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Studies on soil nutrient status and their relationship with chemical properties of soil under turmeric growing areas of Basmat Tahsil of Hingoli district

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Abstract
An investigation was carried out to access the soil nutrient status and their relationship with chemical properties of soil at two stages *viz.* pre sowing and senescence stage under Turmeric growing areas of Basmat Tahsil of Hingoli District during the period 2019-20. It was observed that the pH of the soil was normal to slightly alkaline in nature. Electrical conductivity of the soil was in safe limit of the crop growth. Organic carbon status was low to medium, calcium carbonate was non- calcareous to calcareous in nature. Low nitrogen, low to medium phosphorus and high potassium were observed in these soil. Correlation study showed that, there was positive relationship of organic carbon with other available nutrients at both pre sowing and senescence stage.

Keywords: Soil chemical properties, available nutrients, relationship, pre-sowing, senescence, turmeric

Introduction
Soil is an important component of terrestrial ecosystem because it preserves nutrient reserves, support many biological processes such as activities linked to nutrient cycles. Soil fertility refers to the inherent capacity of soil to supply essential nutrients to plant in adequate amount, in correct proportion and at right time for their optimum growth. Management of the fertility of soils demands its build up and substance at high level to produce adequate food, feed, fodder and fuel for the ever increasing population of human beings and animals. The physico-chemical properties of soil are important for availability of nutrients in the soil and herby crop production. The supply of essential nutrients can be augmented by proper management of these properties. Nitrogen, phosphorus and potassium are important elements of the soil fertility. Nitrogen is the essential constituent of chlorophyll, protoplasm, protein and nucleic acid. Phosphorus is the structural component of plant cell, required for early root development and growth. Potassium is important for increasing the disease resistant in plant, plays important catalytic role in activating enzymes and improves the quality of the produce. Intensive cropping with imbalanced fertilizer and water use and lack of efficient management results in deficiency of these nutrients. Thus soil fertility management is lasting a challenge for sustainable development of agriculture (Nirawar *et al.* 2009) [12].

Soil is a vital natural resource and should be used judiciously according to its potential to meet the increasing demands of the ever growing population. To ensure optimum agricultural production, it is imperative to know the best fact about our soils and their management to achieve sustainable production (Ammannawar *et al.* 2017) [2].

India is the largest producer, consumer and exporter of turmeric in the world. Turmeric grown only in 6% of the total area under spices and condiments in India. Maharashtra state in India ranks sixth in area under turmeric. In Maharashtra Sangali, Satara, Hingoli, Nanded, Parbhani are the major turmeric growing districts. Turmric is one of the major crop in Hingoli and Sangali district (Kadte *et al.* 2018) [8].

Under Marathwada region Hingoli district is the major turmeric growing area. During 2020-21 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. There were no systematic study was done on the aspect of soil nutrient status and their relationship with chemical properties of Turmeric growing areas of Basmat Tahsil of Hingoli. Therefore, the survey on turmeric growing soils in Basmat tahsil of Hingoli district is carried with the object to evaluate the nutrient availability in soil at pre sowing and senescence stage and their relationship with chemical properties of soil.

Materials and Methods

The present investigation was undertaken in order to access soil nutrient status of turmeric growing areas under Basmat tahsil of Hingoli district. The material used and methods adopted during planning and conduct of the experiment are presented as follows.

Experimental site was the Basmat tahsil of Hingoli district. It lies between 19013'40" N to 19033'36" N latitude and 760 54'15" E to 77020'02" E longitude and mean sea level ranges in between 364 to 540 meter. The climate of this region was hot and dry. This area includes three types of season mainly monsoon, winter and summer. Annual average rainfall was 956 mm. The rainy season persist between June to October. Whereas, the average temperature ranging from 16 to 420C. In order to study the nutrient status of turmeric growing soils in Basmat Tahsil of Hingoli district, GPS based soil sample (0-30 cm depth) collected at pre sowing (April to May) and senescence stage (January to February). Fifty farmers randomly selected from different 10 villages of Basmat tahsil. The detailed information regarding soil sample collection was collected in standard format (Questionnaire) from the concern farmer. Details of collected sample are given in Table 1.

Collected soil samples were dried, ground in wooden mortar and pastel and were passed through 2 mm sieve. Each sample was thoroughly mixed to make it homogenous and preserved in properly labelled polythene bags for the laboratory analysis. The soil samples were used for estimation of pH, EC, organic carbon, free calcium carbonate, available nitrogen, phosphorus and potassium. The details of procedure adopted and references are given below.

Soil pH and electrical conductivity was determined in soil water suspension (1:2.5 ratio) using digital pH meter & conductivity meter (Jackson, 1978) [6]. Organic carbon was assessed by Walkely and Black's rapid titration method as described by Jackson (1978) [6]. Calcium carbonate was determined by rapid titration method as outlined by Piper (1966) [15]. Available nitrogen was determined by using alkaline potassium permanganate method as suggested by Subbiah and Asija (1956) [19]. Available phosphorus was determined by using 0.5 M sodium bicarbonate as an extractant as outlined by Olsen *et al.* (1954) [13]. Available potassium was estimated by using neutral normal ammonium acetate as an extractant and extractant was subjected to Flame photometer (Jackson, 1978) [6]. The correlation between chemical properties and available nutrients were worked out as per standard method given by (Panse and Sukhatme, 1985) [14].

Results and Discussion

The survey on "Nutrient status of turmeric growing areas under Basmat tahsil of Hingoli district" was done for assessment of chemical properties and nutrient status of turmeric growing soils at two stages i.e pre- sowing and senescence stage and their relationship with available nutrient in soil. The results are as follows

At the time of pre sowing sampling the average pH of turmeric growing areas under Basmat tahsil was ranged from 7.37 to 7.89 with mean value of

7.60 (Table 2). The lowest pH was recorded from village Nahad and highest pH value noted from village Puyani (khurd). About 30 per cent soil samples were normal in soil reaction (pH 6.5 - 7.5), 62 per cent soil samples were slightly alkaline (pH 7.5 – 8.0) in reaction and only 8 per cent soil samples were found moderately alkaline (pH 8.0 – 8.5) in reaction. As per the overall samples average the soils of Basmat tahsil were slightly alkaline in nature with mean pH value 7.60 (Table 4 and Fig.1). The high range of the pH values may be due to the formation of these soils from basaltic parent material which is rich in basic cations.

