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Assessment of chemical properties of soil collected from different blocks of west Medinipur district, West Bengal

Satyabrata Das, Amreen Hasan, Tarence Thomas, Arun Alfred David and Tarun Kumar

Abstract
An experiment was accomplished to study chemical properties of soil collected from Paschim Medinipur district of West Bengal. Result of chemical properties like pH, electrical conductivity, organic carbon, nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, zinc, iron and copper were preferred to complete the paper. After analysis of the said properties, it was reported that the result of pH, EC, OC, N, P and K are determined from 5.32 to 6.91, 0.20 to 0.47 and 0.33 to 0.57%, 245.93 to 378.58 kg ha^{-1}, 17.44 to 22.81 kg ha^{-1} and 98.34 to 115.87 kg ha^{-1} respectively. The analysis concluded that the nature of soil is moderately acidic to slightly acidic, EC is moderately saline and organic carbon varies from low to medium range. The characteristics of N, P, K in soil are shown from low to medium range. Determination of Ca, Mg, S, Zn. Fe and Cu are varied from 1.11 to 1.45 cmol (p^{+}) kg^{-1}, 1.39 to 1.63 ppm, 12.53 to 14.75 ppm, 0.77 to 0.99 ppm, 4.81 to 7.80 ppm and 0.26 to 0.38 ppm respectively. Ca, Mg and S denote the value of low, high and marginal in soil respectively. Zn, Fe and Cu are marginally sufficient in soil.

Keywords: Chemical properties of soil, macro and micro nutrients, depth and site wise distribution in soil

Introduction
The soil is the most important constituent to fulfil of all the basic needs of human beings. Soil is an essential component of our farming. An eminent position in global cultivation of wheat, rice, sorghum, pulses, sugarcane, vegetables and fruits etc. are occupied by Indian agriculture and reason of physical, chemical condition of whatever land is indispensable for proper implementation of the other management practices (Raja *et al*., 2021). Soil testing is one of the best available practices to ascertain the chemical characteristics and nutrient status of a field so as to assess the fertilizer requirements for a crop or a cropping system or for knowing the reclamation requirements if the soil is saline or sodic in nature (Tigga *et al.,* 2017) [15].

