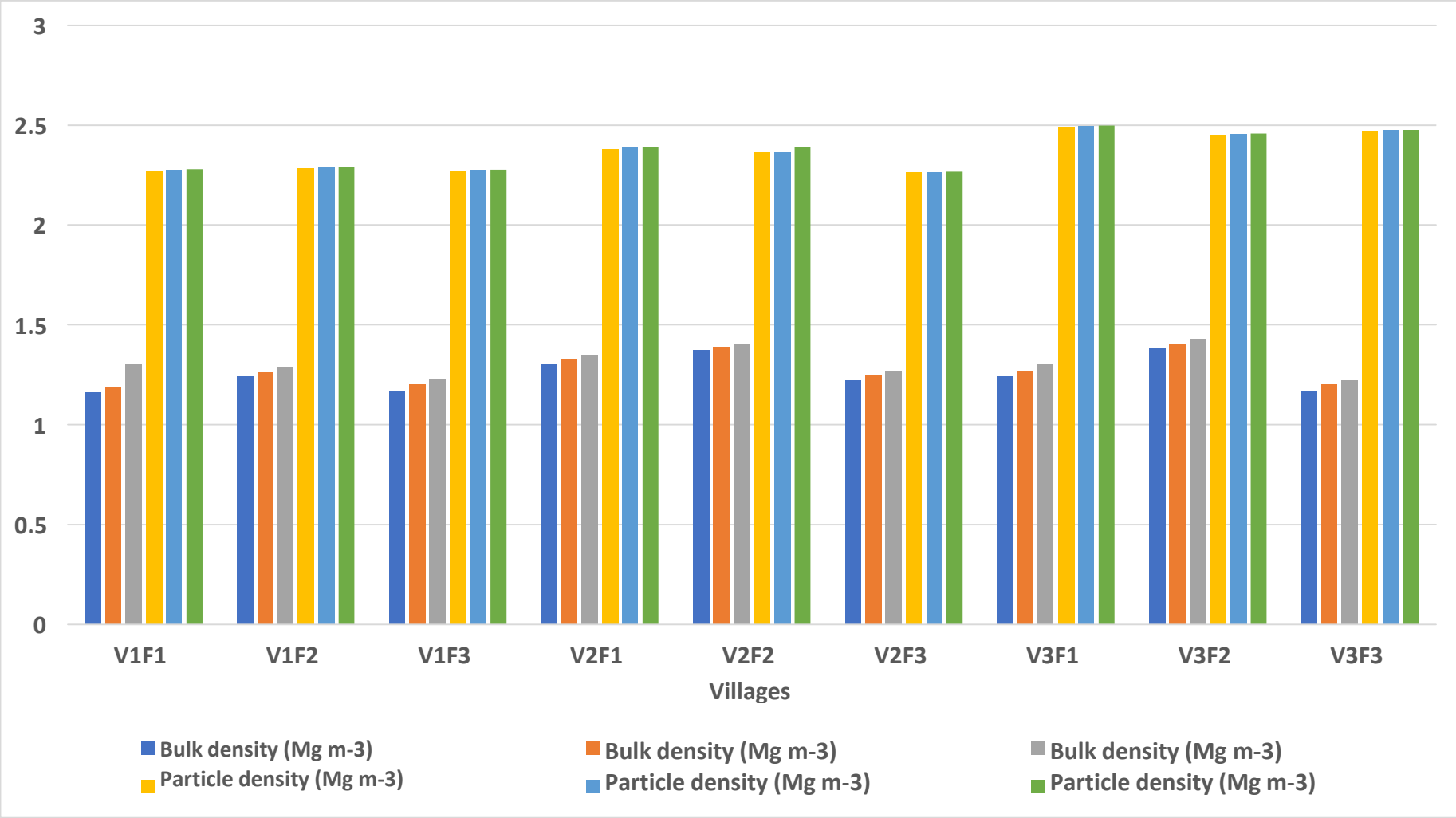


Fig. 1. Bulk density (Mg m-3), and particle density (Mg m-3) of soil at different depth