In case of senescence stage of sampling the lowest value of pH observed in same village Nahad (pH 7.0) and high pH recorded from village Hatta (pH 8.02). Overall pH range of Basmat tahsil were varied from 7.34 to 7.79 with mean value of 7.52. At senescence stage about 48 per cent soil samples were normal in reaction, 46 per cent soil samples were found slightly alkaline and remaining 6 per cent samples were moderately alkaline in nature. On an average whole the turmeric growing soils of Basmat tahsil was slightly alkaline in reaction (mean pH 7.52).

At the time of senescence stage sampling the pH range slightly decreased as compared to pre sowing stage sampling (Fig.3). The reason for this might be due to continuous use of acid producing nitrogenous fertilizers and application of farmyard manure which releases some organic acids which results in decreased pH (Perni *et al.* 2005) [16].

Electrical Conductivity

The results regarding electrical conductivity are presented in Table 2 and categorization of turmeric growing soils of Basmat tahsil on the basis of electrical conductivity are tabulated in Table 5 and in Fig.2.

The data on electrical conductivity (EC) indicated that all the tested soil sample were normal in their soluble salt content i.e. < 2 dSm^{-1}. At glance of table 5 the average electrical conductivity of turmeric growing soil were ranged from 0.30 to 0.42 dSm^{-1} with average of 0.36 dSm^{-1} at pre sowing stage of sampling. The highest EC 0.46 dSm^{-1} was recorded in sample of village Puayani (Budruk) whereas the lowest EC 0.21 dSm^{-1} was noticed in sample from village Nahad. Average low EC 0.30 dSm-1 reported from village Nahad and high average EC 0.42 dSm-1 observed in village Puyani (Khurd). All the soil samples from all villages are categorized as safe for crop growth.

The low EC values are because of well drain soils causes leaching of all soluble salts from surface layer soils. The results are similar to findings of Gajbe *et al.* (1976) [4] who reported norman range of soluble salt content in Marathwada soils.

In case of senescence stage sampling the average soluble salt content in turmeric growing soils of Basmat tahsil was ranged from 0.27 to 0.42 dSm^{-1} with mean value of 0.35 dSm^{-1}. All the soil samples are categorized as safe for crop growth. The slight decrease in soluble salt content at senescence stage was observed as compared to pre sowing stage (Fig. 4) because during the summer season sampling the evaporation losses from the soil is high resulting in the accumulation of salts on the surface of soil but in second stage of sampling 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 *et al.* 2005) [16].

Table 1: Details about soil sample collected

Sr.	Village	Sample no.	MSL (m)	GPS Location
1	Adgaon	A^{-1}	384	N 190 20' 55.3" E 760 57' 33.6"
2	Adgaon	A-2	401	N 190 20' 56.9" E 760 57' 35.6"
3	Adgaon	A-3	414	N 190 22' 34.0" E 760 58' 06.8"
4	Adgaon	A-4	413	N 190 22' 34.09" E 760 58' 05.7"
5	Adgaon	A-5	410	N 190 22' 20" E 760 58' 0.8"
6	Bori (Sawant)	B^{-1}	414	N 190 22' 25.9" E 760 58' 34.09"
7	Bori (Sawant)	B-2	401	N 190 20' 56.9" E 760 57' 35.6"
8	Bori (Sawant)	B-3	414	N 190 22' 34.0" E 760 58' 06.8"
9	Bori (Sawant)	B-4	413	N 190 22' 34.09" E 760 58' 05.7"
10	Bori (Sawant)	B-5	410	N 190 22' 20" E 760 58' 0.8"
11	Parva	C^{-1}	399	N 190 24' 14.6" E 770 06' 13.2"
12	Parva	C-2	399	N 190 24' 15.4" E 770 06' 12.2"
13	Parva	C-3	404	N 190 24' 14.0" E 770 06' 14.5"
14	Parva	C-4	401	N 190 23' 59.01" E 770 06' 21.8"
15	Parva	C-5	400	N 190 23' 59.5" E 770 06' 24.6"
16	Palsgaon	D^{-1}	399	N 190 23' 55.9" E 770 06' 23.6"
Sr.	**Village**	**Sample no.**	**MSL**	**GPS Location**
17	Palsgaon	D-2	401	N 190 23' 54.4" E 770 06' 24.7"
18	Palsgaon	D-3	409	N 190 23' 53.5" E 770 06' 27.7"
19	Palsgaon	D-4	398	N 190 23' 53.1" E 770 06' 30.0"
20	Palsgaon	D-5	404	N 190 23' 54.1" E 770 06' 32.0"
21	Puyani (Khurd)	E^{-1}	404	N 190 24' 00.8" E 770 06' 09.7"
22	Puyani (Khurd)	E-2	404	N 190 24' 04.0" E 770 06' 09.7"
23	Puyani (Khurd)	E-3	402	N 190 24' 08.4" E 770 06' 11.1"
24	Puyani (Khurd)	E-4	395	N 190 23' 09.6" E 770 06' 11.1"
25	Puyani (Khurd)	E-5	411	N 190 23' 59.4" E 770 05' 38.3
26	Puyani (Budruk)	F^{-1}	416	N 190 23' 40.9" E 770 05' 04.1"
27	Puyani (Budruk)	F-2	417	N 190 23' 50.9" E 770 04' 49.5"
28	Puyani (Budruk)	F-3	416	N 190 23' 47.4" E 770 04' 47.9"
29	Puyani (Budruk)	F-4	419	N 190 23' 53.8" E 770 04' 42.8"
30	Puyani (Budruk)	F-5	416	N 190 23' 55.8" E 770 04' 42.8"
31	Kudala	K^{-1}	337	N 190 24' 0.62" E 770 03' 39.1"
32	Kudala	K-2	412	N 190 24' 10.0" E 770 03' 39.4"
33	Kudala	K-3	413	N 190 24' 17.1" E 770 03' 55.5"
34	Kudala	K-4	408	N 190 24' 11.8" E 770 03' 50.7"
35	Kudala	K-5	412	N 190 24' 17.2" E 770 03' 42.0"
36	Nahad	N^{-1}	426	N 190 24' 52.4" E 770 04' 17.03"
37	Nahad	N-2	424	N 190 24' 52.8" E 770 04' 16.1"
38	Nahad	N-3	420	N 190 20' 50.2" E 770 01' 12.02"
39	Nahad	N-4	425	N 190 24' 54.0" E 770 04' 13.8"
40	Nahad	N-5	423	N 190 24' 10.1" E 770 03' 39.4"
41	Pangra	P^{-1}	410	N 190 23' 19.9" E 760 58' 23.8"
42	Pangra	P-2	408	N 190 25' 06.0" E 770 06' 32.4"
43	Pangra	P-3	406	N 190 25' 07.2" E 770 06' 32.6"
44	Pangra	P-4	409	N 190 25' 09.8" E 770 06' 33.2"
45	Pangra	P-5	407	N 190 20' 09.7" E 770 06' 33.2"
46	Hatta	H^{-1}	402	N 190 20' 16.9" E 760 56' 52.6"
47	Hatta	H-2	403	N 190 20' 20" E 760 56' 50.8"
48	Hatta	H-3	405	N 190 22' 13.9" E 760 56' 40.1
49	Hatta	H-4	403	N 190 20' 58" E 760 57' 30.7"
50	Hatta	H-5	409	N 190 21' 32.1" E 760 57' 36.9"