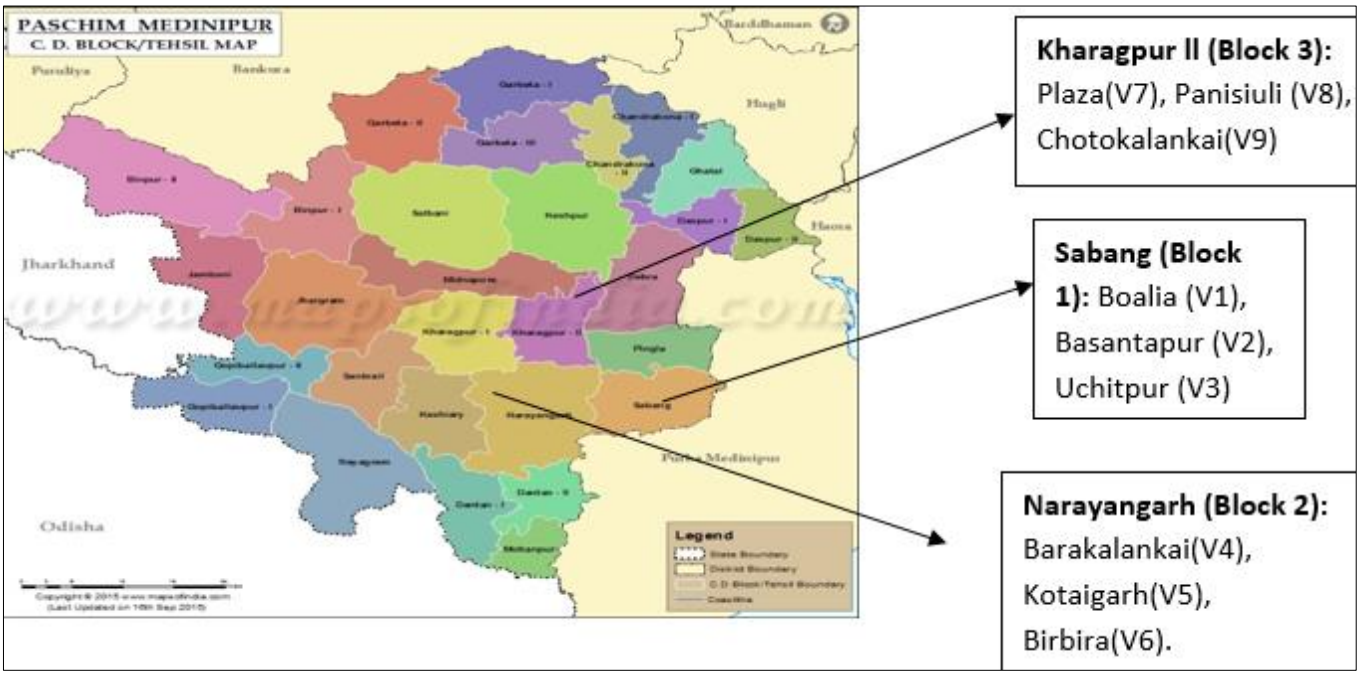
Chemical properties of soil are related to properties that directly affect plant nutrition. Soil pH refers to the negative logarithm of the hydrogen ion activity of the soil which indicates the degree of acidity or alkalinity of a soil. Soil EC is referred to the measure of dissolved salts in a solution. Soil organic matter supplies essential nutrients and has unexcelled capacity to hold water and absorb cations (Bhunia *et al*., 2015) [2]. Nitrogen is one of the most important primary nutrient non-metal element which requires large quantity for the plant growth and nutrition. Phosphorus plays an essential character as a structural component of the cell constituents and metabolically efficient compounds. Potassium is taken up by plants in greater amount than any other mineral nutrient except nitrogen. Sulphur is also involved in various metabolic processes of plants. Source for deposition in soil for calcium and magnesium are dolomite, limestone and calcite. They are available in form of calcium oxide and magnesium oxide (Yadav *et al*., 2017). Crop yield is significantly increased with the use of micronutrients such as Zn, Fe and Cu which have a metabolically important role in plant growth and development and is therefore called an essential trace element or a micronutrient (Bandyopadhyay *et al*., 2018) [1].

West Bengal is a state in eastern part of India. The distribution of soil type is categorised with different soil orders as 1.97 M ha area belongs to Entisols, 4.96 M ha Inceptisols and 1.96 M ha area belongs to Alfisols. It covers 88,752 km^2 (34,267 sq. miles) and ranks 14th state by area in India. It extends from 22^{0}59'12" N and 87^{0}51'18" E. West Medinipur district is situated at 22^{0}25'51" N and 87^{0}19'17" E and 23 meter above sea level. The climate lies a hot tropical monsoon weather pattern. Summers last from April to mid-June with diurnal highs ranging from the upper 30^{0}C to the mid 40^{0}C and lows in the low 30 ^{0}C. Soils are alluvial with a high degree of clay or sand. Vegetations include eucalyptus and Sal forests on the northwest side of town. The Sal forests form part of the Dalma Hill, Bengal-Jharkhand range.

Method and Materials

Soil sampling

Soil samples were collected from 3 depths (0 cm to 15cm, 15cm to 30 cm and 30 cm to 45 cm) of soil from different blocks of West Medinipur district in West Bengal. After harvesting of seasonal crop, all samples were taken from agriculture field. Collection of soil samples was prohibited from the areas such as water logged area, areas near main bund, trees, manure heaps and irrigation channels. After air drying, the clods formed were broken by using wooden mallet. Then the samples were sieved by 2 mm sieve. Sieved samples were stored in poly bags for further estimation of different physical and chemical parameters



Statistical analysis

In Completely randomized design, treatments are allocated at random to the experiment units over the entire experimental material. The data was derived from various determinations was subjected to statistical analysis including mean, Pearson correlation, t=test and ANOVA. The means for the levels in soil in the two divisions were determined. Studying ANOVA and t-test, the means were calculated to analysis whether they were significantly different.

