Original Research Article

Assessment of Physico-chemical properties of soil from different villages of Sundar Nagarblock of Mandi district of Himachal Pradesh

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 analysed and the founding state 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 medium to medium while the range of Potassium was sufficient. 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, Shahabad block, Physico-chemical properties, Texture, etc.

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

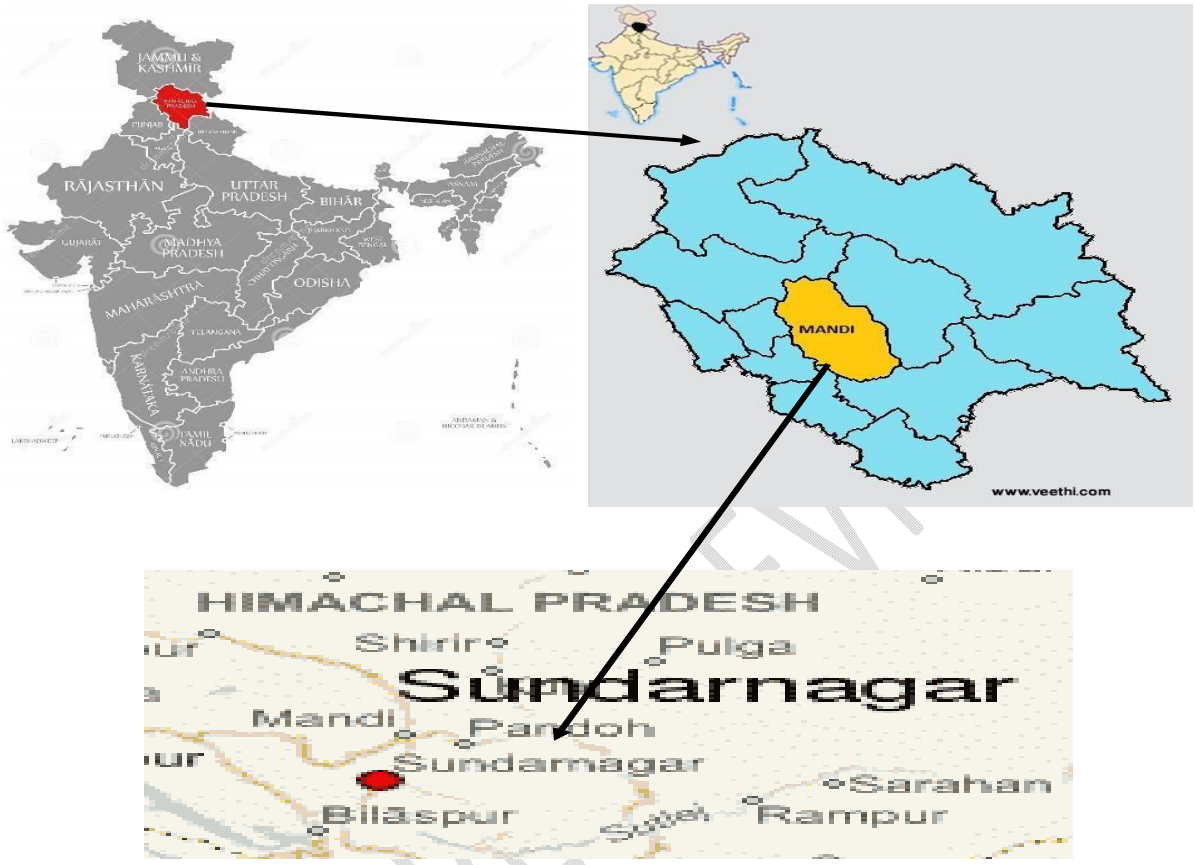
variable depth covering the earth's surface, and providing a medium for terrestrial plant growth. The rate of soil deterioration is influenced by land use patterns, soil types, terrain and climate variables. Inappropriate land use is one of these variables that accelerates the deterioration of soil physico-chemical and biological quality. **(Bindu *et al*., 2022).**

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).**

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.

Materials and Methods



Map 1 : Central Survey of India

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”

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.