Organic Carbon

The organic carbon content of each soil sample is given in Table 3 and the categorization of soil under low, medium and high based on soil organic carbon content is presented in Table 6 and Fig. 5.

At the pre sowing stage of sampling the average organic carbon content of soils in Basmat tahsil varied from 4.5 to 7.9 g kg^{-1} with an average value of 6.05 g kg^{-1}. The lowest organic carbon content was observed in sample of village Nahad (3.0 g kg^{-1}) and the highest organic carbon content was observed in sample of 9.0 g kg^{-1} in village Kudala. Average low 5.08 g kg^{-1} organic carbon content observed in village Parva and high 6.98 g kg^{-1}average organic carbon content reported from village Aadgaon. Among all the tested soil tested samples, 30% soil samples were low in organic carbon status, 54% soil samples were medium in their organic carbon status and only 8 per cent soil samples were categorized as high in organic carbon content.

In case of senescence stage sampling, organic carbon status ranged from 4.13 to 6.98 g kg^{-1} with mean value of 5.67 g kg^{-1}. The lowest value of organic carbon content 2.6 g $kg^{-1}$was recorded from samples of villages Bori and Parva. However, the high organic carbon content 9.9 g kg^{-1} was noticed in sample of village Kudala. There were 38 per cent soil sample low in organic carbon, 52% soil sample found medium in organic

carbon content and 10 per cent soil samples were high in their organic carbon status.

The availability of low to medium organic carbon content in these soils due to high temperature of Marathwada region and less awareness regarding recycling of organic matter and poor management practices (Ghuge *et al*. 2002) [5]. 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 accordance with the findings of More *et al*. (2016) [11] who reported 1.5 to 8.0 g kg^{-1} organic carbon from Basmat tahsil.

Calcium carbonate

The findings of calcium carbonate are presented in Table 3 and classification of the soil samples based on calcium carbonate content is presented in Table 7 and Fig. 6.

At glance of Table 7 the average calcium carbonate content at pre sowing stage varied from 3.0 to 8.75 per cent with mean value of 5.39 per cent. The lowest calcium carbonate was recorded in village Puyani (Budruk) with 1.25 per cent and high calcium carbonate was reported from village Parva (14.75%). About 56 per cent soil samples were found non calcareous, 38 per cent samples were found calcareous in nature and 6 per cent soil samples were highly calcareous in nature.

At senescence stage of sampling the calcium carbonate in these soils were ranged from 3.99 to 9.43% with mean value of 6.45 per cent. The lowest calcium carbonate noted in village Puayani (Budruk) and highest value of calcium carbonate recorded in village Puyani (khurd) with value of 13.65 per cent. There were 30 per cent soil samples categorized as non-calcareous, 74 per cent soil samples categorized as calcareous in nature and 6 per cent soil samples as highly calcareous (Fig. 8).

The low to medium calcium carbonate content of turmeric growing soils of Basmat tahsil might be due to the presence of calcium carbonate in powdery form and hyperthermic regime of Basmat tahsil. Similarly, Waikar *et al.* (2014) [22] reported non calcareous to highly calcareous nature of soils on northern tahsil of Parbhani district. Similar results were also reported by Rekhawar *et al.* (2002) [14], showed that calcium carbonate content of Latur district soil varied from 1.75 to 16.81 per cent.