Chemical analysis

The pH determined in a soil suspension using digital pH meter (Jackson, 1958) [9]. Measurement of electrical conductivity was done by using Digital EC meter (Wilcox, 1950) [17]. Analysis of organic carbon was conducted by Wet Oxidation Method (Walkley and Black, 1947) [16]. Available nitrogen was determined by using Alkaline Permanganate Method as given by Subbiah and Asija (1956) [14]. Available phosphorous was determined with the help of Olsen's colorimetric method (1954) [12]. Available potassium was determined with the help of flame photometer (Toth and Prince (1949). Analysis of Calcium and Magnesium was done by Cheng and Bray (1951). Determination of Sulphur was done by turbidimetric method by Chesnin and Yein (1951). Analysis of micro-nutrient which is Zn, Cu and Fe in soil are completed by Atomic Absorption Spectroscopy Method. It was determined by Lindsay and Norvell (1975) [10].

Result and Discussion

Chemical properties

1. **Soil pH:** The pH of the soil samples is varied within 5.32 to 6.91 range. The depth of 30-45 cm of V_1 village has shown the highest Soil pH (6.91), but 0-15 cm depth of V_5 village has shown the lowest Soil pH (5.32), it depicts as standard deviation of 0.063 due to depth, while 0.499 due to site. Statistically there is significant difference due to depths as well as sites. It is chalked out in table 1 and fig 1. The equality is seen with Das *et al* (2020) [6].
2. **Electrical conductivity:** The Electrical conductivity of the soil samples is found 0.20 to 0.47 in range. The depth of 0-15 cm of V_3 village has shown the highest soil EC (0.47 dSm^{-1}), but 30-45 cm depth of V_2 and V_6 villages have shown the lowest Soil EC (0.20 dSm^{-1}) in soil. It has exposed a standard deviation of 0.019 due to depth, while 0.079 due to site. Statistically there is significant difference due to depths as well as sites. It is described in table 1 and fig 1. Similarity is found with Nagaraju *et al* (2018).
3. **Organic Carbon:** The organic carbon of the soil samples are carried out with 0.33 to 0.57% range. The depth of 0-

15 cm of V_1 village has shown the highest Organic Carbon (0.57%), but 30-45 cm depth of V_5 and V_6 villages have indicated the lowest Organic Carbon (0.33%) in soil. It has exhibited as standard deviation of 0.016 due to depth, while 0.069 due to site. Statistically there is significant difference due to depths as well as sites. It is shown in table 1 and fig 1 which is similarly noticed with Nisab *et al* (2020).

Table 1: Assessment of soil pH, Electrical conductivity and organic carbon of soil collected from different villages of Paschim Medinipur district, West Bengal

Blocks/ Sites	0-15 cm	15-30 cm	30-45 cm	Mean	Blocks/ Sites	0-15 cm	15-30 cm	30-45 cm	Mean	Blocks/ Sites	0-15 cm	15-30 cm	30-45 cm	Mean
Sabang (B1) Soil PH					**Sabang (B1) EC**						**SABANG (B1) OC**			
V1	6.45	6.86	6.91	6.74	V1	0.26	0.22	0.22	0.23	V1	0.57	0.55	0.52	0.54
V2	6.46	6.48	6.50	6.48	V2	0.22	0.21	0.20	O-.21	V2	0.53	0.52	0.50	0.51
V3	5.55	5.62	5.65	5.60	V3	0.47	0.42	0.45	0.44	V3	0.51	0.50	0.47	0.49
Narayangarh (B2)					**Narayangarh (B2)**					**Narayangarh (B2)**				
V4	5.45	5.52	5.55	5.50	V4	0.42	0.41	0.39	0.40	V4	0.42	0.40	0.39	0.40
V5	5.32	5.38	5.41	5.37	V5	0.32	0.31	0.31	0.31	V5	0.36	0.35	0.33	0.34
V6	5.51	5.58	5.62	5.57	V6	0.35	0.29	0.20	0.28	V6	0.37	0.36	0.33	0.35
Kharagpur II (B3)					**Kharagpur II (B3)**					**Kharagpur II (B3)**				
V7	6.19	6.05	6.21	6.15	V7	0.28	0.29	0.28	0.28	V7	0.43	0.41	0.40	0.41
V8	6.32	6.41	6.45	6.39	V8	0.31	0.30	0.31	0.30	V8	0.47	0.46	0.45	0.46
V9	6.20	6.25	6.28	6.24	V9	0.28	0.21	0.21	0.23	V9	0.44	0.42	0.41	0.42
Mean	5.93	6.01	6.06		Mean	0.32	0.29	0.28		Mean	0.45	0.44	0.42	
		F-test	S.Ed (±)	CD at 5%			F-test	S.Ed (±)	CD at 5%			F-test	S.Ed(±)	CD at 5%
	Due to depth	S	0.063	0.01		Due to depth	S	0.019	0.02		Due to depth	S	0.016	4.72
	Due to site	S	0.499	1.16		Due to site	S	0.079	5.71		Due to site	S	0.069	1.84