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.*,1992	Measuring cylinder	Mgm^{-3}
2.	Particle density			$Mg\ m^{-3}$
3.	Pore space			%
4.	Water holding capacity			%
5.	Colour	Munsell,1971	Munsell colour charts	Colour
6.	Texture (Sand, Slit, Clay %)	Bouyoucous,1927	Bouyoucous hydrometer	Texture (Sand, Slit,

				Clay %)
II	**Chemical properties**			
1.	Soil pH (1:2.5)	M. L. Jackson, 1958	pH meter	
2.	Electrical conductivity (1:2.5)	Wilcox, 1950	digital conductivity meter	dSm^{-1}
3.	Organic carbon	Walkley and Black, 1947	Walkley and Black Wet oxidation method	kg ha^{-1}
4.	Available nitrogen	Subbiah and Asija, 1956	Modified alkaline permanganate oxidation method	kg ha^{-1}
5.	Available phosphorus	Olsen *et al.*, 1954.	Olsen's extraction followed by Spectrophotometric method	kg ha^{-1}
6.	Available potassium	Toth and Prince, 1949	Neutral normal ammonium acetate extraction fallowed by Flame photometric method	kg ha^{-1}

Result and Discussion

The maximum bulk density was recorded in Dhanotu (V_3F_2) is 1.38, 1.40 and 1.43 (Mgm^{-3}) and minimum 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 Lalitha Kumari *et al.,* 2013 and Pravin *et al.,* 2013.

The maximum particle density was found in Dhanotu (V_3F_1) 2.49, 2.496 and 2.498 (Mg m^{-3}) and minimum 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 earlier reported by Brar (1991), Lalitha Kumari *et al.*, 2013 and Pravin *et al.*, 2013.

The maximum pore space was recorded in Dhanotu (V_3F_1) was 49.2, 48.9 and 47.5 % and minimum 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.

The maximum water holding capacity (%) was recorded in Dhanotu (V_3F_1) 47.2, 46.9 and 45.5 % and minimum 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.

The maximum pH values with recorded in Jugahan (V_1F_2) 7.63, 7.66 and 7.68 and minimum 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 2015; Patel 2015 and Kumari *et al.,* 2005.

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

The maximum value of organic carbon percent is found in soil of Jaral (V_2F_2) 0.381, 0.377 and 0.372 % and minimum 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).

The maximum value of nitrogen is found in soil of Jaral (V_2F_2) 246.39, 241.11 and Jughan (V_1F_3) 234.38 kg ha^{-1} and minimum value in soilof 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.

The maximum value of phosphorus is found in soil of Dhanotu (V_3F_2) 19.26, 17.26 and 14.88 kg ha^{-1} and minimum 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.

The maximum value of potassium is 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.

The maximum 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 minimum 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.

The maximum value of Manganese is found in soil of Dhanotu (V_3F_1) 18.91, (V_3F_2) 16.80 and 15.23 ppm and minimum 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 resultreported by Shukla *et al.,* 2015.

The maximum 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 minimum 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.

The maximum value of copper is 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.

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.

