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Soil fertility assessment of organically grown turmeric in Vasmat tahsil of Hingoli district

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Abstract
The present investigation was carried out during 2021-2022 to evaluate the soil nutrient status of organic turmeric growing areas under Vasmat tahsil of Hingoli district of Maharashtra. Fifty farmers who adopted organic farming for turmeric cultivation was selected from 12 different villages with the help of Agriculture Technology Management Agency (ATMA), State Agriculture Department Vasmat, Hingoli District who were connected in different organic farming groups of different villages. The total fifty soil samples were (0-20 cm depth) collected at senescence stage by GPS based location system. These soil samples further analyzed for study of important physical properties *viz.* bulk density, particle density, soil colour, water holding capacity and soil texture and chemical properties like pH, EC, organic carbon, calcium carbonate and major nutrients N, P, K & S. The results indicated that these soils are clayey to clay loam in texture. Soil colour is found dark brown, grayish brown, dark gryish brown, brown and very dark gray. The bulk density, particle density, water holding capacity of these soils were varied 1.16 to 1.32 Mg m^{-3}, 2.27 to 2.59 Mg m^{-3}, 66.3 to 76.2 percent, respectively with an average values of 1.24 Mg m^{-3}, 2.41 Mg m^{-3} and 70.5 per cent, respectively. The soils of Vasmat tahsil were neutral to slightly alkaline having safe range of electrical conductivity for crop growth, medium to high in organic carbon and calcareous to highly calcareous in nature. Further data indicated that these soils were found low to medium, medium to high, high and low to high in respect of available N, P, K and S, respectively.

Keywords: Soil fertility status, physic-chemical properties, available nutrient status

Introduction
Turmeric has been used in India for medicinal purposes from centuries. It has been used in traditional medicine as a household remedy for various diseases, including biliary disorders, anorexia, cough, diabetic wounds, hepatic disorders, rheumatism and sinusitis. In addition to its use as spice and pigment, turmeric and its constituents mainly curcumin and essential oils shows a wide spectrum of biological actions. Use of turmeric dates back nearly 4000 years to the Vedic culture in India.

It is extensively used in Ayurveda, Unani and Siddha medicine as home remedy for various diseases. Turmeric is native of South–East Asia and it is used as food additives (Spice), preservative and colouring agent in Asian countries including India, China, Taiwan, Srilanka, Bangladesh, Burma (Myanmar), Nigeria, Australia, West Indies, Peru, Jamaica and some other Caribbean and Latin American countries (Rathaur *et al.* 2012) [9].

With the advent of high yielding varieties, increased shift from organic–based nutrient application to chemical fertilizers took place. Consequently, there was reduction in the consumption of organic manures in addition to excess use of inorganic fertilizers to obtain high yields of improved varieties. The continuous and indiscriminate use of high analysis fertilizers has resulted in several problems such as acidity, alkalinity, micro nutrient deficiencies, soil and ground water pollution (Kadam, 2020) [11]. There is a need to maintain proper co-ordination among resources like soil, water, organic matter, biotic life and plant nutrient supply to maintain crop production at higher level (Anal, 2020) [2].

In the year 2022-23, an area of 3.24 lakh ha was under turmeric cultivation in India with a production of 11.61 lakh tonnes (over 75% of global turmeric production). More than 30 varieties of turmeric are grown in India and it is grown in over 20 states in the country.

India's share in total turmeric production in the world is more than 80%. In India, Andhra Pradesh is the largest producer of Turmeric followed by Tamil Nadu, Orissa, Karnataka, West Bengal, Gujarat, and Kerala. The state of Maharashtra, with over 278 thousand metric tons, was the leading producer of turmeric in India during fiscal year 2022-23. Telangana and Karnataka were second and third in the ranking during that year.

Under Marathwada region Hingoli district is having the major turmeric growing area. During 2022-23, area under turmeric cultivation in Hingoli tahsil was 4,900 ha, in Basmat tahsil 16,000 ha, Kalmnuri tahsil 6,000 ha, Sengaon tahsil 5,100 ha and in Aundha tahsil 3,000 ha. Turmeric is an exhaustive nutrient feeder crop respond well to nutrition. No systematic study was done on the aspect of physico-chemical properties and fertility status of turmeric growing areas in Marathwada region. Therefore, the survey on, "Soil Fertility Assessment of Organically Grown Turmeric in Vasmat Tahsil of Hingoli District" was carried out.

Materials and Methods

The present investigation was undertaken in order to assess soil nutrient status of turmeric growing areas under Vasmat tahsil of Hingoli district for that purpose global positioning system (GPS) based soil samples (0-20 cm depth) were collected at senescence stage (January to February). Fifty farmers who have using organic fertilizers for their fields were randomly selected from 12 different villages with the help of Agriculture Technology Management Agency (ATMA), state Agriculture, Department of Vasmat Hingoli District who were connected in different organic farming groups of different villages.

