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Nutrient availability of soil under inceptisols from Washi Tahsil of Osmanabad district of Maharashtra, India

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Abstract

The present investigation was carried out during the 2012-13 to study the Nutrient availability of soil under Inceptisols from Washi tahsil of Osmanabad District of Maharashtra. For this purpose total 60 representative soil samples were collected from 30 villages and two soil samples from each village of Washi tahsil were collected according to their representative depths. From each village 2 soil samples Inceptisols (10-30 cm) were collected. In physical analysis Bulk density, Particle density, Porosity were studied. Average bulk density, particle density and porosity was ranges from 1.13 to 1.86 Mg m⁻³, 2.03 to 2.96 Mg m⁻³ and 20 to 56 per cent respectively. In chemical analysis viz., pH, EC, organic carbon, free calcium carbonate, macronutrient and micronutrient were analyzed. Available N, P and available K were varied from 42.00 to 343.00 kg ha⁻¹, 4.64 to 48.03 kg ha⁻¹ and 157.90 to 967.60 kg ha⁻¹. Exchangeable Ca⁺⁺ and exchangeable Mg⁺⁺ content ranged from 17 to 58 cmol (P+) kg⁻¹ and 2 to 28 cmol (P+) kg⁻¹, respectively and available S ranged from 3.95 to 50.70 mg kg⁻¹. The DTPA- Fe, DTPA-Mn, DTPA-Zn and DTPA-Cu in soils varied from 0.48 to 4.98 mg kg⁻¹, 1.3 to 12.4 mg kg⁻¹, 0.1 to 1.35 mg kg⁻¹ and 0.63 to 6.66 mg kg⁻¹, respectively. HWS-B ranges from 0.05 to 1.15 mg kg⁻¹.

Keywords: physico-chemical properties, macronutrients, micronutrients, inceptisols

Introduction

The extreme southern part of Marathwada is occupied with Osmanabad and Latur district. Geographically, Osmanabad district is located between 18° 28' to 19° 28' North altitude and 76° 25' to 77° 25' East latitude. The geographical area of Osmanabad district is 7512.40 sq.km. The climate of the area is hot and dry having average annual rainfall 767.5mm. These soils has light medium and heavy texture with undulating topography and varying in soil depth. This district comprises 8 tahsils, out of these, Washi tahsil is selected for study. In this tahsil, there is cultivation of different cereals, pulses, oilseed and horticultural crops. Average annual rainfall was 715.6 mm

The physico-chemical properties like pH, EC, calcium carbonate and organic carbon play important role in relation to availability of nutrients in soils and thereby on crop growth and production. The organic carbon is the store house of all plant nutrients. It provides good aeration, increases microbial activity, water holding capacity; maintain the soil pH, CO₂ level and calcium carbonate content in the soils. (Malewar, 1995) [22].

Every primary and secondary nutrient play important role in soil to maintain the soil fertility and agricultural production. The physico-chemical characteristics, available macro and micronutrient status in the soil profile helps in determining the soil potential to supply nutrients for crop growth. Macronutrients (N, P and K) and micronutrients (Zn, Fe, Mn, Cu and B) are important soil elements that control soil fertility. Soil fertility is one of the important factor controlling yields of the crops. The present investigations were undertaken in Washi Tahsil of Osmanabad district (M.H.) to know nutrient availability of the soils of Washi Tahsil to improve agricultural production by supplying required quantities of nutrients through different fertilizers.

Materials and Methods

Out of 54 villages of washi tahsil 30 villages were selected for this study. The villages were selected randomly in such way that it should cover whole area of the tahsil. Sixty soil samples were collected from Inceptisols of 30 villages of Washi tahsil. These soil samples were dried and processed. The samples were analysed for particle density and bulk density by Pycnometer

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and clod coating methods, respectively (Das and Agrawal, 1997). pH and Electrical conductivity (E.C.) in 1:2.5 soil water suspension (Jackson, 1978) ^[5]. Organic carbon estimated by modified method of Walkely and Black (Piper, 1966). The free calcium carbonate was determined by rapid titration method as outlined by Piper (1966) ^[19].