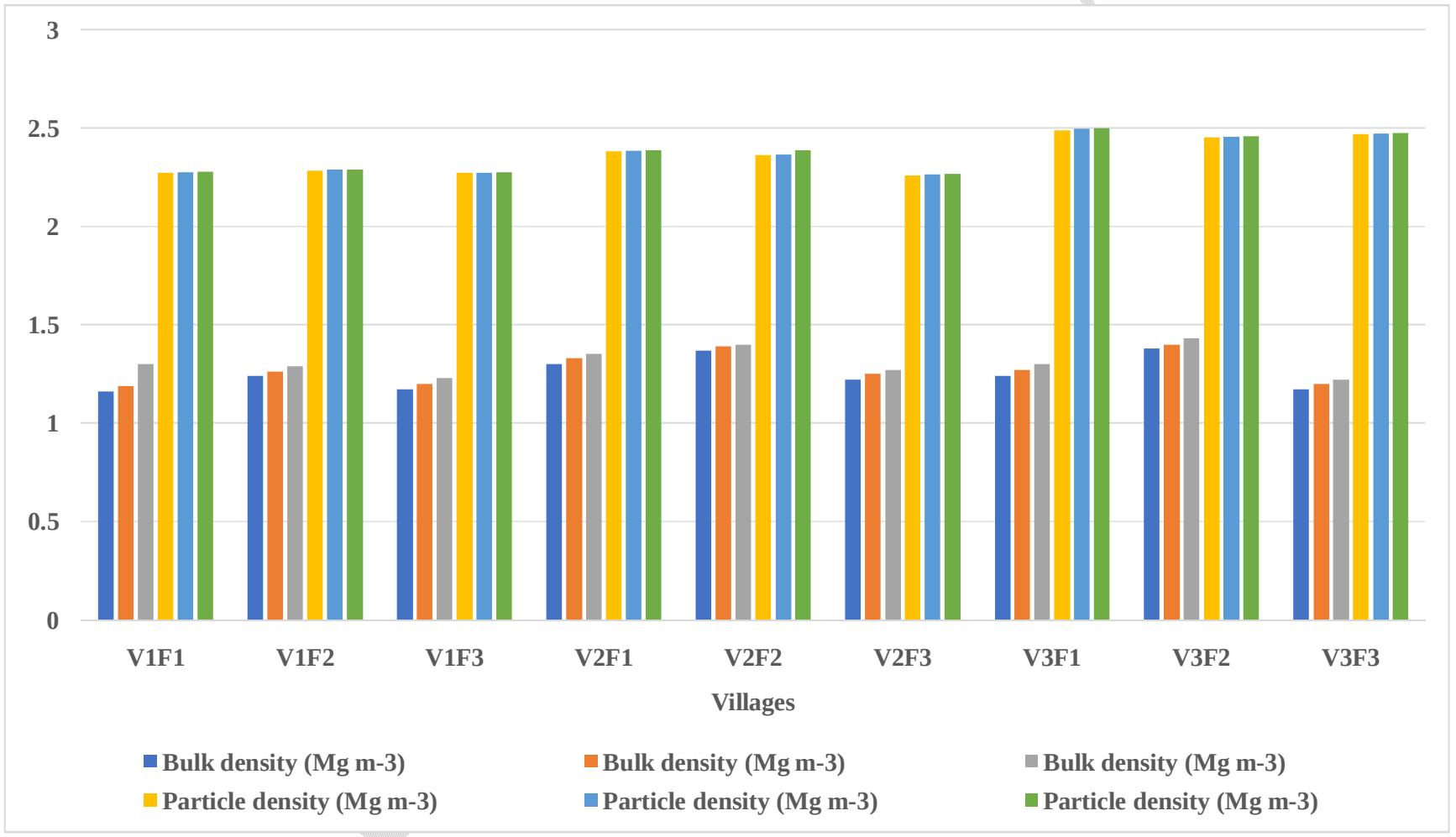
Name of Village and Farmer's Field		pH(w/v)			EC (dSm^{-1})			Organic carbon (%)		
		0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
JUGAHAN	V_1F_1	7.34	7.45	7.64	0.25	0.26	0.29	0.367	0.361	0.354
	V_1F_2	7.39	7.40	7.68	0.40	0.43	0.45	0.323	0.317	0.311
	V_1F_3	7.35	7.37	7.38	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
JUGAHAN	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
	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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Villages
Bulk density (Mg m-3)
Bulk density (Mg m-3)
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Particle density (Mg m-3)
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Fig. 1: Bulk density (Mg m^{-3}), and particle density (Mg m^{-3}) of soil at different depth.