Further the collected soil samples were used for estimation of bulk density particle density, soil colour, water holding capacity, pH, EC, Organic Carbon, free Calcium Carbonate, available nitrogen, phosphorus, potassium and sulphur. The bulk density was estimated by technique given by Black and Hartge (1986) [4], Partical density was determined by Pycnometer method suggested by Chopra and Kanwar (1976) [7], Water holding capacity of soil was estimated by keen- boxes method as suggested by Keen and Raczkowski (1923), soil colour was determined by Munsell colour chart (Munsell 1913) [15]. Soil reaction (pH) and Electrical conductivity was determined by the procedure given by Jackson (1973) [10]. Modified method of Walkely and Black (1934) [29] was used for determination of organic carbon. The free calcium carbonate was determined by rapid titration method as outlined by Piper (1966) [18], available nitrogen was estimated by alkaline $KMnO_4$ method given by Subbiah and Asija (1956) [24], available phosphorus was extracted by Olsen *et al.* (1954) [16], available potassium was extracted through the method given by Jackson (1973) [10]. Exchangeable calcium and magnesium were determined on less than 2 mm samples by leaching with 1N NaCl solution (Piper) and titrating the leachate with standard EDTA solution as per the method of (Richards, 1965) [20]. The available S was determined by using extractant 1:5 soil and 0.15 per cent $CaCl_2$ solution on spectrophotometer at 340 nm (Willams and Steinberg, 1969) [30].

Result and Discussion

Physical Properties of soil

The data regarding physical properties of soil is represented in Table 1.

Bulk density

The bulk density of organically grown turmeric soils of Vasmat tahsil varied between 1.16 to 1.32 Mg m^{-3} with average value 1.24 Mg m^{-3} (Table 1). The lowest bulk density 1.16 Mg m^{-3} was observed in village Amba sample no. V1S1, Dhanora sample no. V2S7 and Pimprala sample no. V6S4 and the highest value of bulk density 1.32 Mg m^{-3} was observed in village Lingi and Pangrasati in the sample no. V4S3 and V9S9, respectively. Some soil sample had low bulk density due to the presence of high organic matter and some sample had high value of bulk density due to the presence of smectite clay minerals. Similar results were also reported by Ewulo *et al.*, (2008) [8] at federal university Nigeria and Badhole (2007) [3] while studying soils of Agricultural Farm of MAU, Parbhani.

Increase in organic inputs like FYM, poultry manure, compost, increase the organic matter content and lowers the bulk density of soil. High bulk density of soil indicates the compactness of the soil. In swelling soils, bulk density decreases with increase in moisture content and vice versa. Similar results were obtained by Chavhan (2020) [6] from the turmeric growing soils of Vasmat tahsil.

Particle density

The particle density of organically turmeric growing areas ranges from 2.27 to 2.59 Mg m^{-3} (Table 1). In this the average particle density of all samples was 2.41 Mg m^{-3}. The highest (2.59 Mg m^{-3}) and lowest (2.27 Mg m^{-3}) particle density was found in the village Vasmat. Similar result was reported by Singh and Mishra (2012) [22].

Water holding capacity

Water holding capacity of organic turmeric growing soil ranged from 66.3 to 76.2 per cent with a mean value 70.5 per cent. The lowest water holding capacity 66.3 per cent was found in village Pangrasati (Sample no.V9S3) whereas, highest water holding capacity was recorded in the village Dhanora (Sample no. V2S9). The water holding capacity is mainly depends on pore spaces of soil due to addition of organic inputs in soil like FYM, poultry manure, compost, it increases the soil pore spaces and hence water holding capacity of soil increases. Biofertilizers adds more organic matter in the soil and create more pore spaces to hold water. These results are in conformity with Thamraj *et al.* (2011) [25].

Soil texture

The data regarding the soil texture is given in the Table1 revealed that among 50 sample from Vasmat tahsil, 48 Sample were clay in texture and only two are in clay loam in texture. Fine clay texture of these soils is due to fine crystalline extrusive basaltic rock. Similar findings were reported by Badhole, (2007) [3] in respect of soils of demonstration farm MAU, Parbhani.

Soil colour

The dominant spectral wavelength of Munsell colour Hue 10YR and 7.5 soils showed variation in value and chroma. The variation in the value ranged from 3 to 5 and in chroma 1 to 4 according to Munsell colour system the soils in Vasmat tahsil are dark brown (10YR3/3), dark grayish brown (10YR4/2), Grayish brown (10YR5/2), brown (10YR4/3), (7.5YR4/2), very dark gray (10YR3/1). Soils from the little variation in colour value and chroma may be because of assemblage of mineral derived from basaltic trap rock. The brown to dark brown colour of soil derived from basaltic trap rock was also reported by Yadav (2005) [31] in soil of college of agriculture, Latur farm.

Chemical properties of organic turmeric growing soils.

Soil reaction

The data regarding soil pH is given the Table 2 and categorization of soil reaction is given in the Table 3.

In collected sample the lowest value of pH (7.31) observed in Vasmat village and high pH (7.81) recorded from village Mohamdpurwadi. Overall pH range of Vasmat tahsil were varied from 7.31 to 7.81 with mean value of 7.51. At senescence stage about 42% soil samples were normal in reaction, and 58 per cent soil samples were found slightly alkaline.