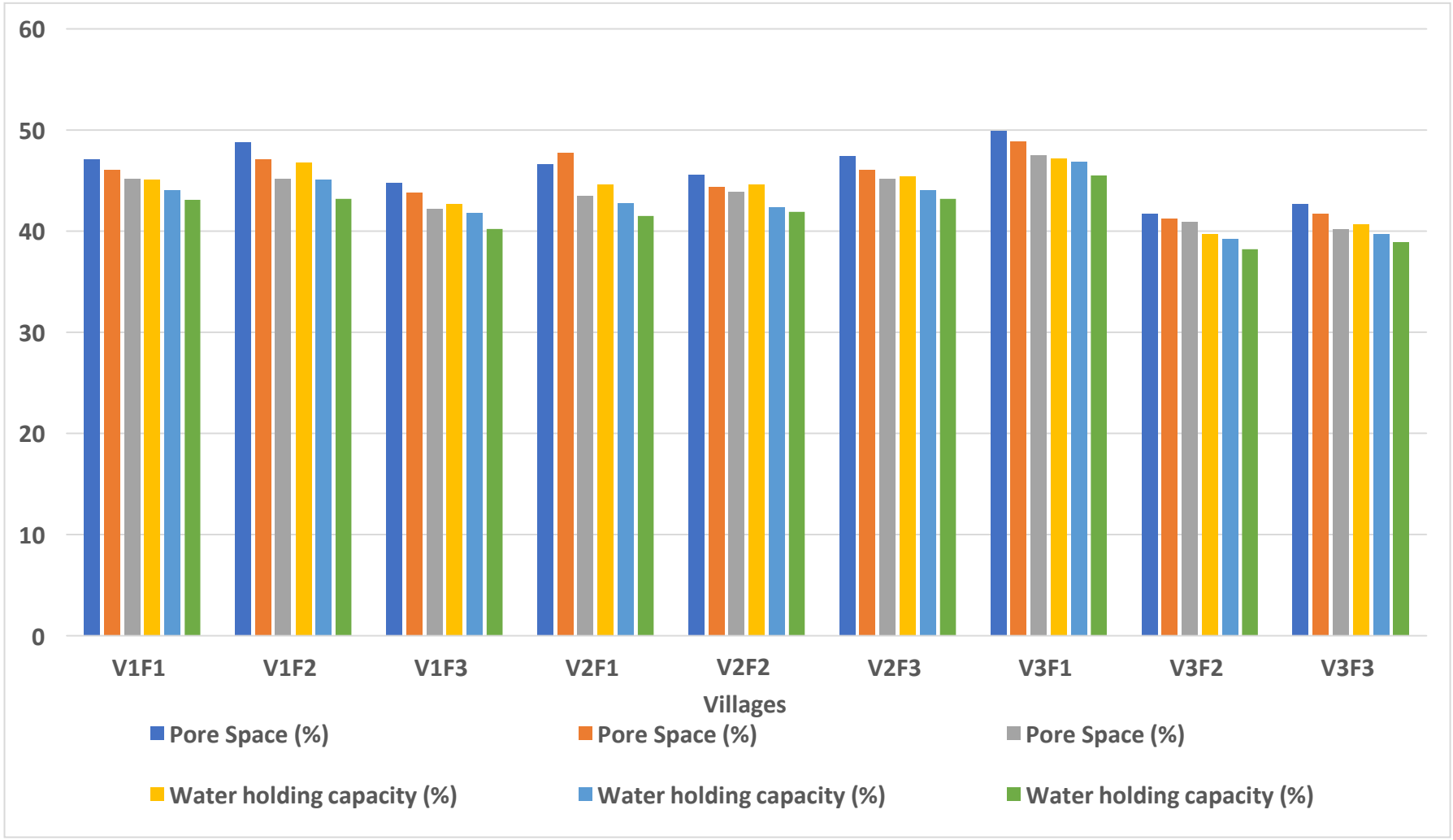


Fig. 2. Pore space (%) and water holding Capacity of soil at different depth.