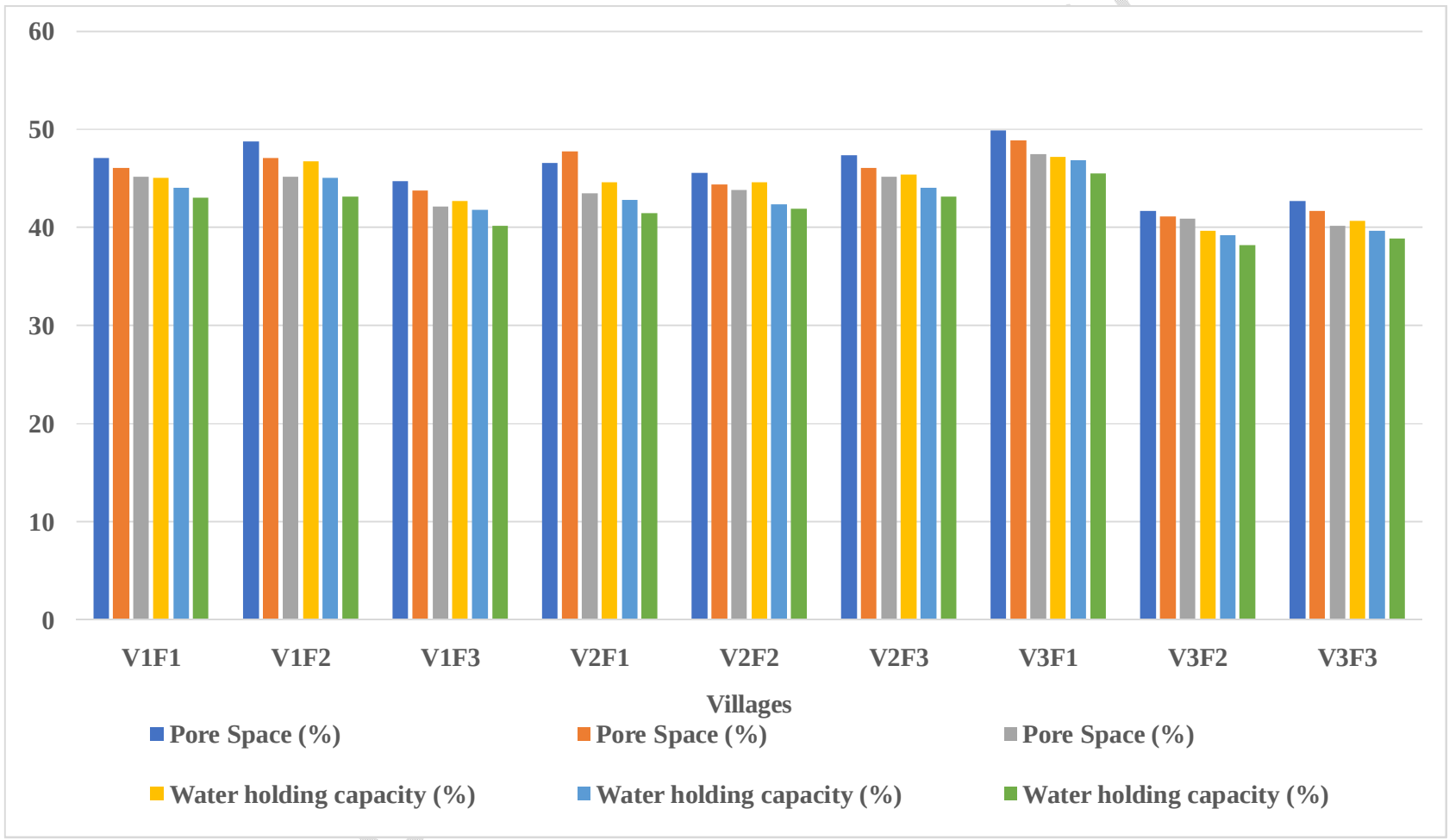

Fig. 2: Pore space (%) and water holding Capacity of soil at different depth.