Macro nutrients

4. **Nitrogen:** The nitrogen of the soil samples is found in 245.93 to 378.58 kg ha^{-1} range. The depth of 0-15 cm of V_1 village has shown the highest available nitrogen (378.58 kg ha^{-1}), but 30-45 cm depth of V_6 village has observed the lowest available nitrogen (245.93 kg ha^{-1}) in soil. It has shown a standard deviation of 13.687 due to depth, while 28.611 due to site. Statistically there is significant difference due to depths as well as sites. It is chalked out in table 2 and fig 1. It has similarity with Sing *et al* (2020) [13].
5. **Phosphorus:** The Phosphorus of the soil samples is determined in 17.44 to 22.81 kg ha^{-1} range. The depth of 0-15 cm of V_8 village has shown the highest available Phosphorus (22.81 kg ha^{-1}), but 30-45 cm depth of V_6 village has analysed the lowest available Phosphorus (7.00 kg ha^{-1}) in soil. It has shown as standard deviation of 0.965 due to depth, while 0.940 due to site. Statistically there is significant difference due to depths as well as sites. The result is described in table 2 and fig 1. Sameness is found with Tigga *et al* (2017) [15].
6. **Potassium:** The Potassium of the soil samples is found in 98.34 to 115.87 kg ha^{-1} range. The depth of 0-15 cm of V_1 village has expressed the highest available Potassium (115.87 kg ha^{-1}), but 0-15 cm depth of V_4 village has shown the lowest available Potassium (98.34 kg ha^{-1}) in soil. It has described a standard deviation of 0.207 due to depth, while 4.102 due to site. Statistically there is non-significant difference due to depths and significant difference due to site. It is followed through in table 2 and fig 1. It has similarity with Panwar *et al* (2014).

Table 2: Assessment of Nitrogen, Phosphorus and Potassium of soil collected from different villages of Paschim Medinipur district, West Bengal