Available nitrogen was analyzed by using alkaline potassium permanganate method (Subbiah and Asija, 1956). Available phosphorus was determined by using 0.5 M sodium bicarbonate as an extractant by Olsen's method on spectrophotometer (Jackson, 1978) ^[5]. Available potassium was treated with normal ammonium acetate and potassium was determined from the extract by using flame photometer (Jackson, 1978) ^[5]. Exchangeable calcium and magnesium was analyzed by ammonium extracts of soils by titration with EDTA (Jackson, 1978) ^[5]. Available sulphur was determined by using 1:5 soil and extractant, 0.15 per cent CaCl₂ solution on spectrophotometer (Williams and Steinberg, 1969).

Micronutrients were estimated as per the procedure described by Lindsay and Norvell (1978) ^[8]. For this 10 g finely sieved soil (0.5 mm) was taken in 20 ml of 0.005 M DTPA solution (Diethylene Triamine Penta Acetic Acid) containing 0.1 M triethanol amine and 0.01 M calcium chloride, adjusted to pH 7.3 with HCl for two hours and then filtered and filtrate was subjected to measurement on Atomic Absorption Spectrophotometer (AAS-200), at different wavelengths for Fe, Zn, Mn and Cu. Available boron was determined from soil samples by using Azomethine-H on spectrophotometer at 420 nm wavelength (Gupta, 1979) ^[4].

Results and Discussion

Physical Characteristics: The data present in Table 1 revealed that the average bulk density under Inceptisol order ranges from 1.13 to 1.86 g cm⁻³ with mean value of 1.50 g cm⁻³. These results are in agreement with results reported by Leelavati *et al.* (2009). Jagdish Prasad (2010) observed that the bulk density of soil was ranged from 1.39 to 1.76 Mg m⁻³

in Nagpur district of Maharashtra in different horizons. Particle density of soils from Inceptisol order ranged from 2.03 to 2.96 Mg m⁻³, with mean value 2.40 Mg m⁻³. The particle density is higher, it might be due to large amount of heavy minerals such as magnetite, limonite and hematite are present in the soil. With increase in organic matter of the soil, the particle density decreases. Singh and Mishra (2012) reported that the particle density in Chairaigaon block of Varanasi district in U. P. soils varied from 2.0 to 2.6 g cm⁻³, respectively. Whereas porosity was ranged from 20.00 to 56.00 per cent with mean value 37.66 per cent.

Chemical Properties: The data in table 2 revealed that the pH of these soils was varied from 6.3 to 8.5 with an average value 7.53. The data indicated that, the Inceptisol soils of Washi tahsil were neutral to alkaline in reaction. These results in accordance with Raut and Mali (2003). The electrical conductivity of these soils was ranged from 0.10 to 0.42 dSm⁻¹ with an average mean of 0.19 dSm⁻¹. The low EC in these soils might be due to proper management of soil and thereby leaching of salts take place from surface to subsurface. These results are confirmatory with results reported by Patil and Kharche (2000). The data on organic carbon and organic matter content presented in table 2 revealed that the organic carbon content ranged from 0.50 to 10.40 g kg⁻¹ with the mean value 4.81g kg⁻¹ and organic matter ranged from 0.86 to 17.92 g kg⁻¹ with mean value of 8.29 g kg⁻¹. Waikar *et al.* (2004) reported that the organic carbon in the soils of Marathwada region were ranges from 7.0 to 25.0 g kg⁻¹. The calcium carbonate content in these soils were ranged from 4.00 to 168.00 g kg⁻¹ with a mean of 46.52 g kg⁻¹. The low to medium CaCO₃ content in soils might be due to fact that presence of CaCO₃ in powdery form and hyper thermic temperature regime of Washi tahsil. The CaCO₃ content of the pedons increased with depth, which explains downward movement of calcium and decomposition of CaCO₃. These results are in confirmatory with the results reported Meena *et al.* (2006) ^[13].