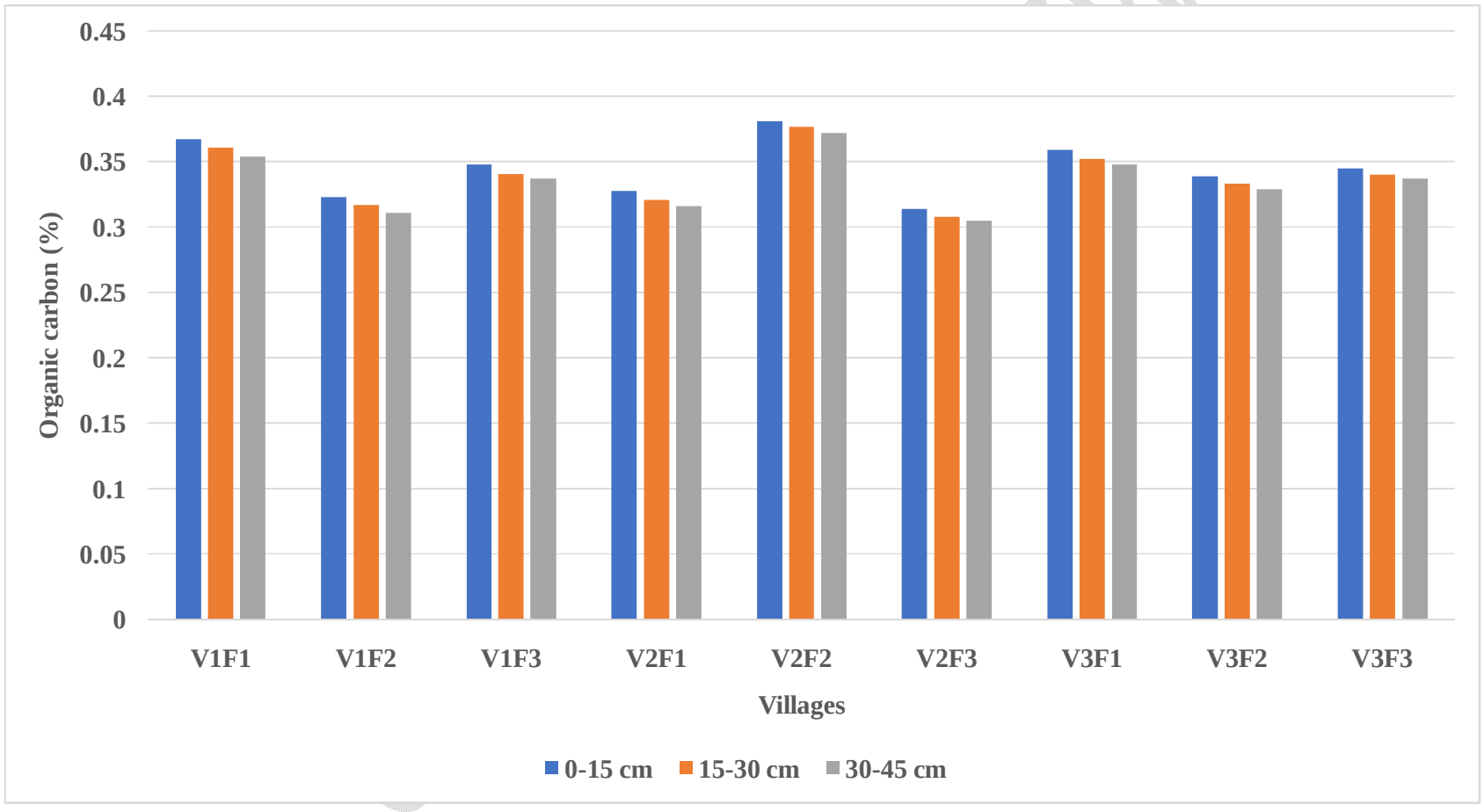

Fig. 3: Organic carbon (%) of soil at different depth.