Table 2: Soil pH and electrical conductivity of turmeric growing soil at pre sowing and senescence stage

Sr. No.	Sample No.	Pre-sowing stage		Senescence stage	
		pH	EC (dSm^{-1})	pH	EC (dSm^{-1})
1	A^{-1}	7.84	0.35	7.53	0.31
2	A-2	7.79	0.27	7.69	0.24
3	A-3	7.59	0.30	7.42	0.31
4	A-4	7.52	0.35	7.36	0.27
5	A-5	7.39	0.37	7.34	0.32
6	B^{-1}	7.63	0.29	7.54	0.31
7	B-2	7.72	0.28	7.80	0.24
8	B-3	7.75	0.32	7.61	0.35
9	B-4	7.78	0.30	7.56	0.31
10	B-5	7.62	0.38	7.81	0.29
11	C^{-1}	7.86	0.41	7.42	0.43
12	C-2	7.72	0.36	7.35	0.31
13	C-3	7.90	0.33	7.52	0.28
14	C-4	7.25	0.37	7.31	0.25
15	C-5	7.76	0.44	7.78	0.49
16	D^{-1}	7.54	0.33	7.33	0.31
17	D-2	8.20	0.39	7.91	0.31
18	D-3	7.72	0.40	7.64	0.41
19	D-4	7.75	0.32	7.32	0.28
20	D-5	7.78	0.38	7.69	0.31
21	E^{-1}	7.62	0.45	7.41	0.38
22	E-2	7.71	0.39	7.73	0.31
23	E-3	7.59	0.38	7.41	0.36
24	E-4	7.42	0.41	7.39	0.38
25	E-5	8.24	0.44	8.01	0.41
26	F^{-1}	7.43	0.32	7.31	0.35
27	F-2	7.56	0.29	7.39	0.24
28	F-3	7.14	0.29	7.43	0.37
29	F-4	7.39	0.46	7.29	0.31
30	F-5	7.45	0.37	7.15	0.35
31	H^{-1}	7.78	0.40	7.65	0.24
32	H-2	7.62	0.32	7.61	0.27
33	H-3	7.64	0.36	7.65	0.31
34	H-4	8.00	0.39	8.02	0.35
35	H-5	7.58	0.31	7.61	0.41
36	K^{-1}	8.10	0.36	8.00	0.35
37	K-2	7.52	0.30	7.49	0.26
38	K-3	7.69	0.45	7.61	0.35
39	K-4	7.41	0.39	7.38	0.33
40	K-5	7.75	0.36	7.54	0.35
41	N^{-1}	7.68	0.34	7.58	0.32
42	N-2	7.54	0.31	7.53	0.30

43	N-3	7.01	0.29	7.34	0.23
44	N-4	7.29	0.21	7.23	0.33
45	N-5	7.44	0.36	7.21	0.34
46	P^{-1}	7.63	0.39	7.65	0.45
47	P-2	7.45	0.32	7.48	0.68
48	P-3	7.29	0.42	7.35	0.51
49	P-4	7.12	0.40	7.24	0.73
50	P-5	7.39	0.44	7.31	0.43
Mean		7.60	0.36	7.52	0.35

Table 3: Organic carbon and calcium carbonate of turmeric growing soil at pre sowing and senescence stage

Sr. No.	Sample No.	Pre-sowing stage		Senescence stage	
		Organic carbon (g kg^{-1})	Calcium carbonate (%)	Organic carbon (g kg^{-1})	Calcium carbonate (%)
1	A^{-1}	6.0	2.75	7.1	6.25
2	A-2	7.9	4.50	6.8	3.20
3	A-3	6.9	2.50	7.2	3.80
4	A-4	9.6	4.75	8.5	5.90
5	A-5	4.5	5.50	6.2	6.25
6	B^{-1}	5.2	2.25	4.1	3.50
7	B-2	7.2	2.00	2.9	3.20
8	B-3	7.5	4.50	4.0	5.30
9	B-4	8.4	3.50	3.7	7.90
10	B-5	4.5	8.00	2.6	8.35
11	C^{-1}	4.5	4.75	3.9	5.25
12	C-2	5.8	14.75	2.6	15.0
13	C-3	4.8	6.50	3.1	7.60
14	C-4	4.2	7.00	3.6	7.85
15	C-5	6.1	9.50	4.7	9.80
16	D^{-1}	6.9	4.75	7.2	5.50
17	D-2	4.8	3.75	5.4	4.50
18	D-3	5.4	6.5	5.8	7.80
19	D-4	7.3	9.25	6.5	9.90
20	D-5	7.6	8.25	6.9	8.35
21	E^{-1}	5.2	4.25	4.8	5.45
22	E-2	6.0	11.25	6.3	13.65
23	E-3	6.6	8.50	5.7	10.85
24	E-4	6.9	4.75	6.5	6.75
25	E-5	5.7	7.00	6.3	7.95
26	F^{-1}	4.6	3.75	5.1	4.75
27	F-2	4.9	2.50	5.3	2.50
28	F-3	5.1	5.50	6.0	6.65
29	F-4	6.4	1.25	6.5	3.45
30	F-5	5.8	3.25	4.7	4.35
31	H^{-1}	4.5	5.75	4.1	6.50
32	H-2	9.0	10.25	8.5	9.70
33	H-3	6.1	4.75	5.7	6.10
34	H-4	7.2	2.25	7.5	5.30
35	H-5	6.3	2.50	6.9	4.30
36	K^{-1}	3.9	8.75	4.2	8.40
37	K-2	8.4	7.25	8.5	7.20
38	K-3	5.2	2.25	5.5	2.70
39	K-4	9.9	2.25	9.1	2.90
40	K-5	3.3	4.75	4.7	5.80
41	N^{-1}	5.8	5.25	6.0	6.20
42	N-2	7.2	3.25	7.5	4.30
43	N-3	4.5	2.75	4.9	3.20
44	N-4	3.6	2.50	4.5	3.75
45	N-5	3.0	6.00	5.3	6.90
46	P^{-1}	5.5	8.25	5.7	9.50
47	P-2	7.5	4.75	7.9	5.50
48	P-3	5.7	6.50	5.5	7.25
49	P-4	7.8	4.50	7.3	8.95
50	P-5	4.9	7.75	4.1	8.65
Mean		6.03	5.39	5.67	6.50

Table 4: Categorization of turmeric growing soils on the basis of ratings of soil pH.