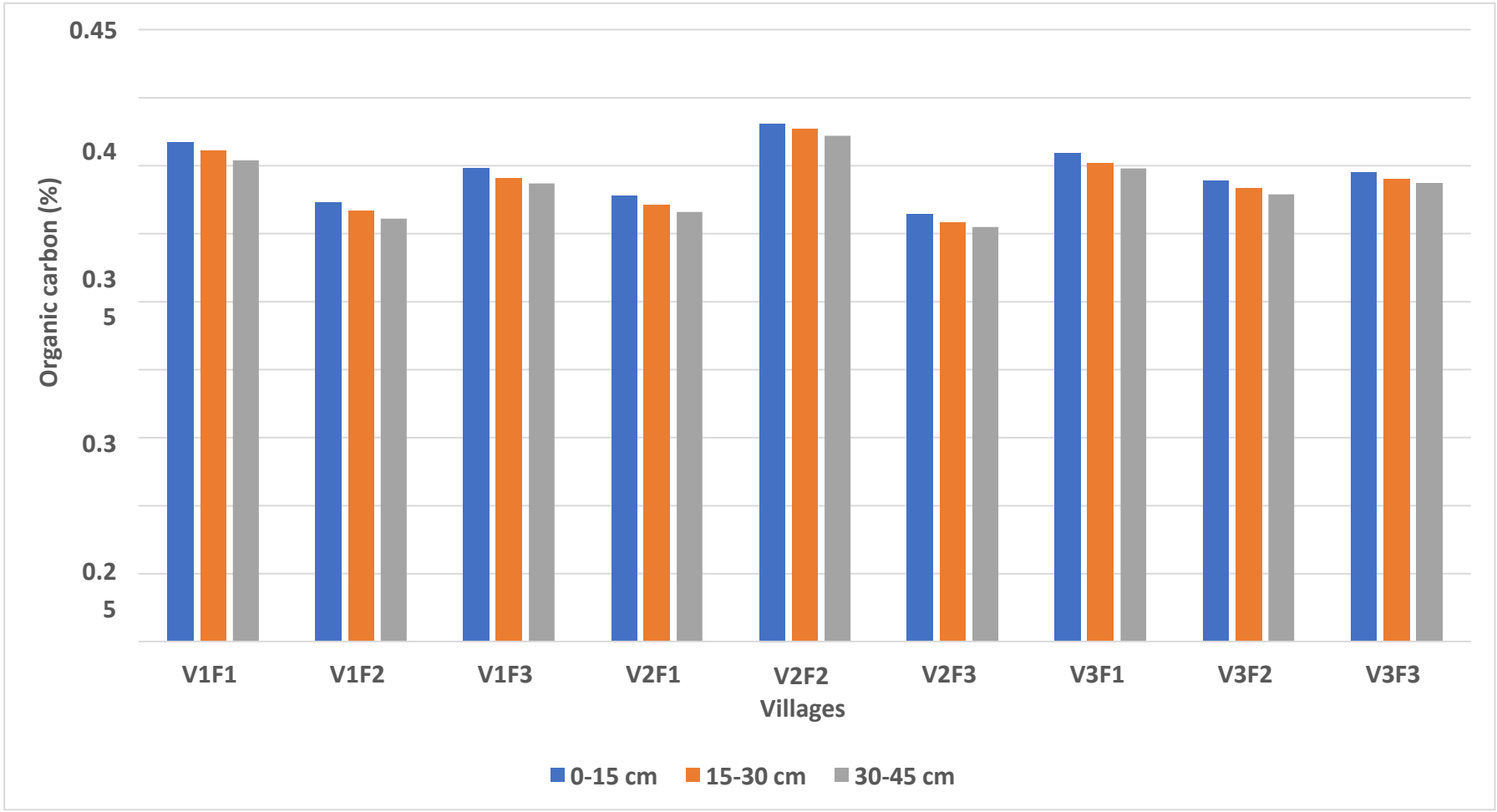


Fig. 3. Organic carbon (%) of soil at different depth

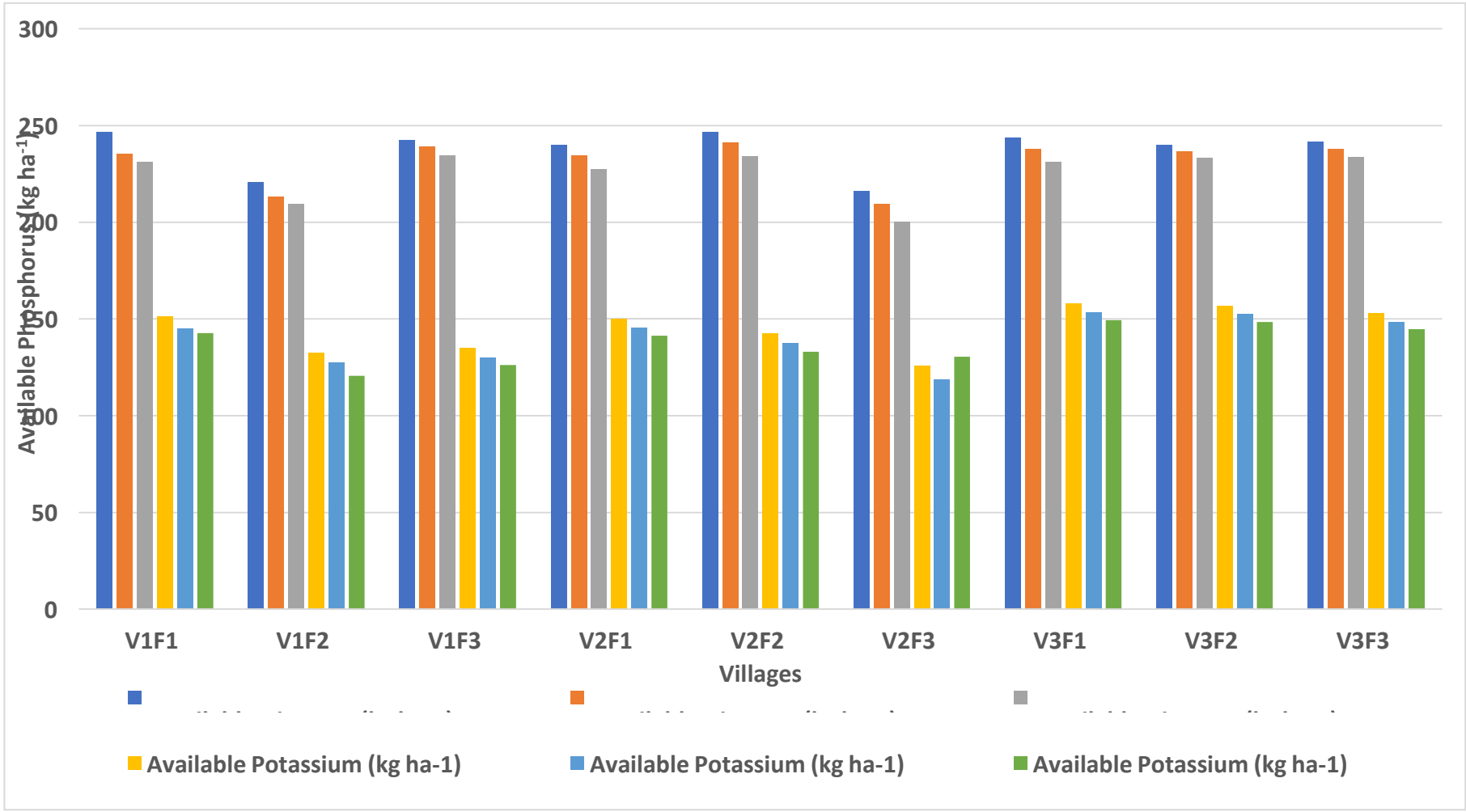


Fig. 4. Available nitrogen (kg ha^{-1}), and available potassium (kg ha^{-1}) of soil at different depth