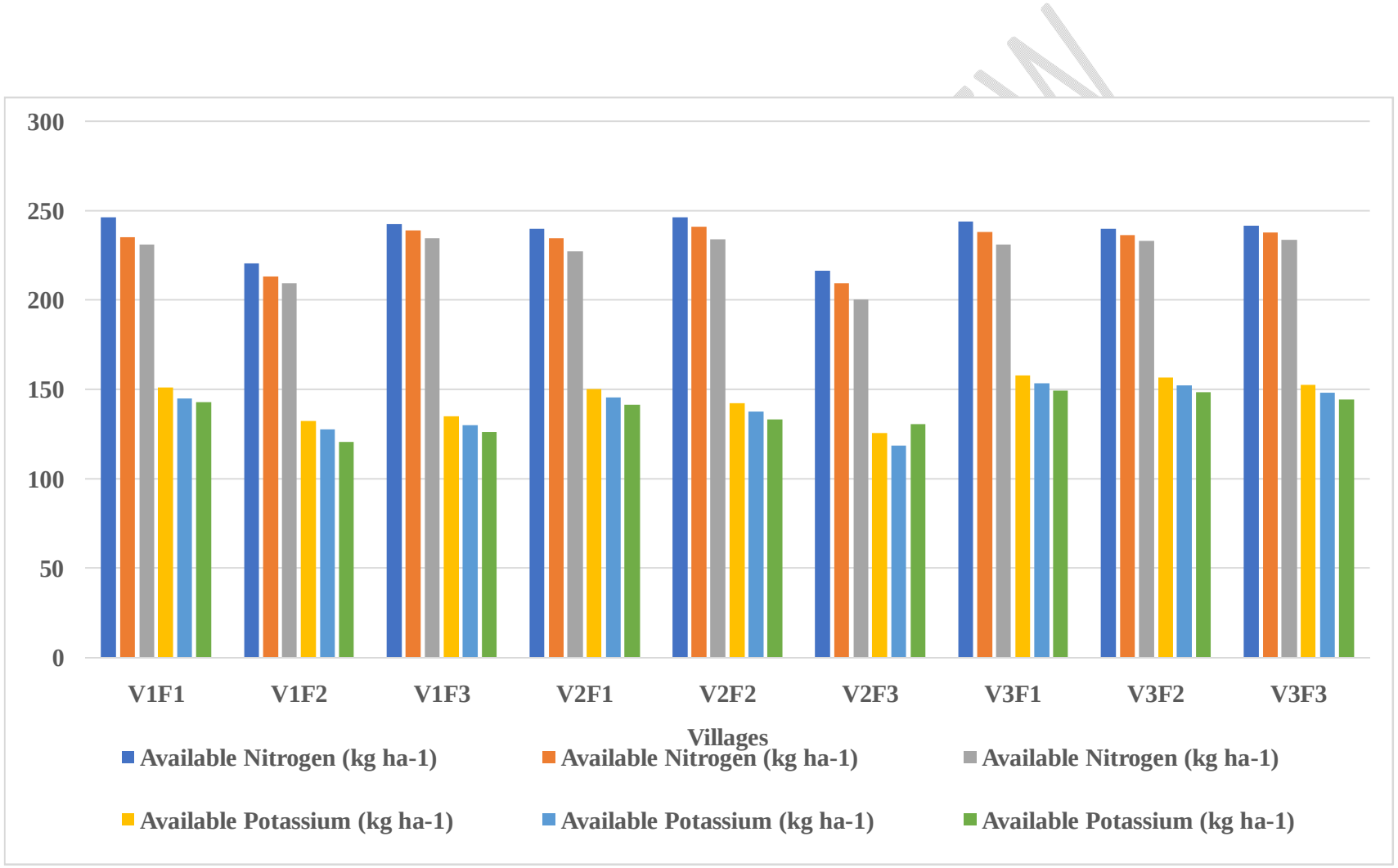

Fig. 4: Available nitrogen (kg ha^{-1}), and available potassium (kg ha^{-1}) of soil at different depth.