Sr. No	Village	No. of sample	Pre sowing stage								Senescence stage							
			pH		Neutral		Slightly Alkaline		Moderately Alkaline		pH		Neutral		Slightly Alkaline		Moderately Alkaline	
			Range	Mean	No.	%	No.	%	No.	%	Range	Mean	No.	%	No.	%	No.	%
1	Aadgaon	5	7.39 - 7.84	7.63	1	20	4	80	-	-	7.34 -7.69	7.74	3	60	2	40	-	
2	Bori	5	7.62 - 7.78	7.70	-	-	5	100	-	-	7.54 -7.81	7.67	-	-	5	100	-	-
3	Parva	5	7.25 - 7.90	7.69	1	20	4	80	-	-	7.31 -7.78	7.48	3	60	2	40	-	-
4	Palsgaon	5	7.72 - 8.20	7.79	-	-	4	80	1	20	7.32 -7.91	7.58	2	40	3	60	-	-
5	Puyani (khurd)	5	7.42 - 8.24	7.71	1	20	3	60	1	20	7.39 -8.01	7.59	3	60	1	20	1	20
6	Puyani (Budruk)	5	7.14 - 7.56	7.39	4	80	1	20	-	-	7.20 -7.39	7.32	5	100	-	-	-	-
7	Hatta	5	7.58 - 8.00	7.72	-		4	80	1	20	7.61 -8.02	7.70	-	-	4	80	1	20
8	Kudala	5	7.41 - 8.10	7.69	1	20	3	60	1	20	7.38 -8.00	7.60	1	20	3	60	1	20
9	Nahad	5	7.01 - 7.68	7.39	3	60	2	40	-	-	7.00 -7.58	7.38	3	60	2	40	-	-
10	Pangra	5	7.12 - 7.63	7.37	4	80	1	20	-		7.24 -7.65	7.40	4	80	1	20	-	-
Average			7.37 - 7.89	7.60	15	30	31	62	4	8	7.34 -7.79	7.52	24	**48**	**23**	**46**	**3**	**6**

Table 5: Categorization of turmeric growing soils on the basis of ratings of electrical conductivity.

Sr. No	Village	No. of sample	Pre sowing stage								Senescence stage							
			$^{-1}$ EC (dSm)		Safe (<0.8)		Normal (0.8 – 2.5)		Unsafe (>2.5)		$^{-1}$ EC (dSm)		Safe (<0.8)		Normal (0.8 – 2.5)		Unsafe (>2.5)	
			Range	Mean	No	%	No.	%	No.	%	Range	Mean	No.	%	No.	%	No.	%
1	Aadgaon	5	0.27 – 0.37	0.33	5	100	-	-	-	-	0.24 – 0.32	0.29	5	100	-	-	-	-
2	Bori	5	0.28 – 0.38	0.32	5	100	-	-	-	-	0.24 – 0.35	0.3	5	100	-	-	-	-
3	Parva	5	0.33 – 0.44	0.39	5	100	-	-	-	-	0.25 – 0.49	0.36	5	100	-	-	-	-
4	Palsgaon	5	0.32 – 0.40	0.37	5	100	-	-	-	-	0.28 – 0.41	0.33	5	100	-	-	-	-
5	Puyani (khurd)	5	0.38 – 0.45	0.42	5	100	-	-	-	-	0.31 – 0.41	0.37	5	100	-	-	-	-
6	Puyani (Budruk)	5	0.29 – 0.46	0.35	5	100	-	-	-	-	0.24 – 0.37	0.33	5	100	-	-	-	-
7	Hatta	5	0.31 – 0.40	0.36	5	100	-	-	-	-	0.24 – 0.41	0.32	5	100	-	-	-	-
8	Kudala	5	0.30 – 0.45	0.38	5	100	-	-	-	-	0.26 – 0.35	0.33	5	100	-	-	-	-
9	Nahad	5	0.21 – 0.36	0.30	5	100	-	-	-	-	0.23 – 0.34	0.30	5	100	-	-	-	-
10	Pangra	5	0.32 – 0.44	0.39	5	100	-	-	-	-	0.43 – 0.73	0.56	5	100	-	-	-	-
Average			0.30 – 0.42	0.36	50	100	-	-	-	-	0.27 –0.42	0.35	50	100	-	-	-	-