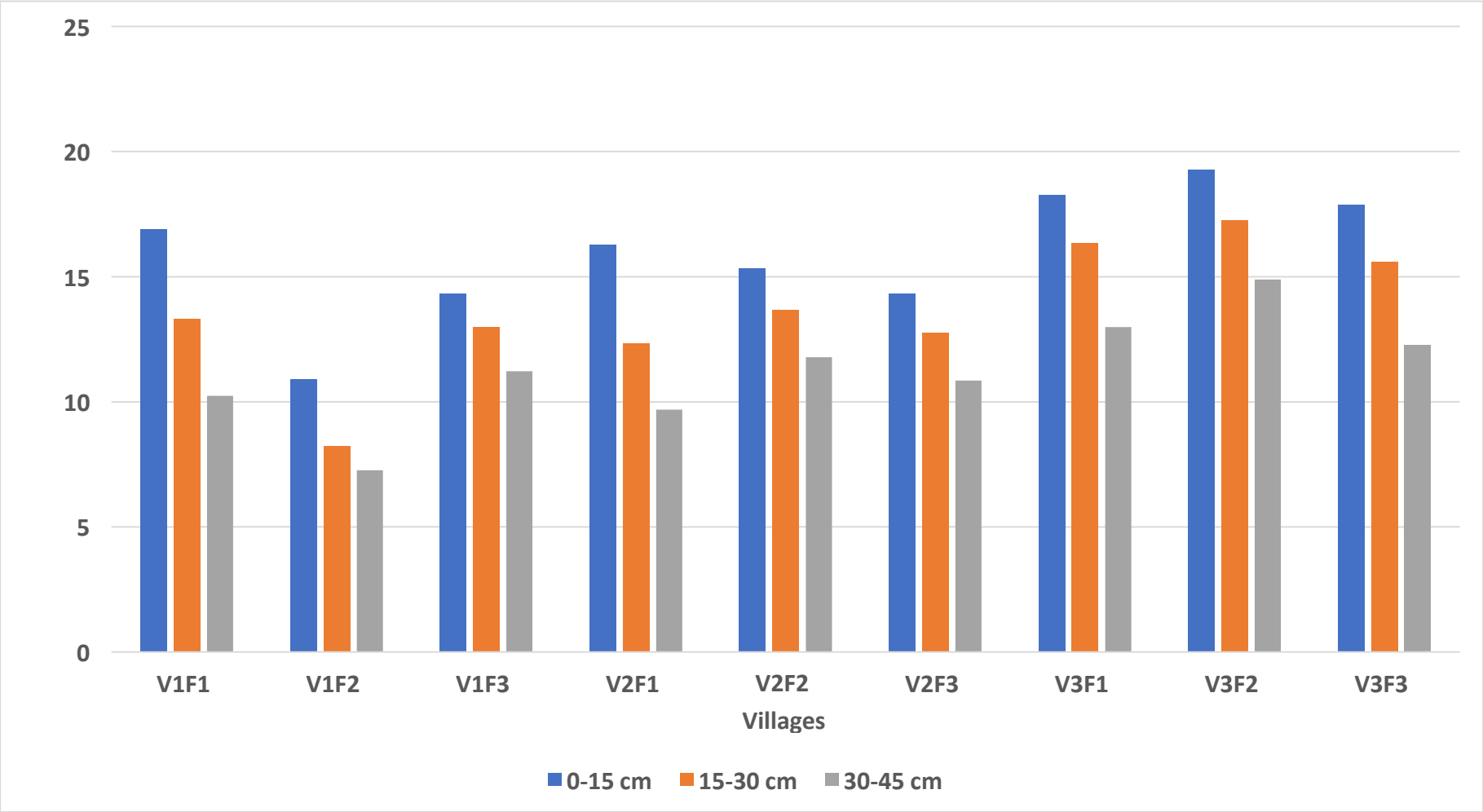


Fig. 5. Available phosphorus (kg ha^{-1}) of soil at different depth