Table 1: Physical properties of soil from Washi tahsil of Osmanabad district under Inceptisols

Sr. No	Vilage sample no	Bulk Density (g cm ⁻³)	Particle density (g cm ⁻³)	Porosity (%)
1	Mandava 1	1.86	2.40	23
2	Mandava2	1.44	2.23	36
3	Junner 1	1.51	2.43	38
4	Junner2	1.50	2.43	39
5	Dasmegaon 1	1.42	2.15	34
6	Dasmegaon 2	1.61	2.46	35
7	Ghodaki 1	1.56	2.35	34
8	Ghodaki 2	1.52	2.37	36
9	Gojawada 1	1.40	2.11	34
10	Gojawada 2	1.65	2.37	31
11	Gambhirwadi 1	1.47	2.59	44
12	Gambhirwadi 2	1.77	2.41	27
13	Sarola 1	1.55	2.16	29
14	Sarola 2	1.43	2.25	37
15	Para 1	1.78	2.23	21
16	Para 2	1.70	2.11	20
17	Lakhangaon 1	1.31	2.22	41
18	Lakhangaon 2	1.50	2.26	34
19	Shendi 1	1.13	2.11	47
20	Shendi 2	1.40	2.45	43
21	Bramhgaon 1	1.51	2.60	42
22	Bramhgaon 2	1.55	2.96	48
23	Pimpalgaon 1	1.57	2.40	35
24	Pimpalgaon 2	1.33	2.28	42
25	Rui 1	1.45	2.53	43
26	Rui 2	1.68	2.36	29

27	Paragaon 1	1.56	2.27	32
28	Paragaon 2	1.50	2.43	39
29	Shelgaon 1	1.41	2.57	46
30	Shelgaon 2	1.59	2.41	35
31	Vijora 1	1.33	2.64	50
32	Vijora 2	1.54	2.54	40
33	Bangarwadi 1	1.65	2.55	36
34	Bangarwadi 2	1.27	2.28	45
35	Ghatpimpri 1	1.51	2.50	40
36	Ghatpimpri 2	1.55	2.20	30
37	Vesvandi 1	1.37	2.10	35
38	Vesvandi 2	1.63	2.31	30
39	Bhaykundi 1	1.62	2.47	35
40	Bhaykundi 2	1.40	2.03	32
41	Washi 1	1.35	2.60	49
42	Washi 2	1.49	2.22	33
43	Golegaon 1	1.41	2.47	43
44	Golegaon 2	1.53	2.83	46
45	Sonarwadi 1	1.46	2.53	43
46	Sonarwadi 2	1.50	2.37	37
47	Khanapur 1	1.62	2.49	35
48	Khanapur 2	1.31	2.95	56
49	Indapur 1	1.59	2.13	26
50	Indapur 2	1.40	2.40	42
51	Bori 1	1.46	2.78	48
52	Bori 2	1.75	2.55	32
53	Terkheda 1	1.33	2.90	55
54	Terkheda 2	1.40	2.71	49
55	Umra 1	1.57	2.30	32
56	Umra 2	1.62	2.37	32
57	Kadakhnathwadi 1	1.20	2.11	44
58	Kadakhnathwadi 2	1.55	2.27	32
59	Khamkarwadi 1	1.47	2.45	40
60	Khamkarwadi 2	1.53	2.49	39
Range		1.13-1.86	2.03-2.96	20-56
Mean		1.50	2.40	37.66
SE±		0.018	0.027	0.995
CV (%)		9.28	8.86	20.47

Table 2: Physico-chemical properties of soils from Washi tahsil of Osmanabad district under Inceptisols

Sr. No	Village sample no	pH	EC (dS m ⁻¹)	Organic carbon (g kg ⁻¹)	Organic matter (g kg ⁻¹)	CaCO ₃ (g kg ⁻¹)
1	Mandava 1	7.0	0.32	3.00	5.17	115.00
2	Mandava2	7.3	0.13	7.30	12.58	115.00
3	Junner 1	7.1	0.11	5.00	8.62	62.00
4	Junner2	7.4	0.17	6.90	11.89	78.00
5	Dasmegaon 1	7.8	0.16	0.50	0.86	115.00
6	Dasmegaon 2	7.7	0.12	6.50	11.20	103.00
7	Ghodaki 1	7.7	0.34	5.60	9.65	25.00
8	Ghodaki 2	7.9	0.27	6.00	10.34	168.00
9	Gojawada 1	8.0	0.17	5.70	9.82	93.00
10	Gojawada 2	7.7	0.18	6.00	10.34	145.00
11	Gambhirwadi 1	7.6	0.12	2.10	3.62	24.00
12	Gambhirwadi 2	7.6	0.14	1.50	2.58	32.00
13	Sarola 1	7.0	0.16	1.00	1.72	77.00
14	Sarola 2	7.6	0.24	1.30	2.24	65.00
15	Para 1	7.6	0.16	1.40	2.41	129.00
16	Para 2	7.8	0.18	3.90	6.72	143.00
17	Lakhangaon 1	7.7	0.17	4.00	6.89	139.00
18	Lakhangaon 2	7.8	0.13	4.60	7.93	143.00
19	Shendi 1	8.0	0.17	5.60	9.65	40.00
20	Shendi 2	8.3	0.15	4.10	7.06	36.00
21	Bramhgaon 1	7.2	0.25	4.20	7.24	53.00
22	Bramhgaon 2	7.1	0.23	5.00	8.62	58.00
23	Pimpalgaon 1	7.5	0.17	4.60	7.93	44.00
24	Pimpalgaon 2	7.3	0.10	3.90	6.72	39.00
25	Rui 1	7.5	0.14	5.00	8.62	105.00
26	Rui 2	7.5	0.17	8.70	14.99	140.00
27	Paragaon 1	8.0	0.17	7.90	13.61	58.00