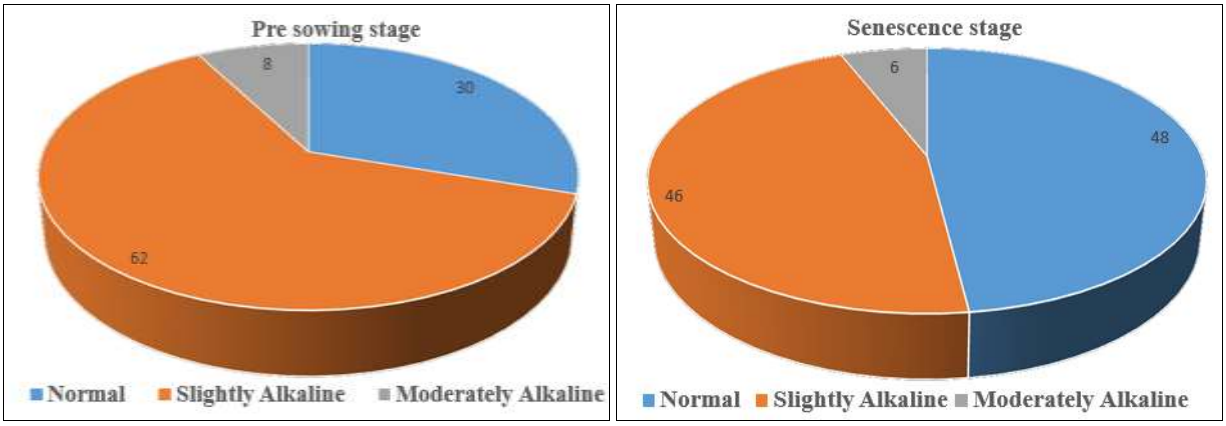


Fig 1: Categorization of turmeric growing soil on the basis of soil pH

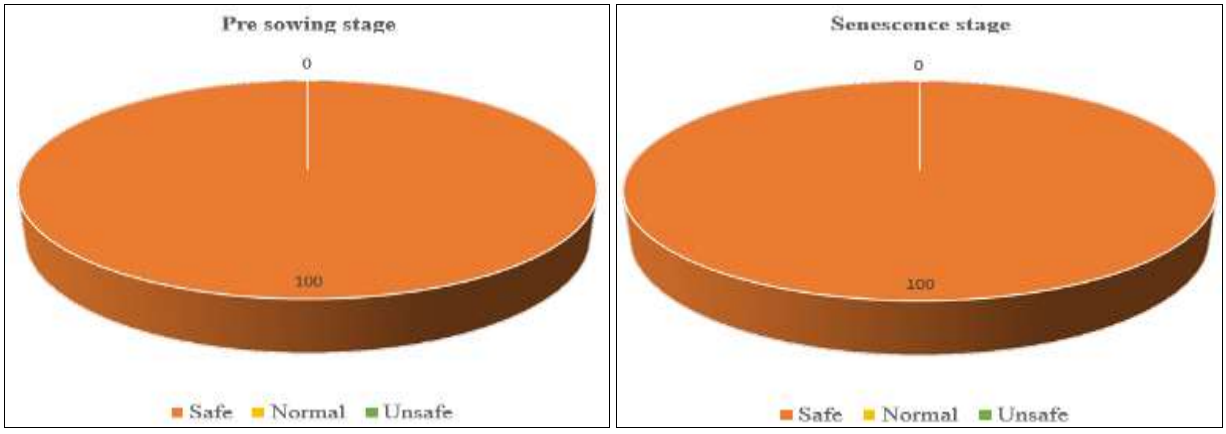


Fig 2: Categorization of turmeric growing soil on the basis of electrical conductivity

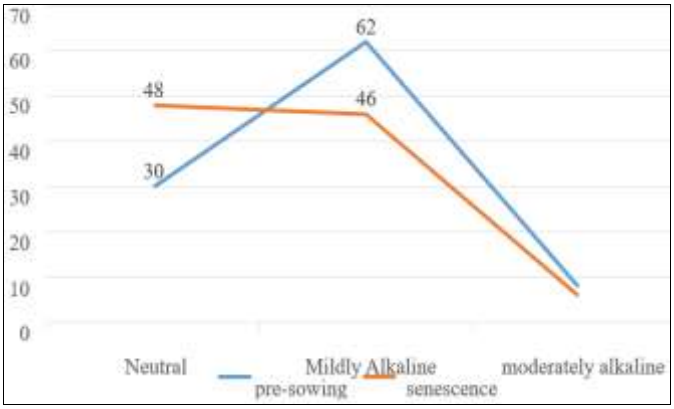


Fig 3: Variation in soil pH at pre sowing and senescence stage of turmeric.

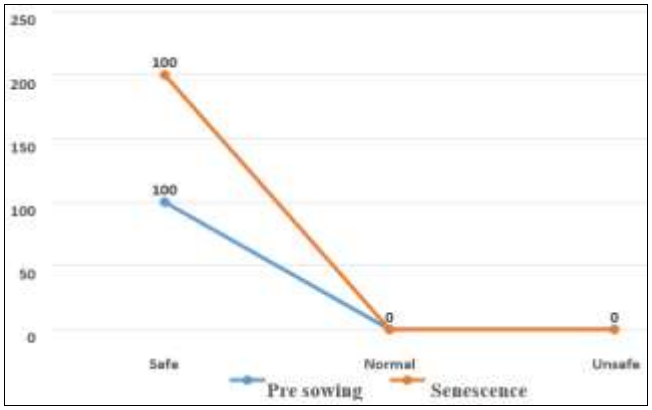


Fig 4: Variation in soil EC at pre sowing and senescence stage of turmeric

Table 6: Categorization of turmeric growing soil on the basis of rating of organic carbon.

Sr. No	Village	No. of sample	Pre sowing stage								Senescence stage							
			Organic carbon (g kg^{-1})		Low (< 0.5)		Medium (0.5 –0.75)		High (> 0.75)		Organic carbon (g kg^{-1})		Low (< 0.5)		Medium (0.5-0.75)		High (> 0.75)	
			Range	Mean	No.	%	No.	%	No.	%	Range	Mean	No.	%	No.	%	No.	%
1	Aadgaon	5	6.0 - 9.6	6.98	1	20	2	40	2	40	6.2 -8.5	7.16	-	-	4	80	1	20
2	Bori	5	4.5 - 8.4	6.56	1	20	3	60	1	20	2.6 - 4.1	3.46	5	100	-	-	-	-
3	Parva	5	4.2 - 6.1	5.08	3	60	2	40	-	-	2.6 - 4.2	3.58	5	100				
4	Palsgaon	5	4.8 -7.6	6.40	1	20	3	60	1	20	5.4 - 7.2	6.36	-	-	5	100	-	-
5	Puyani (khurd)	5	5.2 - 6.9	6.08	-	-	5	100	-	-	4.8 - 6.5	5.92	1	20	4	80	-	-
6	Puyani (Budruk)	5	4.6 - 6.4	5.36	2	40	3	60	-	-	4.7 - 6.5	5.52	1	20	4	80	-	-
7	Hatta	5	4.5 - 9.0	6.62	1	20	3	60	1	20	4.1 - 8.5	6.54	1	20	3	60	1	20
8	Kudala	5	3.3 - 9.9	6.14	2	40	1	20	2	40	3.5 - 9.1	6.41	2	40	1	20	2	40
9	Nahad	5	3.0 - 7.2	4.82	3	60	2	40	-	-	3.3 - 7.3	5.64	3	60	2	40	-	-
10	Pangra	5	4.9 - 7.8	6.28	1	20	3	60	1	20	4.1 - 7.9	6.10	1	20	3	60	1	20
Average			4.5 - 7.9	6.03	15	30	27	54	8	16	4.13 - 6.98	5.67	19	38	26	52	5	10