Blocks/ Sites	0-15 cm	15-30 cm	30-45 cm	Mean	Blocks/ Sites	0-15 cm	15-30 cm	30-45 cm	Mean	Blocks/ Sites	0-15 cm	15-30 cm	30-45 Cm	Mean
Sabang (B1) N					**Sabang (B1) P**						**Sabang (B1) K**			
V1	378.58	367.80	340.18	362.18	V1	21.51	20.49	20.47	20.82	V1	115.87	112.53	109.15	112.51
V2	349.60	337.12	321.65	336.12	V2	20.63	19.68	18.69	19.66	V2	111.55	106.82	103.21	107.19
V3	330.68	318.19	309.56	319.47	V3	21.31	20.25	19.20	20.25	V3	113.42	110.59	109.81	111.27
Narayangarh (B2)					**Narayangarh (B2)**					**Narayangarh (B2)**				
V4	325.63	318.50	305.18	316.43	V4	19.42	19.40	19.39	19.40	V4	98.34	102.51	103.6	101.50
V5	295.75	280.12	265.86	280.57	V5	19.61	18.55	17.60	18.58	V5	99.63	105.82	107.51	104.32
V6	289.48	260.57	245.93	265.32	V6	19.54	18.13	17.44	18.37	V6	98.64	99.59	104.61	100.94
Kharagpur II (B3)					**Kharagpur II (B3)**					**Kharagpur II (B3)**				
V7	325.19	307.54	298.62	310.45	V7	20.81	19.34	18.98	19.71	V7	110.83	108.56	107.41	108.93
V8	315.80	297.37	290.55	301.24	V8	22.81	21.20	19.61	21.20	V8	106.85	102.88	100.7	103.47
V9	328.61	320.56	315.60	321.59	V9	21.89	19.72	18.95	20.18	V9	103.50	106.82	108.91	106.41
MEAN	326.59	311.97	299.23		MEAN	20.83	19.64	18.92		MEAN	106.51	106.23	106.10	
		F-test	S.Ed (±)	CD at 5%			F-test	S.Ed (±)	CD at 5%			F-test	S.Ed(±)	CD at 5%
	Due to depth	S	13.687	4.83		Due to depth	S	0.965	1.86		Due to depth	NS	0.207	0.965
	Due to site	S	28.611	1.32		Due to site	S	0.940	4.12		Due to site	S	4.102	0.004

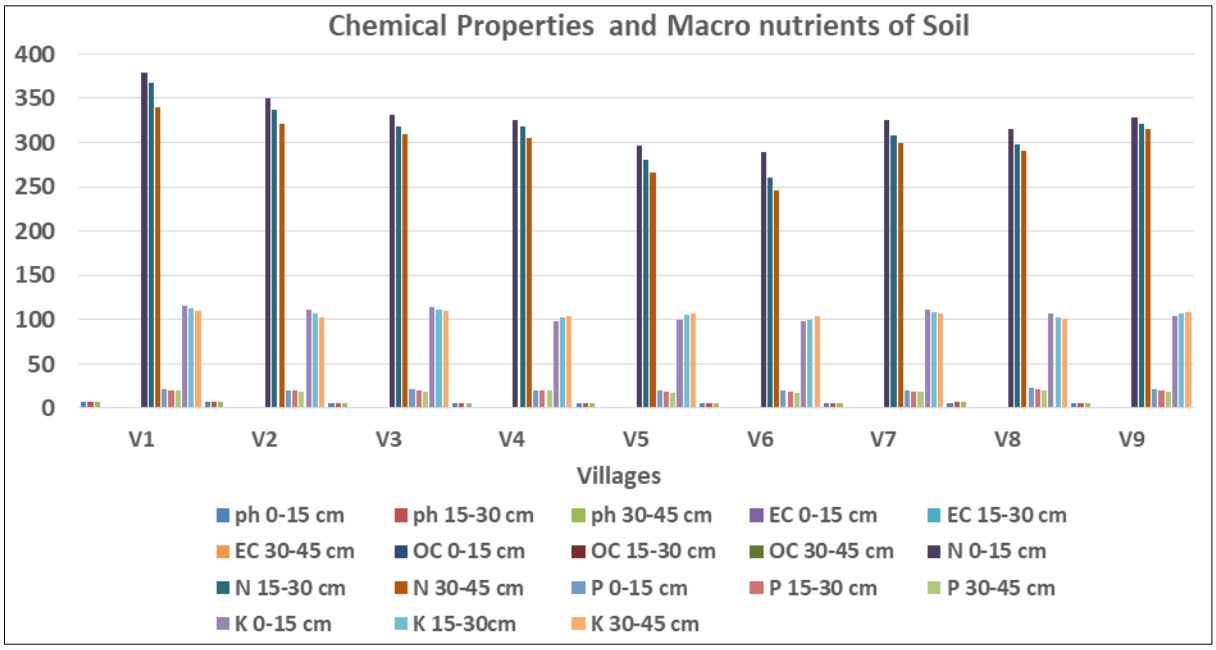


Fig 1: Graphically arrangement of chemical properties of soil collected from different villages of Paschim Medinipur district, West Bengal