The pH range slightly decreased when compared to conventional farming than in organic farming. The reason for this might be due to continuous use organic inputs and less use of synthetic chemical fertilizers and application of farmyard manure which releases some organic acids which results in decreased pH. Similar results were obtained by Chavan (2020) [6] under the turmeric growing soils of Vasmat tahsil found pH range 7.32 to 8.12.

Electrical Conductivity

The results regarding electrical conductivity are presented in Table 2 and categorization of turmeric growing soils of Vasmat tahsil on the basis categorization of electrical conductivity are tabulated in Table 4. The data on electrical conductivity indicated that all the tested soil sample were normal in their EC i.e., < 2 dS m^{-1}. The average electrical conductivity of organically turmeric growing soil was ranged from 0.202 to 0.304 dSm^{-1} with average of 0.248 dSm^{-1}. The highest EC 0.304 dSm^{-1} was recorded in sample of village Mohamdpurwadi. Whereas, the lowest EC was recorded in the Vasmat village that was 0.202 dSm^{-1}. All the soil samples from all villages are categorized as safe for crop growth.

The low EC value because of well drain soils causes leaching of all soluble salts from surface layer soils. The results are similar to findings of Boraiah *et al.* (2015) [5]. Sampling is done in standing crop; the evaporation losses are low due the presence of standing crop in the field and continuous irrigation practices results in the leaching of salts to the lower region **(**Perni, 2005) [17]. Soil health and yield of crop tend to improve when the soil organic carbon level increases. Higher soil organic carbon promotes soil structure or tilth meaning there is greater physical stability. This promotes soil aeration water drainage and retention, reduces the risk of erosion and nutrient leaching.

Organic Carbon

The organic carbon content of each soil sample is given in Table 2 and the categorization of soil under low, medium and high based on soil organic carbon content are presented in Table 5.

The organic carbon content of soil sample is varying according to village. Lowest organic carbon content (6.1 g kg^{-1}) was observed in sample of Mohamdpurwadi and the highest organic carbon content (9.9 g kg^{-1}) was observed in village Phata and Pangrasati. The range of all soil samples tested in which the minimum and maximum range is 6.1 g kg^{-1} to 9.9 g kg^{-1} with mean value of 8.6 g kg^{-1}. Among the all soil samples tested, 6 per cent soil sample were medium in organic carbon status, 94 per cent soil samples are high in their organic carbon.

The availability of low to medium organic carbon content in this soil due to high temperature of Marathwada region and less awareness regarding recycling of organic and poor management practices (Ghuge 2002) [9]. While high organic carbon content is due to the addition of organic matter to the soil in the form of FYM and crop residues. These results are in accordance with the findings of Kumar *et al.* (2018) [12] who reported 6.2 to 9.6 g kg^{-1} organic carbon under performance of turmeric under different agroforestry tree species in G. B. Pant university of agriculture, Uttarakhand.

Calcium Carbonate

The data on calcium carbonate from collected soil sample of turmeric growing areas of Vasmat tahsil are given in Table 2 and categorization is given in the Table 6.

Average calcium carbonate content varied from 5.7 to 14.2 per cent with average value of 9.23%. The lowest calcium carbonate (5.7%) was recorded in village Dhanora and highest calcium carbonate (14.2%) was reported from village Pangrasati. About 70 per cent soil samples were found calcareous and 30 per cent found highly calcareous in nature. There was low to medium calcium carbonate content of turmeric growing soils of Vasmat tahsil which might be due to the presence of calcium carbonate in powdery form and hyper thermic regime of Vasmat tahsil Waghmare *et al.* (2008) [27]. Similar results were also reported by Waikar *et al.* (2014) [28] who observed non calcareous to highly calcareous nature soils in northern tahsil of Parbhani district.

Nutrient Status in soil

Available nitrogen

The results of available nitrogen are presented in Table 7 and the categorization of soil samples according to ratings of nitrogen expressed in Table 8.

The average available nitrogen content of all the villages was ranged from 178.7 to 291.6 kg ha $^{-1}$ with mean value 246.9 kg ha $^{-1}$. The lowest available nitrogen (178.7 $kgha^{-1}$) was reported in sample of village Pangrasati and the highest available nitrogen (291.6 $kgha^{-1}$) was reported from the sample in village Dhanora 291.6 kg ha $^{-1}$, the average total nitrogen was 243.4 kg ha $^{-1}$.

All the soil samples from turmeric growing areas were categorized under 92 percent low status of available nitrogen and 8 percent medium in their status, no one sample recorded high status of nitrogen. Similar results were reported by Chavan (2020) [6]. Low nitrogen status is due to the crop removal, may be subjected to leaching and volatilization losses (Perni 2005) [17]. Alane (2010) [1] reported that the available nitrogen content from Aundha tahsil varied from 106.62 to 298.5 kg ha^{-1} with mean value of 147.6kg ha^{-1}. The low nitrogen status is might be due to the arid environment and low organic matter content in these soils.

It is also concerned with the application of FYM and fertilizers applied to previous crop (Srikanth *et al.* 2008) [23]. And another reason for this is the loss of applied nitrogen by means of leaching and denitrification results in low nitrogen status (Tur *et al.* 2008) [26].