Table 7: Categorization of turmeric growing soil on the basis of rating of calcium carbonate

Sr. No	Village	No. of sample	Pre sowing stage								Senescence stage							
			Calcium carbonate (%)		Non Cal. (< 5)		Cal. (5 - 10)		Highly cal. (> 10)		Calcium carbonate (%)		Non Cal. (< 5)		Cal. (5 - 10)		Highly cal. (> 10)	
			Range	Mean	No	%	No	%	No	%	Range	Mean	No.	%	No.	%	No.	%
1	Aadgaon	5	2.50 - 5.50	4.00	4	80	1	20	-	-	3.20- 6.25	5.08	2	40	3	60	-	-
2	Bori	5	2.00– 8.00	4.05	4	80	1	20			3.20- 8.35	5.65	2	40	3	60	-	-
3	Parva	5	4.75 -14.75	8.50	1	20	3	60	1	20	5.25 – 15.00	9.10	-	-	4	80	1	20
4	Palsgaon	5	3.75 -9.25	6.50	2	40	3	60	-	-	4.50- 9.90	7.21	1	20	4	80	-	-
5	Puyani (khurd)	5	4.25 -11.25	7.15	2	40	2	40	1	20	5.50- 13.65	8.93	-	-	3	60	2	40
6	Puyani (Budruk)	5	1.25 - 5.50	3.25	4	80	1	20	-	-	2.50 - 6.65	4.34	4	80	1	20	-	-
7	Hatta	5	2.25 - 10.25	5.10	3	60	1	20	1	20	4.30- 9.70	6.38	1	20	4	80	-	-
8	Kudala	5	2.25 -8.75	5.05	3	60	2	40	-	-	2.75 - 8.40	5.41	2	40	4	80	-	-
9	Nahad	5	2.50– 6.00	3.95	3	60	2	40	-	-	3.20- 6.90	4.86	3	60	2	40	-	-
10	Pangra	5	4.50 - 8.25	6.35	2	40	3	60	-	-	5.50- 9.50	7.97	-	-	4	80	-	-
Average			3.00 - 8.75	5.39	28	56	19	38	3	6	3.99– 9.43	6.50	15	30	32	64	3	6

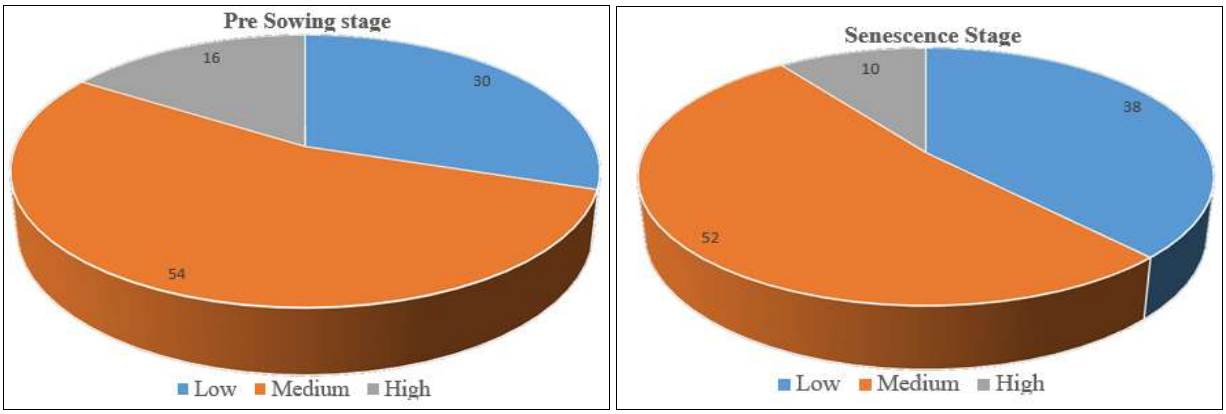


Fig 5: Categorization of turmeric growing soil on the basis of organic carbon content

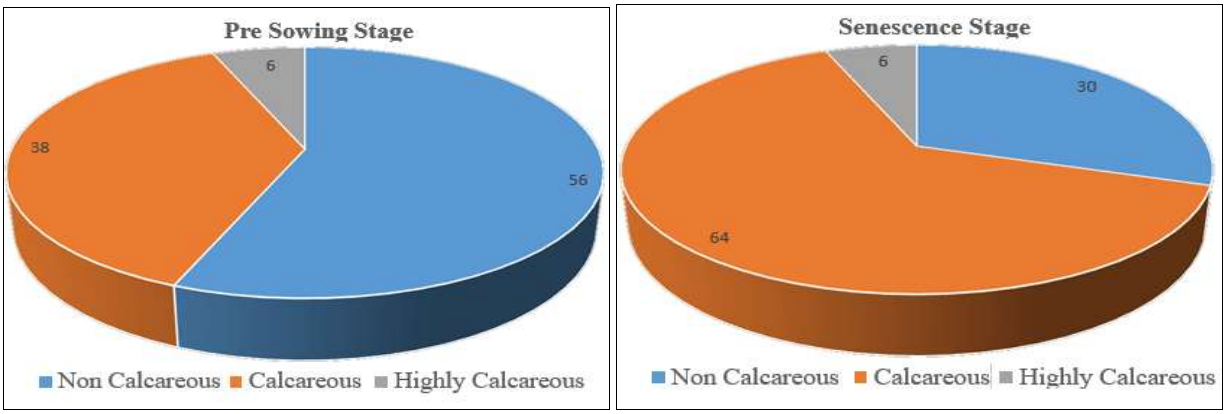


Fig 6: Categorization of turmeric growing soil on the basis of calcium carbonate content.