28	Paragaon 2	7.2	0.22	9.80	16.89	35.00
29	Shelgaon 1	7.0	0.10	2.30	3.96	38.00
30	Shelgaon 2	8.1	0.24	7.70	13.27	79.00
31	Vijora 1	7.2	0.10	1.50	2.58	27.00
32	Vijora 2	7.5	0.15	1.50	2.58	104.00
33	Bangarwadi 1	7.0	0.17	1.20	2.06	38.00
34	Bangarwadi 2	7.1	0.17	1.70	2.93	36.00
35	Ghatpimpri 1	6.3	0.11	1.40	2.41	31.00
36	Ghatpimpri 2	7.5	0.23	5.40	9.30	60.00
37	Vesvandi 1	7.7	0.26	4.00	6.89	55.00
38	Vesvandi 2	8.0	0.27	6.40	11.03	48.00
39	Bhaykundi 1	6.8	0.13	2.50	4.31	30.00
40	Bhaykundi 2	8.3	0.20	2.50	4.31	38.00
41	Washi 1	7.1	0.12	8.10	13.96	55.00
42	Washi 2	7.5	0.10	7.90	13.61	48.00
43	Golegaon 1	7.5	0.24	7.30	12.58	45.00
44	Golegaon 2	8.5	0.21	9.50	16.37	137.00
45	Sonarwadi 1	8.1	0.25	3.50	6.03	127.00
46	Sonarwadi 2	7.9	0.23	6.90	11.89	151.00
47	Khanapur 1	7.8	0.21	10.40	17.92	167.00
48	Khanapur 2	7.7	0.23	1.20	2.06	134.00
49	Indapur 1	7.2	0.14	3.50	6.03	11.00
50	Indapur 2	7.4	0.16	3.50	6.03	6.00
51	Bori 1	7.9	0.32	5.20	8.96	19.00
52	Bori 2	6.6	0.10	1.10	1.89	8.00
53	Terkheda 1	7.2	0.11	4.80	8.27	7.00
54	Terkheda 2	7.1	0.11	7.70	13.27	4.00
55	Umra 1	7.8	0.37	10.20	17.58	34.00
56	Umra 2	7.9	0.42	7.10	12.24	32.00
57	Kadakhnathwadi 1	7.7	0.22	5.40	9.30	29.00
58	Kadakhnathwadi 2	7.8	0.29	5.60	9.65	34.00
59	Khamkarwadi 1	7.0	0.23	4.60	7.93	60.00
60	Khamkarwadi 2	8.1	0.38	6.20	10.68	72.00
	Range	6.3-8.5	0.10-0.42	0.50-10.40	0.86-17.92	4.00-168.00
	Mean	7.53	0.193	4.81	8.29	46.52
	SE±	0.056	0.009	0.334	0.57	6.00
	CV (%)	5.76	39.21	53.86	53.88	67.32

Table 3: Status of available N,P,K Ca, Mg and S soil from Washi tahsil of Osmanabad district under Inceptisols.