Available phosphorus

The total phosphorus content in soil consists of organic and inorganic phosphorus. It occurs as orthophosphates in the mineral suite. A variable amount of phosphorus is associated with organic matter moiety, but in non-ortho forms. The data on the available phosphorus is presented in Table 7 and the categorization of turmeric growing soils on the basis of available phosphorus is presented in Table 9. The data of soil survey analysis average available phosphorus content in organic turmeric growing soil was varied from 17.6 kg to 24.5 kg ha^{-1} with a mean value of 20.56 kg ha^{-1}. The lowest phosphorus content (17.6 kg ha^{-1}) was observed in samples of village Lingi and highest available phosphorus (24.5 kg ha^{-1}) was found in samples of two villages Pangrasati and Vasmat. The 56% of

samples were categorized under medium and 44% soil samples were rated in high in phosphorus content. These results in accordance with Chavan (2020) [6] and Kumar *et al.* (2018) [12].

Available potassium

The data on the available potassium in turmeric growing soils of Vasmat tahsil is given in Table 3. In the sampling the available potassium ranged from 639.9 to 843.3 kg ha^{-1} with average value of 750.8 kg ha^{-1}. The lowest potassium (639.9 kg ha^{-1}) was noted in the sample of village Mohamadpurwadi and highest amount of potassium (843.3 kg ha^{-1}) was found in sample of village Pimprala. All samples were categorized as high in available potassium content. The similar results were reported by Alane (2010) [1] who showed that the available potassium from the Aundha tahsil were ranged from 215.7 to 1279.7 kg ha^{-1} with average value of 533.89 kg ha^{-1}.

The high amount of available potassium probably was due to the presence of higher potassium bearing minerals like feldspar and mica in the parent material. These results are similar with results reported by Malewar and Patil (1998) [13] observed that the available potassium in semi-arid soils of Maharashtra ranged from 318.0 to 616.0 kg ha^{-1}.

High amount of potassium was recorded earlier by More *et al.* (2005) [14] who showed potassium content of Vasmat tahsil soils ranged from 182.10 to 1078.20 kg ha^{-1} with mean value of 513.78 kg ha^{-1}.

Available Sulphur

The data in Table 7 and categorization of available sulphur is given in Table 11. The available Sulphur in these soils was ranged from 18.1 to 28.9 kg ha^{-1} with a mean of 24.5 kg ha^{-1}.

The highest available Sulphur (28.9 kg ha^{-1}) was observed in village Vasmat and the lowest Sulphur (18.1 kg ha^{-1}) were found in the village Dhanora. Among the 50 soil samples, no samples being low, where 4% samples are medium in available sulphur and 96% high in status from organic turmeric growing areas soils of Vasmat. The sufficiency of available S is due to high amount of clay content in soils which can adsorbed varying amounts of sulphur (Waikar *et al*. 2014) [28].

The low to moderate content of sulphur is might be due to gypsiferrous nature of Sulphur which is non-available in black soil. These results were collaborated with the Sawashe *et al.* (2007) [21] while studying the soils of Latur and Renapur tahsil of Latur district, the available sulphur content varied from 10.31 to 49.27 and 4.45 to 41.05 mg kg^{-1}, respectively.

Table 1: Physical properties of organic turmeric growing soil of Vasmat Tahsil

Sr. No	Sample No.	Soil Texture	Bulk density (Mg m-3)	Particle density (Mg m-3)	WHC (%)	Colour Notation	Munsell soil colour
1	V1S1	Clay	1.22	2.28	69.3	10YR3/3	Dark Brown
2	V1S2	Clay	1.17	2.31	73.2	10YR4/2	Dark grayish brown
3	V1S3	Clay	1.16	2.36	74.9	10YR4/3	Brown
4	V2S1	Clay	1.19	2.45	72.5	7.5YR4/2	Brown
5	V2S2	Clay	1.28	2.50	74.2	7.5YR3/2	Dark brown
6	V2S3	Clay	1.19	2.34	66.3	10YR4/1	Dark gray
7	V2S4	Clay	1.21	2.38	71.3	10YR5/3	Brown
8	V2S5	Clay	1.23	2.35	70.0	7.5YR4/2	Brown
9	V2S6	Clay	1.19	2.29	72.0	10YR3/3	Dark brown
10	V2S7	Clay	1.16	2.45	73.0	10YR4/1	Dark gray
11	V2S8	Clay	1.27	2.52	69.4	10YR4/3	Brown
12	V2S9	Clay	1.24	2.46	76.2	7.5YR3/2	Dark brown
13	V3S1	Clay	1.22	2.42	68.9	7.5YR3/2	Dark brown
14	V4S1	Clay	1.19	2.38	71.6	10YR3/3	Dark Brown
15	V4S2	Clay	1.28	2.37	69.3	10YR5/3	Brown
16	V4S3	Clay	1.32	2.58	68.4	10YR4/1	Dark gray
17	V5S1	Clay	1.26	2.37	70.3	10YR4/3	Brown
18	V5S2	Clay	1.20	2.42	74.3	10YR4/3	Brown
19	V5S3	Clay	1.25	2.47	69.9	10YR4/1	Dark gray
20	V6S1	Clay	1.27	2.28	72.3	7.5YR3/2	Dark brown
21	V6S2	Clay Loam	1.29	2.32	71.6	10YR3/3	Dark brown
22	V6S3	Clay	1.28	2.39	74.6	10YR3/2	Very dark grayish brown
23	V6S4	Clay	1.16	2.37	72.3	10YR3/2	Very dark grayish brown
24	V6S5	Clay	1.29	2.45	72.4	10YR3/3	Dark brown
25	V6S6	Clay	1.25	2.48	67.5	10YR3/3	Dark Brown
26	V6S7	Clay	1.21	2.36	73.6	10YR4/2	Dark grayish brown
27	V6S8	Clay	1.24	2.34	68.3		
28	V6S9	Clay Loam	1.19	2.38	73.3	10YR3/3	Dark brown
29	V6S1	Clay	1.30	2.52	66.9	7.5YR4/2	Brown
30	V7S1	Clay	1.17	2.32	68.4	10YR4/1	Dark gray
31	V7S2	Clay	1.22	2.40	70.9	10YR5/3	Brown
32	V8S1	Clay	1.25	2.49	72.5	10YR4/1	Dark gray
33	V9S2	Clay	1.19	2.35	70.3	10YR5/3	Brown
34	V9S1	Clay	1.20	2.43	71.2	10YR4/3	Brown
35	V9S2	Clay	1.31	2.48	66.3	10YR3/3	Dark Brown
36	V9S3	Clay	1.27	2.44	69.8	10YR4/1	Dark gray
37	V9S4	Clay	1.23	2.41	70.3	10YR4/1	Dark gray
38	V9S5	Clay	1.21	2.47	68.5	10YR3/3	Dark brown
39	V9S6	Clay	1.26	2.36	72.7	10YR3/2	Very dark grayish brown
40	V9S8	Clay	1.18	2.34	70.3	7.5YR4/2	Brown