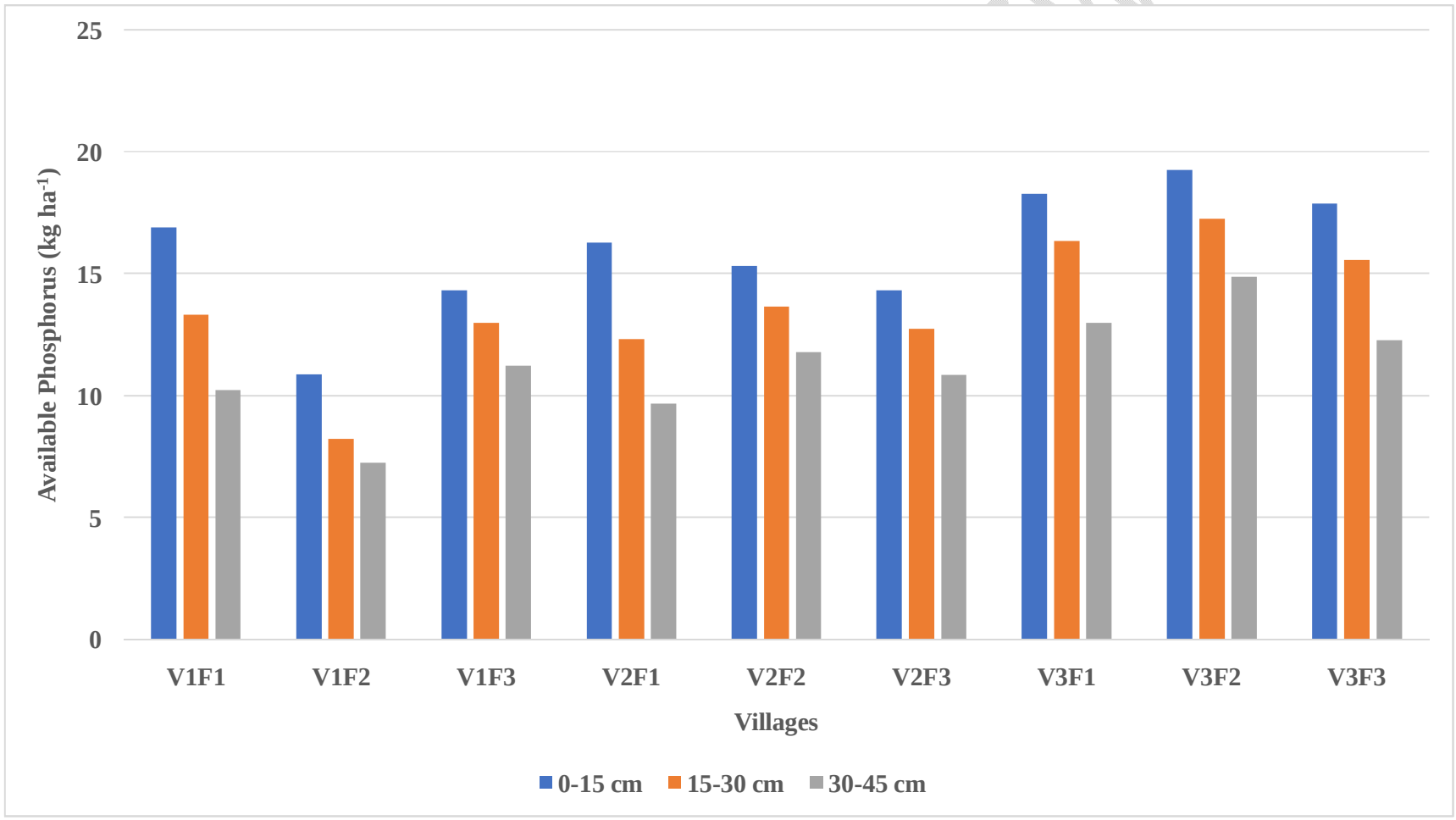

Fig. 5: Available phosphorus (kg ha^{-1}) of soil at different depth.

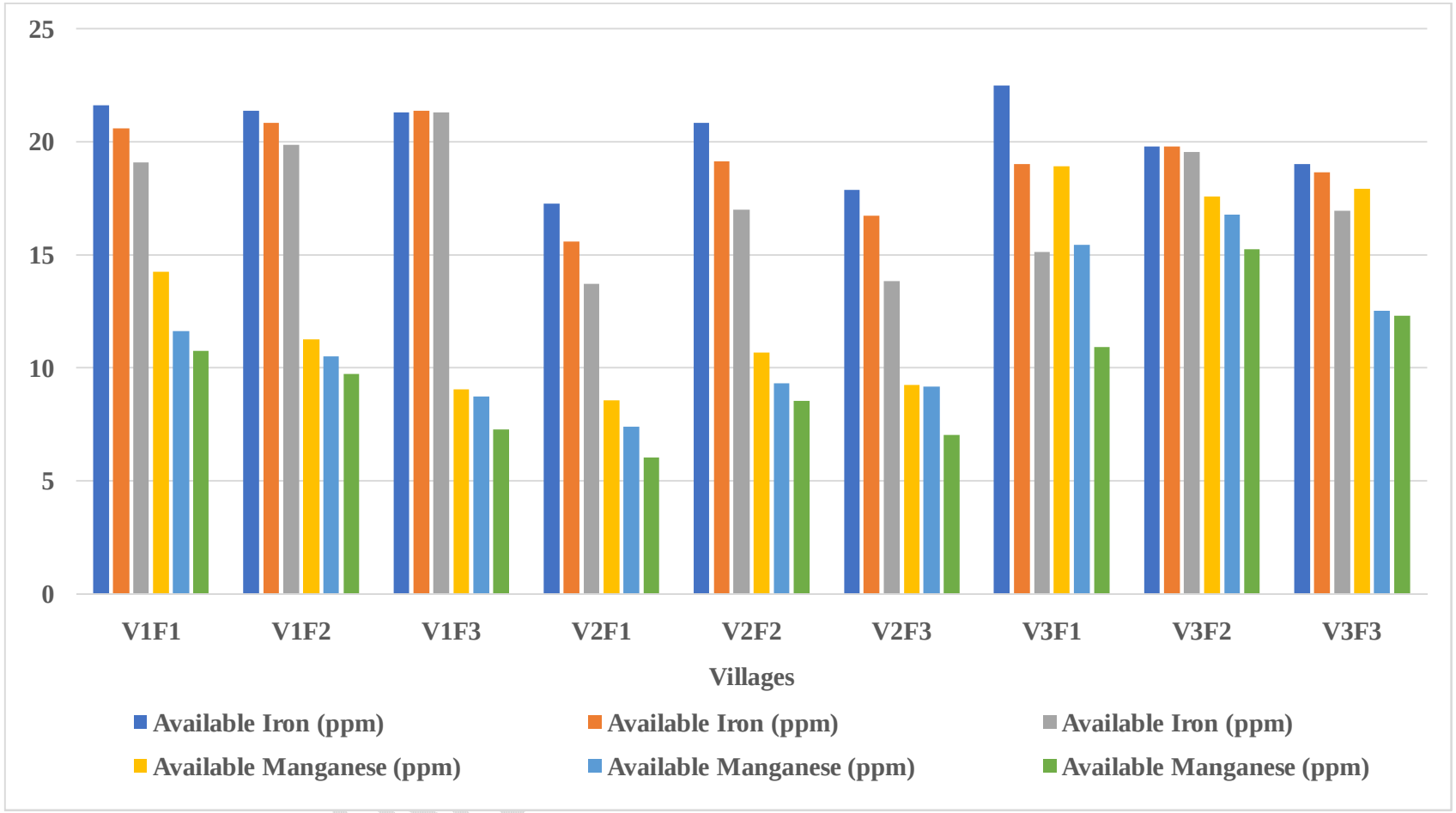

Fig. 6: Available iron (ppm), and available manganese (ppm) of soil at different depth.