7. **Calcium:** The Calcium of the soil sample is found with 1.11 to 1.45 cmol (p^+) kg^{-1} range. The depth of 30-45cm of V_6 village has shown the highest Calcium [1.45 cmol (p^+) kg^{-1}], but 30-45 cm depth of V_3 village has shown the lowest Calcium [1.11 cmol (p^+) kg^{-1}] in soil. It depicts as standard deviation of 0.006 due to depth, while 0.096 due to site. Statistically there is non-significant difference due to depths but significant difference due to sites. The value is put in table 3 and fig 2. Similarity is found with Sing *et al* (2017).
8. **Magnesium:** The Magnesium of the soil sample is carried out from 1.39 to 1.63 mg kg^{-1} range. The depth of 0-15 cm of V_6 village has determined the highest Magnesium [1.63 mg kg^{-1}], but 30-45 cm depth of V_9 village has identified the lowest Magnesium [1.39 mg kg^{-1}] in soil. It has shown a standard deviation of 0.014 due to depth, while 0.062 due to site. Statistically there is significant difference due to depths as well as sites. The value is added in table 3 and fig 2. The result is similar with Sing *et al* (2017).
9. **Sulphur:** The Sulphur of the soil sample is concluded from 12.53 to 14.75 kg ha^{-1} range. The depth of 30-45 cm of V_3 village has shown the highest available Sulphur (14.75 mg kg^{-1}), but 30-45 cm depth of V_8 village has described the lowest available Sulphur (12.53 mg kg^{-1}) in soil. It has fixed the standard deviation of 0.112 due to depth, while 0.440 due to site. Statistically there is non-significant difference due to depths as well as sites. The range of sulphur is chalked out in table 3 and fig 2. The result is matched with Tigga *et al* (2017) [15].

Table 3: Assessment of Calcium, Magnesium and Sulphur of soil collected from different villages of Paschim Medinipur district, West Bengal

Blocks/ Sites	0-15 cm	15-30 cm	30-45 cm	Mean	Blocks/ Sites	0-15 cm	15-30 cm	30-45 cm	Mean	Blocks/ Sites	0-15 cm	15-30 cm	30-45 cm	Mean
Sabang (B1) Ca					**Sabang (B1) Mg**						**Sabang (B1) S**			
V1	1.39	1.36	1.32	1.35	V1	1.59	1.56	1.55	1.56	V1	14.65	14.31	13.95	14.30
V2	1.18	1.16	1.12	1.15	V2	1.54	1.51	1.50	1.51	V2	14.21	13.56	12.82	13.53
V3	1.15	1.12	1.11	1.12	V3	1.53	1.50	1.49	1.50	V3	13.82	14.56	14.75	14.37
Narayangarh (B2)					**Narayangarh (B2)**					**Narayangarh (B2)**				
V4	1.23	1.24	1.26	1.24	V4	1.52	1.53	1.56	1.53	V4	13.28	14.31	14.45	14.01
V5	1.21	1.23	1.24	1.22	V5	1.48	1.46	1.42	1.45	V5	12.65	13.75	14.61	13.67
V6	1.42	1.44	1.45	1.43	V6	1.63	1.61	1.57	1.60	V6	12.82	13.15	13.36	13.11
Kharagpur II (B3)					**Kharagpur II (B3)**					**Kharagpur II (B3)**				
V7	1.28	1.20	1.18	1.22	V7	1.51	1.47	1.46	1.48	V7	13.71	13.27	13.19	13.39
V8	1.19	1.20	1.23	1.20	V8	1.43	1.45	1.46	1.44	V8	13.89	13.72	12.53	13.38
V9	1.25	1.26	1.28	1.26	V9	1.42	1.40	1.39	1.40	V9	13.60	13.95	14.40	13.98
Mean	1.25	1.24	1.24		Mean	1.51	1.49	1.48		Mean	13.62	13.84	13.78	
		F-test	S.Ed (±)	CD at 5%			F-test	S.Ed (±)	CD at 5%			F-test	S.Ed(±)	CD at 5%
	Due to depth	NS	0.006	0.62		Due to depth	S	0.014	0.02		Due to depth	NS	0.112	0.74
	Due to site	S	0.096	1.06		Due to site	S	0.062	2.16		Due to site	NS	0.440	0.21