	Available N (kg ha ⁻¹)	Available P (kg ha ⁻¹)	Available K (kg ha ⁻¹)	Sulphur (S) (mg kg ⁻¹)	Calcium (Ca) (cmol (P ⁺) kg ⁻¹)	Magnesium (Mg) (cmol (P ⁺) kg ⁻¹)
Mandava 1	200.85	28.13	449.00	28.13	46	03
Mandava2	255.50	31.99	193.90	14.35	32	09
Junner 1	175.00	29.55	231.30	29.55	41	10
Junner2	87.87	40.86	481.80	11.00	50	14
Dasmegaon 1	138.08	39.33	315.40	9.15	50	12
Dasmegaon 2	227.50	33.10	253.70	33.10	30	16
Ghodaki 1	196.00	10.03	356.90	12.66	39	06
Ghodaki 2	210.00	18.89	339.80	18.89	32	12
Gojawada 1	100.42	22.76	605.40	12.10	25	14
Gojawada 2	100.42	27.42	927.20	17.26	42	05
Gambhirwadi 1	138.08	9.87	186.40	5.50	31	10
Gambhirwadi 2	52.50	13.81	173.80	16.32	28	13
Sarola 1	150.63	41.05	579.20	6.75	46	07
Sarola 2	65.50	37.78	641.00	30.54	58	02
Para 1	89.63	14.52	475.20	35.48	46	07
Para 2	100.42	11.39	526.50	50.70	31	13
Lakhangaon 1	105.52	16.00	655.50	28.40	38	11
Lakhangaon 2	75.32	23.25	551.90	23.25	33	19
Shendi 1	49.00	13.98	395.50	34.10	43	07
Shendi 2	213.40	16.96	509.60	16.96	32	20
Bramhgaon 1	100.42	10.75	522.90	9.48	50	03
Bramhgaon 2	175.00	4.64	434.52	15.48	28	06
Pimpalgaon 1	138.08	16.96	292.10	16.96	37	11
Pimpalgaon 2	136.50	19.08	226.70	11.26	39	10
Rui 1	87.87	12.65	755.70	4.99	30	13
Rui 2	304.50	9.58	689.10	9.05	22	12
Paragaon 1	87.87	7.42	684.90	16.22	30	16

Paragaon 2	343.00	10.03	663.80	17.03	46	06
Shelgaon 1	175.74	14.52	271.30	3.95	29	06
Shelgaon 2	87.87	22.24	967.60	22.24	26	08
Vijora 1	112.98	5.73	162.26	18.21	17	15
Vijora 2	62.50	11.20	258.50	8.68	28	17
Bangarwadi 1	163.19	18.91	247.40	12.00	32	10
Bangarwadi 2	59.50	15.53	263.40	15.63	21	13
Ghatpimpri 1	138.08	12.33	167.28	16.65	25	10
Ghatpimpri 2	155.23	6.70	263.50	14.20	31	11
Vesvandi 1	150.64	22.18	579.90	6.30	24	22
Vesvandi 2	224.00	15.06	452.90	6.65	20	20
Bhaykundi 1	150.63	7.22	304.00	50.28	27	20
Bhaykundi 2	87.50	20.70	325.10	36.20	36	12
Washi 1	138.08	26.34	218.60	10.56	42	06
Washi 2	276.50	19.39	256.40	19.39	29	05
Golegaon 1	138.08	23.21	827.10	41.32	23	11
Golegaon 2	332.50	17.87	300.90	17.87	45	11
Sonarwadi 1	125.53	30.20	681.10	30.54	42	17
Sonarwadi 2	241.50	48.03	283.80	36.83	30	12
Khanapur 1	125.53	16.22	199.90	10.59	31	15
Khanapur 2	42.00	31.72	191.60	16.20	27	21
Indapur 1	122.50	17.44	222.50	13.05	30	09
Indapur 2	188.30	25.27	157.90	5.90	28	12
Bori 1	112.98	8.87	597.30	8.56	27	06
Bori 2	88.50	13.44	327.70	12.22	21	25
Terkheda 1	112.98	20.70	250.00	6.32	38	28
Terkheda 2	112.98	28.04	279.20	17.25	34	19
Umra 1	150.63	19.08	181.80	9.56	40	16
Umra 2	248.50	10.39	162.50	6.83	42	13
Kadakhnathwadi 1	175.74	24.45	736.80	45.29	46	03
Kadakhnathwadi 2	196.00	14.87	624.00	39.20	42	05
Khamkarwadi 1	161.00	10.75	475.00	11.15	26	10
Khamkarwadi 2	217.00	19.00	325.47	10.58	21	11
Range	42.00-343.00	4.64-48.03	157.90-967.60	3.95-50.70	17-58	2-28
Mean	149.65	19.48	411.35	18.58	33.91	11.76
SE±	8.91	1.25	27.13	1.53	1.17	0.72
CV (%)	46.14	50.04	51.09	63.96	26.83	47.80