41	V9S9	Clay	1.32	2.51	68.7	10YR3/2	Very dark grayish brown
42	V10S	Clay	1.27	2.54	66.5	10YR3/3	Dark Brown
43	V10S	Clay	1.31	2.39	68.4	7.5YR3/2	Dark brown
44	V10S	Clay	1.22	2.43	72.6	7.5YR4/2	Brown
45	V11S1	Clay	1.29	2.27	69.3	7.5YR3/2	Dark brown
46	V11S2	Clay	1.31	2.59	66.1	10YR4/1	Dark gray
47	V11S3	Clay	1.19	2.28	65.3	10YR4/1	Dark gray
48	V11S4	Clay	1.30	2.5	68.4	10YR4/1	Dark gray
49	V12S1	Clay	1.30	2.58	70.2	10YR3/2	Very dark grayish brown
50	V12S1	Clay	1.27	2.52	71.6	7.5YR4/2	Brown
Mean			1.24	2.41	70.5		

Table 2: Chemical properties of turmeric growing soils of Vasmat tehsil

Sr. No.	Sample no.	Soil pH	EC (dSm-1)	Organic Carbon (g kg-1)	Calcium Carbonate (%)
1	V1S1	7.50	0.272	8.7	9.2
2	V1S2	7.71	0.203	8.2	8.0
3	V1S3	7.62	0.248	9.1	8.2
4	V2S1	7.70	0.277	9.0	9.7
5	V2S2	7.48	0.274	7.8	13.0
6	V2S3	7.32	0.223	8.5	13.5
7	V2S4	7.39	0.231	9.1	5.7
8	V2S5	7.58	0.280	8.8	11.7
9	V2S6	7.46	0.212	8.5	7.0
10	V2S7	7.42	0.293	7.8	8.0
11	V2S8	7.48	0.205	9.4	8.7
12	V2S9	7.44	0.238	8.2	9.7
13	V3S1	7.56	0.249	9.1	11.6
14	V4S1	7.59	0.267	8.7	9.0
15	V4S2	7.51	0.216	9.6	10.2
16	V4S3	7.62	0.240	8.8	11.1
17	V5S1	7.63	0.276	9.3	9.7
18	V5S2	7.54	0.304	9.0	7.0
19	V5S3	7.81	0.297	6.1	8.2
20	V6S1	7.39	0.272	8.8	8.5
21	V6S2	7.52	0.223	8.7	9.5
22	V6S3	7.77	0.234	8.8	6.5
23	V6S4	7.56	0.215	9.4	6.2
24	V6S5	7.52	0.246	8.7	8.7
25	V6S6	7.34	0.247	9.0	9.2
26	V6S7	7.58	0.230	7.9	8.0
27	V6S8	7.46	0.282	8.8	7.5
28	V6S9	7.38	0.283	9.2	11.5
29	V6S10	7.60	0.272	9.6	10.7
30	V7S1	7.71	0.271	9.9	10.2
31	V7S2	7.42	0.267	8.7	8.5
32	V8S1	7.53	0.262	8.8	7.5
33	V9S2	7.52	0.221	9.3	9.0
34	V9S1	7.57	0.224	7.2	14.2
35	V9S2	7.56	0.281	6.3	13.0
36	V9S3	7.59	0.211	8.4	12.0
37	V9S4	7.37	0.242	9.9	7.2
38	V9S5	7.45	0.218	7.5	8.5
39	V9S6	7.32	0.215	7.9	10.7
40	V9S8	7.44	0.217	9.6	8.3
41	V9S9	7.38	0.232	9.3	6.7
42	V10S1	7.40	0.243	8.7	8.5
43	V10S2	7.59	0.248	8.1	9.2
44	V10S3	7.76	0.249	7.8	9.2
45	V11S1	7.69	0.202	9.0	6.7
46	V11S2	7.51	0.228	7.9	10.7
47	V11S3	7.35	0.289	8.8	9.2
48	V11S4	7.31	0.282	9.3	8.5
49	V12S1	7.42	0.242	9.4	7.0
50	V12S2	7.60	0.251	7.3	11.7
Mean		7.51	0.248	8.6	9.3