Micro nutrients

10. **Iron:** The Iron of the soil sample is shown between 4.81 to 7.80 mg kg^{-1} range. The depth of 0-15 cm of V_4 village has denoted the highest Iron (7.80 mg kg^{-1}), but 0-15 cm

depth of V_7 village has shown the lowest Iron (4.81 mg kg^{-1}) in soil. It has calculated a standard deviation of 0.005 due to depth, while 1.094 due to site. Statistically there is non-significant difference due to depths and significant difference due to sites. It is described in table 4 and fig 2. The similar result is seen in Sing *et al* (2017)

11. **Copper:** The Copper of the soil sample is founded in soil with 0.26 to 0.38 mg kg^{-1} range. The depth of 0-15 cm of V_1 village and V_4 village have shown the highest Copper (0.38 mg kg^{-1}), but 0-15 cm depth of V_7 village has identified the lowest Copper (0.26 mg kg^{-1}) in soil. It has described as standard deviation of 0.003 due to depth, while 0.032 due to site. Statistically there is non-significant difference due to depths but significant difference due to sites. The range of copper is set in table 4 and graphically varied in fig 2. It is observed similarly with Raja *et al* (2021).
12. **Zinc:** The Zinc of the soil sample is conducted between 0.77 to 0.99 mg kg^{-1} range. The depth of 30-45 cm of V_8 village has shown the highest Zinc (0.99 mg kg^{-1}), but 30-45 cm depth of V_2 village has carried out the lowest Zinc (0.77 mg kg^{-1}) in soil. It has denoted a standard deviation of 0.006 due to depth, while 0.059 due to site. Statistically there is non-significant difference due to depths but significant difference due to sites. The value of zinc is put on the table 4 and chalked out the graphically on fig 2. It has shown similar result in Nisab *et al* (2020).

Table 4: Assessment of Iron, Copper and Zinc of soil collected from different villages of Paschim Medinipur district, West Bengal

Blocks/ Sites	0-15 cm	15-30 cm	30-45 cm	Mean	Blocks/ Sites	0-15 cm	15-30 cm	30-45 cm	Mean	Blocks/ Sites	0-15 cm	15-30 cm	30-45 cm	Mean
Sabang (B1) Fe					**Sabang(B1) Cu**						**Sabang (B1) Zn**			
V1	6.21	6.23	6.24	6.22	V1	0.38	0.37	0.32	0.35	V1	0.87	0.85	0.80	0.84
V2	5.29	5.27	5.26	5.27	V2	0.36	0.35	0.33	0.34	V2	0.81	0.78	0.77	0.78
V3	5.39	5.37	5.36	5.37	V3	0.31	0.33	0.34	0.32	V3	0.83	0.82	0.80	0.81
Narayangarh (B2)					**Narayangarh (B2)**					**Narayangarh (B2)**				
V4	7.80	7.77	7.76	7.77	V4	0.38	0.37	0.35	0.36	V4	0.88	0.89	0.91	0.89
V5	7.54	7.50	7.49	7.51	V5	0.29	0.28	0.27	0.28	V5	0.84	0.88	0.89	0.87
V6	6.88	6.86	6.81	6.85	V6	0.31	0.29	0.28	0.29	V6	0.86	0.85	0.82	0.84
Kharagpur II (B3)					**Kharagpur II (B3)**					**Kharagpur II (B3)**				
V7	4.81	4.85	4.86	4.84	V7	0.26	0.28	0.31	0.28	V7	0.95	0.93	0.92	0.93
V8	4.92	4.94	4.99	4.95	V8	0.29	0.30	0.34	0.31	V8	0.95	0.96	0.99	0.96
V9	5.80	5.78	5.77	5.78	V9	0.31	0.30	0.29	0.30	V9	0.94	0.92	0.91	0.92
Mean	6.07	6.06	6.06		Mean	0.32	0.31	0.31		Mean	0.88	0.87	0.86	
		F-test	S.Ed (±)	CD at 5%			F-test	S.Ed (±)	CD at 5%			F-test	S.Ed(±)	CD at 5%
	Due to depth	NS	0.005	0.63		Due to depth	NS	0.003	0.78		Due to depth	NS	0.006	0.44
	Due to site	S	1.094	3.94		Due to site	S	0.032	0.0003		Due to site	S	0.059	3.16