Status of macronutrient in soil

Available N

Perusal of data on available N, P, and K was presented in table 3 and revealed that the available N content of these soils was varied from 42.00 to 343.00 kg ha⁻¹ with an average value of 149.65 kg ha⁻¹. It was observed that soils under Inceptisol of Washi tahsil were low in available nitrogen status. The variation in available N content in soil could be attributed due to the differences in their physiography, differential cultivation and management practices of these soils but also removal of N by the crop, losses through leaching, denitrification, and fixation and volatilization takes place. Some nitrogen is immobilized by soil microbes. This results in low availability of N in these soils. Ambulgekar (1995) reported that available N content in Vertisols, Inceptisols and Entisols varied from 175.61 to 269.69, 144.50 to 269.69 and 141.20 to 232.06 kg ha⁻¹ with a mean values 232.17, 206.8 and 183.49 kg ha⁻¹ N, respectively in soils of Maharashtra.

Available P

The available P content in these soils were ranged from 4.64 to 48.03 kg ha⁻¹ with an average value of 19.48 Kg ha⁻¹. Among the 60 soil samples, 8 samples were low (< 10 kg ha⁻¹), 37 samples were medium (10 to 25 kg ha⁻¹) and 15 samples were categorized under high (> 25 kg ha⁻¹) content of available P. From the above data it was clearly observed that the soils of Washi tahsil were medium to high in available P content. Malewar (1995) [22] reported that the available P

content in the soils of Marathwada region was ranged from 16 to 51 kg ha⁻¹.

Available K

The available K content in these soils were ranged from 157.90 to 967.60 kg ha⁻¹ with an average value of 411.35 kg ha⁻¹. Out of 60 samples 24 samples (40%) were medium and 36 samples (60%) were high in available K content In Inceptisol. The data indicated that, the Inceptisol of Washi tahsil were medium to high in K content. This could be attributed due to the presence of K bearing mineral like Feldspar and mica in the parent material. These results are in confirmatory with results of More and Gavali (2000).

Available Sulphur

The data on status of available S in soils of Washi tahsil are presented in table 3. The available sulphur contents in soils of Washi tahsil were ranged from 3.95 to 50.70 mg kg⁻¹ with an average value of 18.58 mg kg⁻¹. Out of 60 samples 3 (5%) samples were categorized as low, 12 (20%) as medium and 45 (75%) samples were high in available S content, respectively. This result was confirmatory with results obtained by Mehra *et al.* (2006) reported that available sulphur content in various districts of Rajasthan were ranged between 2.31-52.88 mg kg⁻¹.

Exchangeable Ca⁺⁺ and Exchangeable Mg⁺⁺

The data revealed that the exchangeable Ca⁺⁺ content of these soils were ranged from 17.00 to 58.00 cmol (P⁺) kg⁻¹ with an

average value of 33.91 cmol (P⁺) kg⁻¹. The exchangeable Mg⁺⁺ content in soils of Washi tahsil were varied from 2.00 to 28.00 cmol (P⁺) kg⁻¹ with a mean value of 11.76 cmol(P⁺) kg⁻¹. The result indicated that 60 samples collected from 30 villeges of Washi tahsil contained high in exchangeable Ca

and Mg. This might be due to more content of CaCO₃ and organic matter. Similar findings were also reported by Nayak *et al.* (2006). Mg⁺⁺ content is high might be due to presence of clay, dolomite parent material and organic matter in soils. Similar findings were also reported by Mandal *et al.* (2005).