Table 3: Categorization of turmeric growing soils on the basis of ratings of soil pH.

Sr. No.	Village	No. of sample	Categorization							
			pH		Neutral		Slightly Alkaline		Moderately Alkaline	
			Range	Mean	No.	%	No.	%	No	%
1	Amba	3	7.50-7.71	7.61	1	33.3	2	66.6	-	-
2	Dhanora	9	7.32-7.70	7.47	6	66.6	3	33.3	-	-
3	Hayatnagar	1	7.56	-	-	-	1	100	-	-
4	Lingi	3	7.51-7.62	7.57	-	-	3	100	-	-
5	Mohamdpurwadi	3	7.54-7.81	7.59	-	-	3	100	-	-
6	Pimprala	10	7.34-7.77	7.51	3	30	7	70	-	-
7	Phata	2	7.42-7.71	7.56	1	50	1	50	-	-
8	Raywadi	1	7.53	-	-	-	1	100	-	-
9	Pangrasati	9	7.32-7.59	7.46	6	66.6	3	33.3	-	-
10	Telgaon	3	7.40-7.76	7.58	1	33.3	2	66.6	-	-
11	Vasmat	4	7.31-7.69	7.46	2	50	2	50	-	-
12	Hatta	2	7.42-7.60	7.51	1	50	1	50	-	-
Average				7.53	21	42	29	58		

Table 4: Categorization of turmeric growing soils on the basis of ratings of electrical conductivity

Sr. No	Village	No. of sample	Categorization							
			EC (dSm-1)		Safe (<0.8)		Normal (0.8- 2.5)		Unsafe (>2.5)	
			Range	Mean	No	%	No.	%	No.	%
1	Amba	3	0.203-0.272	0.241	3	100	-	-	-	-
2	Dhanora	9	0.205-0.293	0.248	9	100	-	-	-	-
3	Hayatnagar	1	0.249	-	1	100	-	-	-	-
4	Lingi	3	0.216-0.267	0.240	3	100	-	-	-	-
5	Mohamdpurwadi	3	0.276-0.304	0.297	3	100	-	-	-	-
6	Pimprala	10	0.215-0.283	0.250	10	100	-	-	-	-
7	Phata	2	0.267-0.271	0.269	2	100	-	-	-	-
8	Raywadi	1	0.262	-	1	100	-	-	-	-
9	Pangrasati	9	0.215-0.281	0.229	9	100	-	-	-	-
10	Telgaon	3	0.243-0.249	0.246	3	100	-	-	-	-
11	Vasmat	4	0.202-0.289	0.250	4	100	-	-	-	-
12	Hatta	2	0.242-0.251	0.246	2	100	-	-	-	-
Mean				0.252	50	100				

Table 5: Categorization of turmeric growing soil on the basis of rating of Organic Carbon

Sr. No	Village	No. of sample	Categorization							
			Organic carbon (g kg-1)		Low (<5)		Medium (5 -7.5)		High (> 7.5)	
			Range	Mean	No.	%	No.	%	No.	%
1	Amba	3	8.2-9.1	8.6	-	-	-	-	3	100
2	Dhanora	9	7.8-9.4	8.5	-	-	-	-	9	100
3	Hayatnagar	1	9.1	-	-	-	-	-	1	100
4	Lingi	3	8.7-9.6	9.0	-	-	-	-	3	100
5	Mohamdpurwadi	3	6.1-9.3	8.1	-	-	1	33.3	2	66.6
6	Pimprala	10	7.9-9.6	8.8	-	-	-	-	10	100
7	Phata	2	8.7-9.9	9.3	-	-	-	-	2	100
8	Raywadi	1	8.8	-	-	-	-	-	1	100
9	Pangrasati	9	6.3-9.9	8.3	-	-	1	11.1	8	88.8
10	Telgaon	3	7.8-87	8.2	-	-	-	-	3	100
11	Vasmat	4	79-93	8.7	-	-	-	-	4	100
12	Hatta	2	73-94	8.3	-	-	1	33.3	2	22.2
Mean				8.5			3	6	47	94

Table 6: Categorization of turmeric growing soil on the basis of rating of calcium carbonate