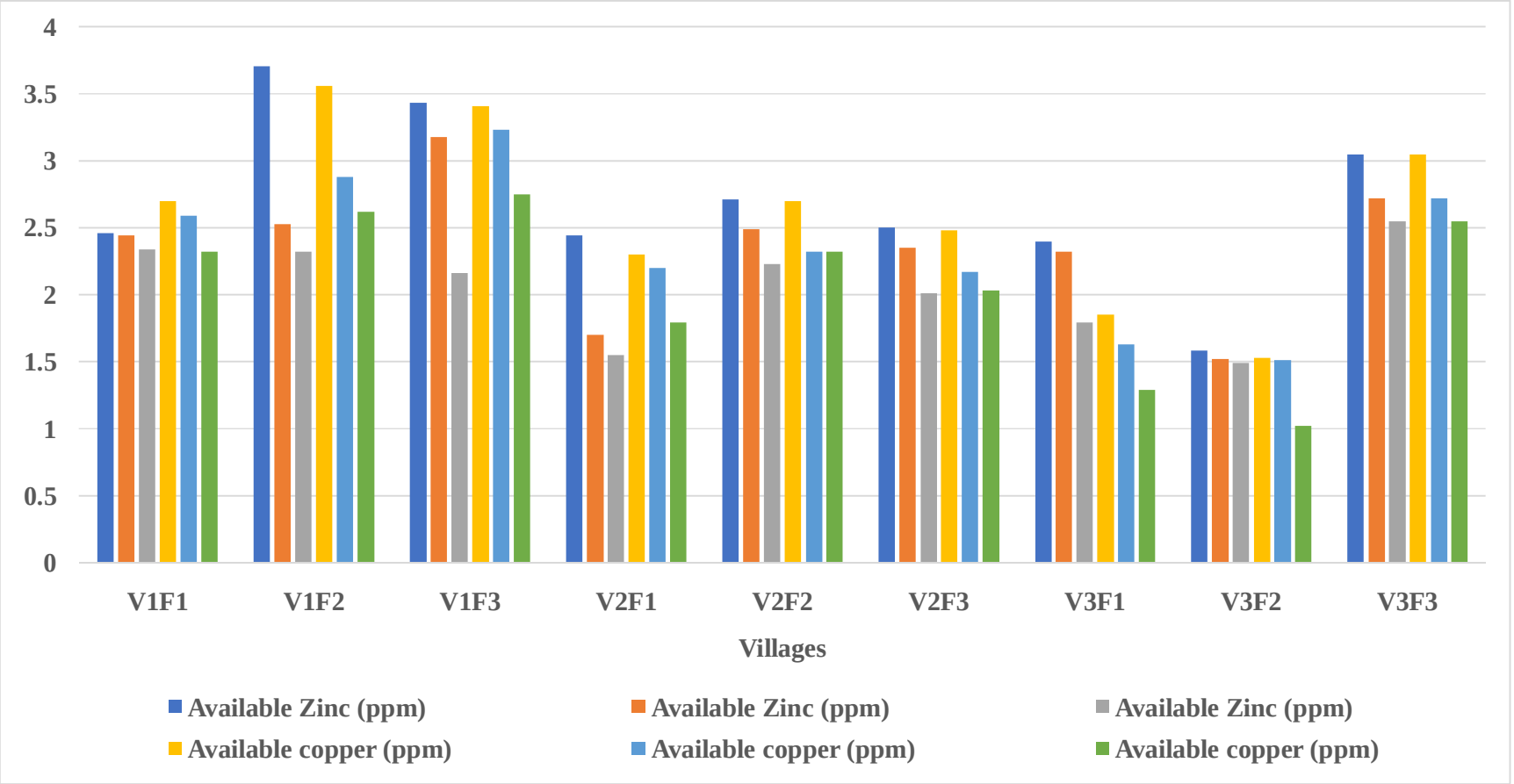

Fig. 7: Available zinc (ppm) and available copper (ppm) of soil at different depth.

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.

Reference

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