Table 4: Status of available micro nutrients in Inceptisols of Washi tahsil of Osmanabad district

Sr. No	Vilage sample no	DTPA-Fe (mg kg ⁻¹)	DTPA-Mn (mg kg ⁻¹)	DTPA-Zn (mg kg ⁻¹)	DTPA-Cu (mg kg ⁻¹)	HWS-B (mg kg ⁻¹)
1	Mandava 1	1.24	6.94	0.80	2.82	0.63
2	Mandava2	1.50	7.26	0.16	2.13	0.41
3	Junner 1	2.45	5.31	0.13	1.77	0.74
4	Junner2	2.80	3.43	0.10	1.80	0.68
5	Dasmegaon 1	1.26	1.48	0.54	3.76	0.81
6	Dasmegaon 2	1.97	2.47	0.90	6.66	0.98
7	Ghodaki 1	2.15	5.57	1.30	4.41	0.23
8	Ghodaki 2	2.04	6.90	0.88	3.40	0.14
9	Gojawada 1	3.12	8.24	0.23	2.67	0.38
10	Gojawada 2	1.74	9.10	0.35	3.03	0.45
11	Gambhirwadi 1	0.85	1.30	0.73	1.92	0.10
12	Gambhirwadi 2	2.02	1.37	0.11	1.79	0.33
13	Sarola 1	2.51	5.98	0.20	2.77	0.06
14	Sarola 2	0.68	5.33	0.86	2.13	0.19
15	Para 1	0.48	4.09	0.93	1.48	0.50
16	Para 2	0.89	4.78	0.75	2.55	0.68
17	Lakhangaon 1	3.34	9.59	0.52	3.61	0.82
18	Lakhangaon 2	2.35	10.34	0.47	4.64	1.00
19	Shendi 1	4.98	7.08	1.20	4.98	0.78
20	Shendi 2	3.42	10.81	1.05	5.63	0.81
21	Bramhgaon 1	1.31	3.19	1.29	1.45	0.96
22	Bramhgaon 2	2.18	3.48	1.11	1.51	0.99
23	Pimpalgaon 1	2.28	6.76	0.75	2.61	0.08
24	Pimpalgaon 2	2.88	2.98	1.00	2.53	0.21
25	Rui 1	1.33	3.41	0.66	2.59	0.56
26	Rui 2	1.45	1.73	0.71	2.42	0.74
27	Paragaon 1	1.63	6.12	0.85	1.09	1.00
28	Paragaon 2	2.14	9.33	0.44	1.21	1.12
29	Shelgaon 1	2.26	8.87	0.72	1.76	0.97
30	Shelgaon 2	2.82	9.72	0.56	2.10	0.75
31	Vijora 1	3.18	10.53	0.22	2.67	0.06
32	Vijora 2	2.55	4.97	0.57	2.38	0.18
33	Bangarwadi 1	4.31	5.55	0.26	1.87	0.36
34	Bangarwadi 2	4.96	6.44	0.48	2.75	0.40
35	Ghatpimpri 1	2.53	4.59	0.97	0.99	0.63
36	Ghatpimpri 2	2.24	1.55	0.45	0.63	0.58
37	Vesvandi 1	0.52	2.96	0.43	1.00	0.94
38	Vesvandi 2	0.84	12.40	0.31	0.83	0.82
39	Bhaykundi 1	0.77	9.83	1.35	3.89	1.10
40	Bhaykundi 2	1.05	7.26	0.39	2.84	0.98
41	Washi 1	3.54	3.80	0.46	1.54	0.89
42	Washi 2	4.29	5.45	0.50	2.03	1.15
43	Golegaon 1	4.53	2.48	0.14	1.10	0.05
44	Golegaon 2	1.37	2.94	0.56	1.77	0.24
45	Sonarwadi 1	1.46	7.41	0.50	2.32	0.28
46	Sonarwadi 2	2.09	9.12	0.49	2.54	0.45
47	Khanapur 1	1.45	5.20	0.14	3.00	0.68
48	Khanapur 2	1.78	7.19	0.23	4.94	0.73
49	Indapur 1	3.22	12.00	0.42	2.58	0.94
50	Indapur 2	4.06	11.53	0.59	5.85	0.82
51	Bori 1	0.76	8.82	0.50	4.66	0.59
52	Bori 2	1.00	6.24	0.33	1.85	0.71
53	Terkheda 1	2.38	3.55	1.20	1.51	0.88
54	Terkheda 2	3.87	3.21	0.58	2.43	0.63
55	Umra 1	2.80	2.06	0.34	2.05	0.96
56	Umra 2	2.65	2.19	1.10	1.74	1.11
57	Kadakhnathwadi 1	2.11	9.28	0.98	1.23	0.97
58	Kadakhnathwadi 2	1.70	11.08	1.05	4.33	0.78
59	Khamkarwadi 1	1.50	7.60	0.36	3.28	0.46