Sr. No.	Village	No. of sample	Categorization							
			Calcium Carbonate (%)		Non-Calcareous (< 5)		Calcareous (5 - 10)		Highly cal. (> 10)	
			Range	Mean	No	%	No	%	No	%
1	Amba	3	8.0-9.2	8.46	-	-	3	100		
2	Dhanora	9	5.7-13.5	9.66	-	-	6	66.6	3	33.3
3	Hayatnagar	1	11.6	-	-	-	-	-	1	100
4	Lingi	3	9.0-11.1	10.1	-	-	1	33.3	2	66.6
5	Mohamdpurwadi	3	7.0-9.7	8.3	-	-	3	100	-	-
6	Pimprala	10	6.2-11.5	8.63	-	-	8	80	2	20
7	Phata	2	8.5-10.2	9.35	-	-	1	50	1	50

8	Raywadi	1	7.5	-	-	-	1	100	-	-
9	Pangrasati	9	6.7-14.2	9.95	-	-	5	55.5	4	44.4
10	Telgaon	3	8.5-9.2	8.96	-	-	3	100	-	-
11	Vasmat	4	6.7-10.7	8.7	-	-	3	75	1	25
12	Hatta	2	7.0-11.7	9.35	-	-	1	50	1	50
Mean				9.14			35	70	15	30

Table 7: Available Macro nutrients status of turmeric growing soil

Available nutrients (Kg ha-1)					
Sr. No.	**Sample no.**	**N**	**P**	**K**	**S**
1	V1S1	200.7	20.5	735.8	23.2
2	V1S2	260.2	19.5	707.8	26.8
3	V1S3	235.2	19.0	759.3	21.8
4	V2S1	279.4	24.5	741.1	18.2
5	V2S2	222.6	20.1	665.8	24.6
6	V2S3	247.7	17.9	708.5	25.9
7	V2S4	291.6	19.2	756.6	20.3
8	V2S5	263.4	20.1	761.6	22.8
9	V2S6	269.1	21.2	772.7	22.5
10	V2S7	279.1	20.3	727.3	18.1
11	V2S8	225.7	18.7	713.6	21.5
12	V2S9	279.1	18.1	701.1	25.5
13	V3S1	263.4	19.0	785.7	25.3
14	V4S1	260.2	20.3	796.9	28.7
15	V4S2	272.8	17.6	695.5	28.6
16	V4S3	269.6	20.1	689.8	24.1
17	V5S1	282.2	19.8	663.8	24.4
18	V5S2	281.1	19.0	639.9	24.3
19	V5S3	238.3	18.1	721.2	26.1
20	V6S1	279.3	21.1	768.8	22.9
21	V6S2	228.9	21.7	787.9	23.9
22	V6S3	241.4	22.5	803.4	23.2
23	V6S4	272.8	23.4	720.4	24.8
24	V6S5	206.9	22.4	780.8	26.6
25	V6S6	244.6	19.1	783.6	23.9
26	V6S7	203.8	18.3	668.6	23.7
27	V6S8	219.5	21.2	826.5	26.8
28	V6S9	222.6	21.7	843.3	24.5
29	V6S10	191.3	22.5	776.2	25.7
30	V7S1	228.9	23.4	832.1	27.1
31	V7S2	216.3	21.7	810.3	21.0
32	V8S1	210.1	22.4	677.6	26.4
33	V9S2	194.4	18.7	815.3	26.3
34	V9S1	178.7	18.1	750.2	22.9
35	V9S2	191.2	22.8	769.4	29.4
36	V9S3	222.6	21.7	715.6	23.7
37	V9S4	272.8	21.4	735.5	29.2
38	V9S5	260.2	20.9	749.7	22.2
39	V9S6	250.8	22.3	795.3	24.4
40	V9S8	238.3	23.6	834.4	21.2
41	V9S9	200.7	19.2	704.0	28.2
42	V10S1	285.3	19.5	788.2	27.1
43	V10S2	247.7	20.6	782.8	22.2
44	V10S3	219.5	17.9	749.3	20.3
45	V11S1	225.7	22.8	818.7	24.4
46	V11S2	250.8	24.5	716.9	28.9
47	V11S3	272.8	21.7	728.9	26.6
48	V11S4	263.4	21.2	776.1	24.1
49	V12S1	250.8	19.0	785.3	27.7
50	V12S2	257.1	18.5	705.6	23.9
Mean	243.4		20.56	750.8	24.5

Table 8: Categorization of turmeric growing areas of Vasmat tahsil on the basis of available Nitrogen

Sr. No	Village	No. of sample	Categorization							
			Nitrogen (kg ha-1)		Low (< 280)		Medium (280-420)		High (> 420)	
			Range	Mean	No	%	No	%	No	%
1	Amba	3	200-235.2	232.0	3	100	-		-	-
2	Dhanora	9	222.6-291.6	261.9	8	88.8	1	11.1	-	-
3	Hayatnagar	1	263.4	-	1	100	-	-	-	-
4	Lingi	3	260.2-272.8	269.5	3	100	-	-	-	-
5	Mohamadpurwadi	3	238.3-282.2	267.2	1	33.3	2	66.6		
6	Pimprala	10	191.3-279.3	235.5	10	100	-	-	-	-
7	Phata	2	216.3-228.9	222.6	2	100	-	-	-	-
8	Raywadi	1	210.1	-	1	100	-	-	-	-
9	Pangrasati	9	178.7-272.8	223.3	9	100	-	-	-	-
10	Telgaon	3	219.5-285.3	250.8	2	66.6	1	33.3	-	-
11	Vasmat	4	225.7-272.8	253.1	4	100	-	-	-	-
12	Hatta	3	250.8-257.1	253.9	2	100	-	-	-	-
Average				246.9	46	92	4			