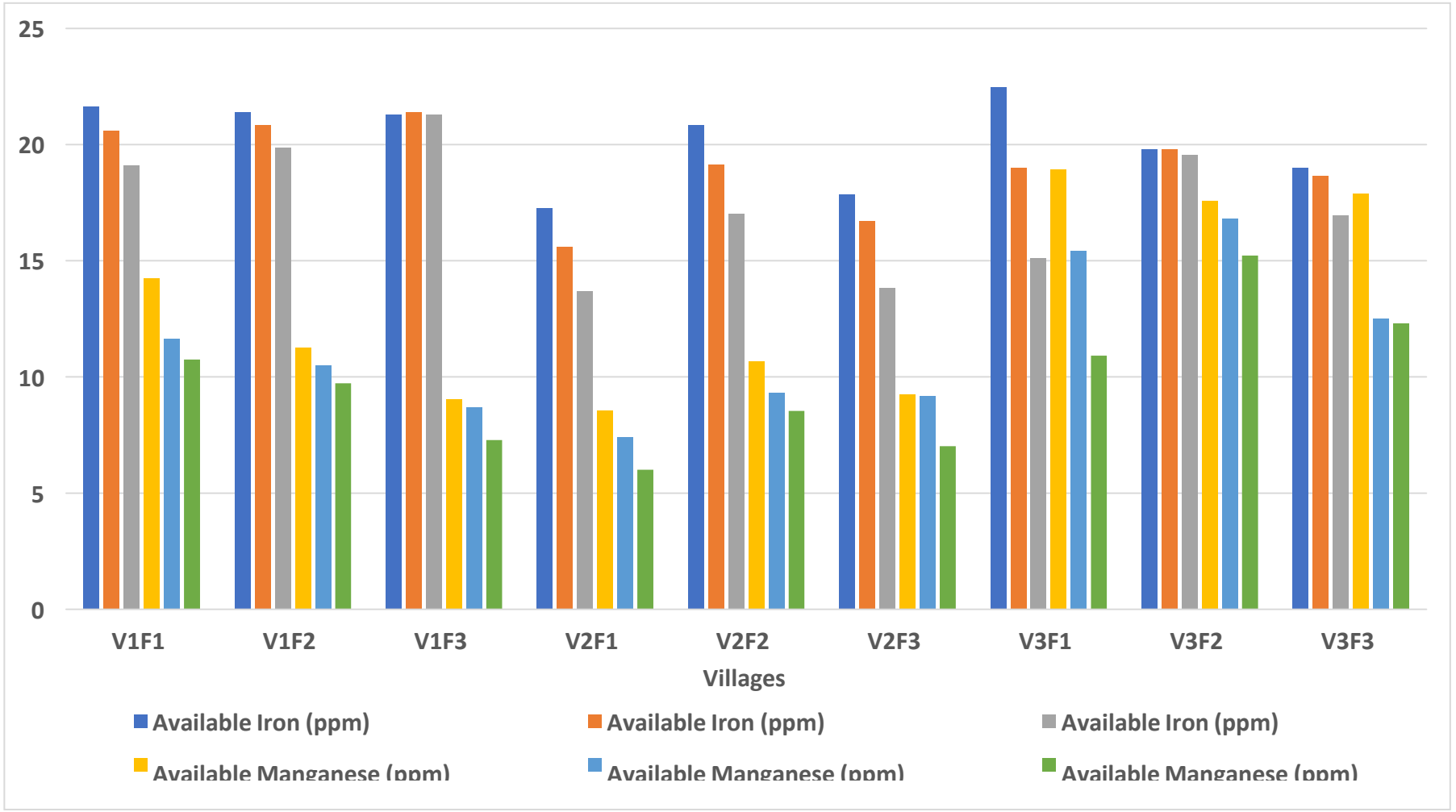


Fig. 6. Available iron (ppm), and available manganese (ppm) of soil at different depth