60	Khamkarwadi 2	1.26	6.18	0.54	2.67	0.35
	Range	0.48-4.98	1.3-12.4	0.1-1.35	0.63-6.66	0.05-1.15
	Mean	2.21	6.10	0.61	2.60	0.63
	SE±	0.14	0.39	0.04	0.16	0.04
	CV (%)	50.76	50.14	55.30	50.27	50.60

Status of available micronutrients viz., Fe, Zn, Mn, Cu and B in soil

The data regarding available micro nutrient status viz; DTPA Fe, Mn, Zn, Cu and available B were presented in Table 4. The DTPA- Fe content of these soils were ranged from 0.48 to 4.98 mg kg⁻¹ with an average value of 2.21 mg kg⁻¹. Out of 60 samples, 39 (65%) samples were low, 18 (30%) samples were medium and 3 (5%) samples were high in DTPA-Fe content. Malewar and Ismail (1999) [11] noticed the range of DTPA- Fe in between 0.36 to 25.14 mg kg⁻¹ in soils of Marathwada. The data revealed that the DTPA- Zn content in soils of Washi tahsil was ranged from 0.10 to 1.35 mg kg⁻¹ with a mean value of 0.61 mg kg⁻¹. Among 60 soil samples, 36 (60%), 21 (35%) and remaining 3 (5%) samples were categorized as deficient, marginal and sufficient, respectively in DTPA-Zn content. Diwale and Chavan (1999) studied zinc in lateritic soils of Konkan and noticed that the DTPA-Zn in these soils were ranged from 0.5 to 4.2 mg kg⁻¹ soil with a mean value of 1.4 mg kg⁻¹ soil.

The DTPA- Mn content of these soils were varied from 1.30 to 12.40 mg kg⁻¹ with a mean value of 6.10 mg kg⁻¹. Among the 60 soil samples, only 5 (8%) samples were deficient, 18 (30%) samples were marginal and 37 (62%) samples were sufficient in DTPA-Mn content. High content of Mn might be due to reason that the soils were derived from basaltic alluvium parent material rich in ferromagnesium mineral (Patil and Jagdish Prasad, 2004). The DTPA- Cu content in Washi soils were ranged from 0.63 to 6.66 mg kg⁻¹ with an average value of 2.60 mg kg⁻¹. All soil samples collected from 30 villeges of Washi tahsil was high in DTPA-Cu content. Similar results also observed by Patil and Sonar (1994) reported that the Cu in swell-shrink soils of Maharashtra which were varied between 0.73 to 3.02 mg kg⁻¹. The HWS- B content of these soils was varied from 0.05 to 1.15 mg kg⁻¹ with a mean value of 0.63 mg kg⁻¹. Out of 60 soil samples, only 1 sample was low (<0.1mg kg⁻¹), 13 soil samples were medium (0.1 to 0.5 mg kg⁻¹) and 46 samples were high (> 0.5 mg kg⁻¹) in HWS-B content. These results are in accordance with the results reported by Malewar (2005) [10] noticed that the hot water soluble boron ranged from 0.12 to 0.34 mg kg⁻¹ in soils of Jammu region.

The results summarized can be concluded that the Inceptisols of Washi tahsil of Osmanabad district were neutral to alkaline in reaction, safe in electrical conductivity, low to moderate in organic carbon content and non-calcareous to calcareous in nature. Available primary macronutrient viz N was low, phosphorus content was medium to high, K content was medium to high in soils of Washi tahsil of Osmanabad district under Inceptisol. These soils were categorized as medium to high in available sulphur content. Exchangeable Ca⁺⁺, Mg⁺⁺ were found to be high in soils of Washi tahsil. The lowest content of DTPA-Fe and Zn while, high content of DTPA-Mn and DTPA-Cu were observed in soils of Washi tahsil. However, available B content was medium to high in soils of Washi tahsil.

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