Table 9: Categorization of turmeric growing areas of Vasmat tahsil on the basis of available Phosphorus

Sr. No	Village	No. of sample	Categorization							
			Phosphorus (kg ha-1)		Low (7-14)		Medium (14 -21)		High (21-28)	
			Range	Mean	No	%	No	%	No	%
1	Amba	3	19-20.5	19.66	-	-	3	100		
2	Dhanora	9	17.9-24.5	20.01	-	-	7	77.7	2	22.2
3	Hayatnagar	1	19	-	-	-	1	100	-	-
4	Lingi	3	17.6-20.3	19.3	-	-	3	100	-	-
5	Mohamdpurwadi	3	18.1-19.8	18.9	-	-	3	100	-	-
6	Pimprala	10	18.3-23.4	21.39	-	-	2	-	8	-
7	Phata	2	21.7-23.4	22.5	-	-	-	-	2	100
8	Raywadi	1	22.4	-	-	-	-	-	1	100
9	Pangrasati	9	18.1-23.6	20.96	-	-	4	44.4	5	55.5
10	Telgaon	3	17.9-20.6	19.3	-	-	3	100	-	-
11	Vasmat	4	21.2-24.5	22.5	-	-		-	4	100
12	Hatta	2	18.5-19	18.7	-	-	2	100	-	-
Average				20.3			28	56	22	44

Table 10: Categorization of turmeric growing areas Vasmat tahsil on the basis of available Potassium

Sr. No	Village	No. of sample	Categorization							
			Potassium (kg ha-1)		Low (< 150)		Medium (150-300)		High (> 300)	
			Range	Mean	No	%	No	%	No	%
1	Amba	3	707.8-759.3	734.3	-	-	-	-	3	100
2	Dhanora	9	665.8-772.7	727.5	-	-	-	-	9	100
3	Hayatnagar	1	785.7	-	-	-	-	-	1	100
4	Lingi	3	689.8-796.9	727.4	-	-	-	-	3	100
5	Mohamadpurwadi	3	639.9-721.2	674.9	-	-	-	-	3	100
6	Pimprala	10	720.4-843.3	775.5	-	-	-	-	10	100
7	Phata	2	810.3-832.1	821.2	-	-	-	-	2	100
8	Raywadi	1	677.6	-	-	-	-	-	1	100
9	Pangrasati	9	704.0-834.4	763.2	-	-	-	-	9	100
10	Telgaon	3	749.3-788.2	773.4	-	-	-	-	3	100
11	Vasmat	4	716.9-818.7	776.1	-	-	-	-	4	100
12	Hatta	2	705.6-785.3	745.4	-	-	-	-	2	100
Average				751.8					50	100

Table 11: Categorization of turmeric growing areas of Vasmat tahsil on the basis of available Sulphur

Sr. No	Village	No. of sample	Categorization							
			Sulphur (kg ha-1)		Low (< 10)		Medium (10-20)		High (> 20)	
			Range	Mean	No	%	No	%	No	%
1	Amba	3	21.8-23.2	23.93	-	-	-	-	3	100
2	Dhanora	9	18.1-25.5	22.15	-	-	2	22.2	7	77.7
3	Hayatnagar	1	25.3	-	-	-	-	-	1	100
4	Lingi	3	24.1-28.7	27.1	-	-	-	-	3	100
5	Mohamdpurwadi	3	24.3-26.1	24.9	-	-	-	-	3	100
6	Pimprala	10	22.9-26.8	24.7	-	-	-	-	10	100
7	Phata	2	21.0-27.1	24.5	-	-	-	-	2	100
8	Raywadi	1	26.4	-	-	-	-	-	1	100
9	Pangrasati	9	21.2-28.2	25.27	-	-	-	-	9	100
10	Telgaon	3	20.3-27.1	23.2	-	-	-	-	3	100
11	Vasmat	4	24.1-28.9	26.0	-	-	-	-	4	100
12	Hatta	2	23.9-27.7	25.8	-	-	-	-	2	100
Average				24.7			2	4	48	96

Conclusion

From the results obtained during these investigations the soils of study area were clay to clay loam in texture with good water holding capacity. Soil colour was found dark brown, grayish brown, dark gryish brown, brown and very dark gray. Bulk density and Particle density was normal and favourable for the crop growth. The organic turmeric growing soils in Vasmat tahsil showed that the pH of these soil was normal to slightly alkaline in nature. Electrical conductivity of the soil in safe limit for crop growth whereas organic carbon status was medium to high and $CaCO_3$ were non-calcareous to calcareous in nature. The organic turmeric growing soils were low in available nitrogen, low to medium available phosphorus, high in available potassium content and medium to high in sulphur.

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