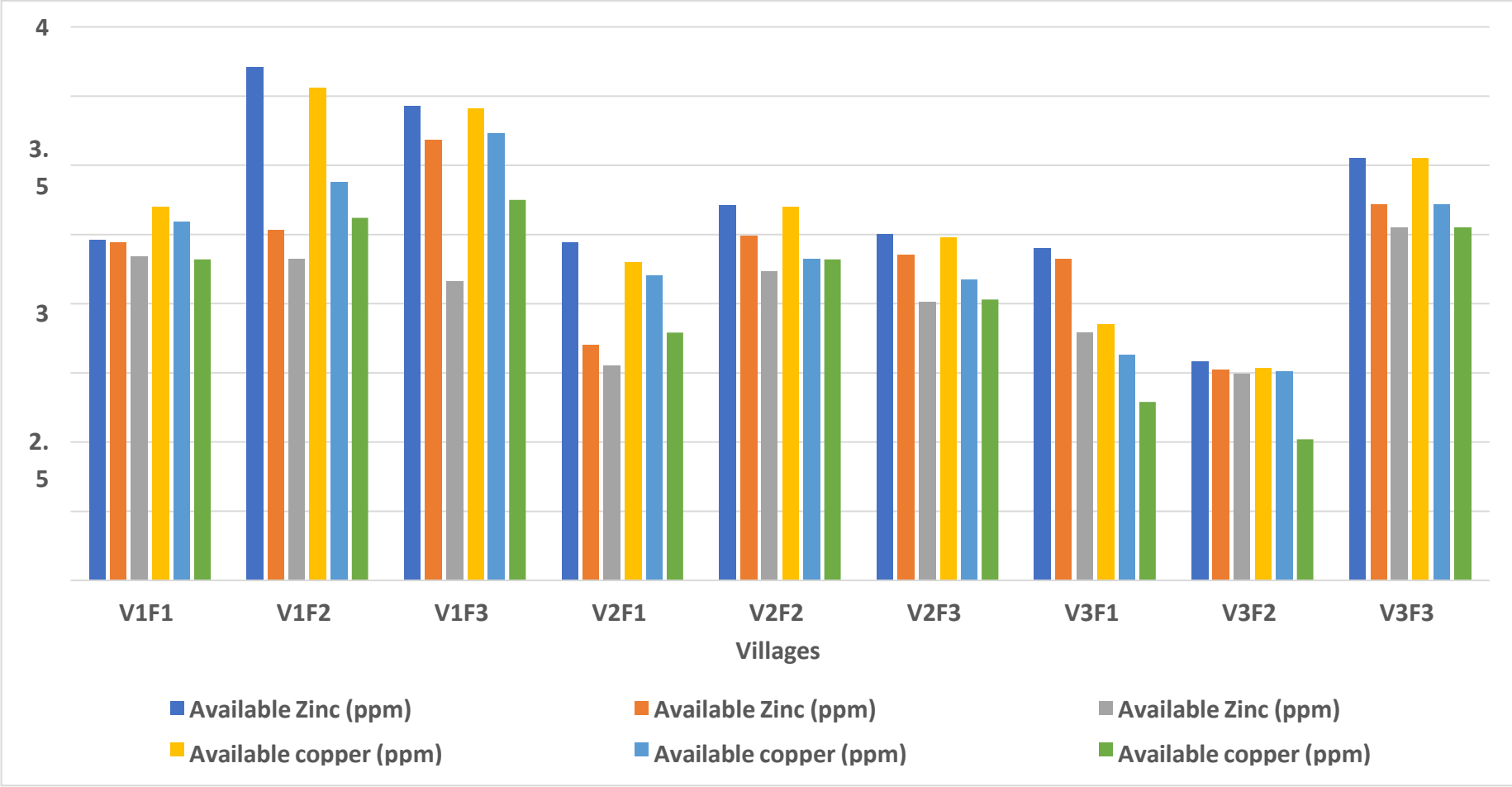


Fig. 7. Available zinc (ppm) and available copper (ppm) of soil at different depth

3.13 Available Zinc

The highest value of Zinc is found in soil of Jugahan (V_1F_2) 3.17, (V_1F_3) 3.18 and Dhanotu (V_3F_3) 2.55 ppm and lowest value in soil of Dhanotu (V_3F_2) 1.58, 1.52 and 1.49 ppm with depth 0-15, 15-30 and 30-45 cm. Similarly result reported by Shukla et al., 2015.

3.14 Available Copper

The highest value of copper was found in soil of Jugahan (V_1F_2) 3.56, (V_1F_3) 3.23 and 2.75 ppm and minimum value in soil of Dhanotu (V_3F_2) 1.53, 1.51 and 1.02 ppm with depth 0-15 15-30 and 30-45 cm. The value of copper (ppm) is found invaried from 1.63-7.54. Similarly result reported by Shukla et al*.,* 2015.

4. CONCLUSION

It is concluded that the soils samples were moderately to strongly alkaline in reaction and non-saline. The physical properties of both surficial and sub-surficial soils are normal as the bulk density value is optimum. The Water Holding Capacity is medium. The overall fertility status of the soils was low, medium and high in nitrogen, phosphorus and potassium respectively. As the soils were calcareous and strongly alkaline, there is need for application of any acid forming amendment and organic materials to alleviate the nutrient deficiency and improve productivity.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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