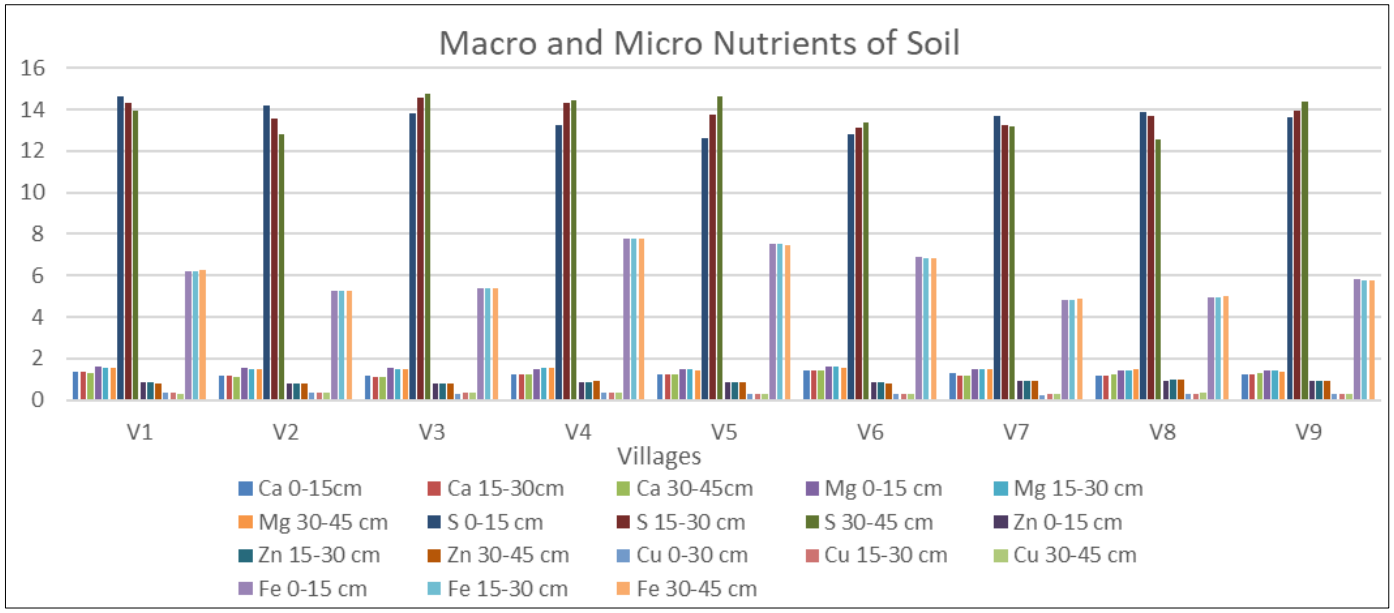


Fig 2: Graphically arrangement of Macro and micro nutrients of soil collected from different villages of Paschim Medinipur district, West Bengal.

Conclusion

The analysis of soil describes the status of chemical properties of soil samples and it will be very helpful to advise a sounded cropping pattern as well as fertilizer doses at low cost to the farmers. After investigation of soil, it is concluded that soil is moderately acidic to slightly acidic, few samples are neutral and EC is moderately saline, suitable for all crops. Organic carbon, Nitrogen, Phosphorus and potassium in soil sample

contain low to medium range. The range of some macro nutrients like Calcium, magnesium and sulphur of soil sample are in low, high and marginal amount respectively. Some micronutrients like Fe, Cu and Zn are in marginally sufficient in soil. This study will help to suggest soil health card to the farmers as per different crops for developing fertility of soil and nature also.

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