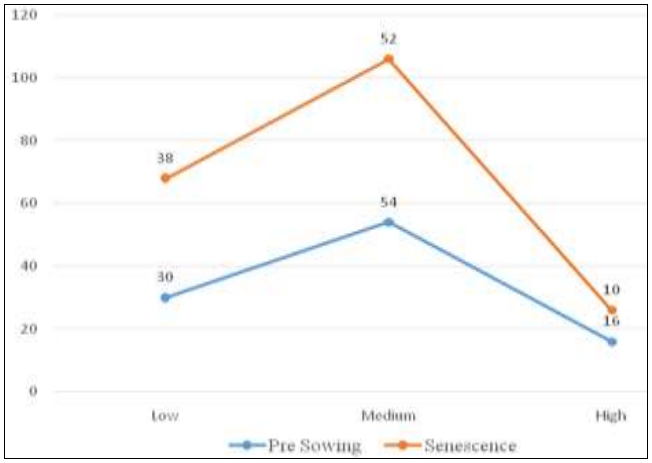


Fig 7: Variation in organic carbon content in soil at pre sowing and senescence stage of turmeric

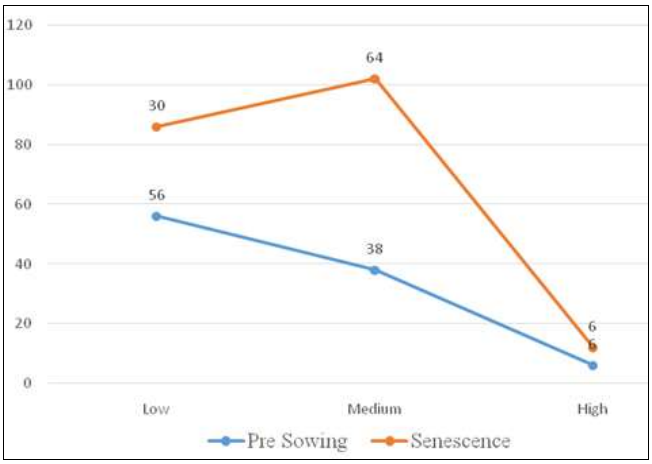


Fig 8: Variation in calcium carbonate in soil at pre sowing and senescence stage of turmeric

Available Nitrogen

The results of available nitrogen are presented in Table 8 and the categorization of soil samples according to ratings of nitrogen is expressed in Table 9 and Fig. 9.

The average available nitrogen content of all the villages at pre sowing stage were ranged from 131.08 to 166.86 kg ha^{-1} with mean value 149.5 kg ha^{-1}. The lowest available nitrogen was reported in sample of village Kudala (119.16 kg ha^{-1}) and the highest available nitrogen was reported from the sample in village Palsgaon (185.02 kg ha^{-1}). The village Puyani (Budruk) having low average nitrogen (mean 145.99 kg ha^{-1}) and high in village Aadgaon (mean 153.16 kg ha^{-1}). All the soil samples from turmeric growing areas were categorized under low status of available nitrogen. Similarly, More *et al.* (2005) [23], showed that available nitrogen content of Basmat tahsil ranged from 105.02 to 290.51 kg ha^{-1}.

At the time of senescence stage of sampling the available nitrogen content was varied from 185.07 to 225.59 kg ha^{-1} with mean value of 205.95 kg ha^{-1}. The lowest available nitrogen was noticed in sample from village Kudala (179.8 kg ha^{-1}) whereas, the high content of available nitrogen content was found in sample from village Palsgaon (240.20 kg ha^{-1}). The average low nitrogen reported in village Nahad (mean 191.35 kg ha^{-1}) and high content in village Palsgaon (mean 219.19 kg ha^{-1}). On the whole all soil samples were recorded as low in nitrogen content. There was slight increase in available nitrogen content in second stage of sampling. No one sample recorded high status of nitrogen. It is due to the crop removal, may be subjected to leaching and volatilization losses (Perni *et al* 2005) [16]. Alane *et al.* (2010) [1] showed that the available nitrogen content from Aundha tahsil varied from 106.62 to 298.5 kg ha^{-1} with mean value of 147.64 kg 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. Also the loss of applied nitrogen by means of leaching and denitrification results in low nitrogen status (Tur *et al.* 2008) [20].

Available phosphorus

The data on the available phosphorus is presented in Table 8 and the categorization of turmeric growing soils on the basis of available phosphorus is presented in Table 10 and Fig. 10.

The available phosphorus at pre sowing stage was ranged between 9.82 to 15.77 kg ha^{-1} with mean value of 12.88 kg ha^{-1} in Basmat tahsil and the lowest phosphorus was recorded in the sample from village Kudala (7.52 kg ha^{-1}) whereas, the highest amount of phosphorus was noted from village Nahad (18.81 kg ha^{-1}). The average low phosphorus content found in village Parva (mean 9.59 kg ha^{-1}) and high in village Bori (mean 15.99 kg ha^{-1}). On an average 22 per cent soil samples recorded as low and 78 per cent soil samples recorded as medium with respect to available phosphorus. These results were in agreement with More *et al.* (2010) [24] who reported that there was 5.37 to 18.18 kg ha^{-1} phosphorus in soils of Basmat tahsil. Alane *et al.* (2010) [1] reported the available phosphorus content of soils in Aundha tahsil were ranged from 5.98 to 20.87 kg ha^{-1} with mean value of 10.10 kg ha^{-1}.

In case of second stage of sampling i.e. senescence stage the average available phosphorus content in turmeric growing soils was reported between 16.59 to 24.21 kg ha^{-1} with mean value

20.87 kg ha^{-1}. The lowest phosphorus content was observed in sample of village Parva (14.22 kg ha^{-1}) and highest available phosphorus found in sample of village Palsgaon (29.05 kg ha^{-1}). The average low phosphorus content was reported in village Parva (mean 17.18 kg ha^{-1}) and high in village Bori (mean 24.01 kg ha^{-1}). At this time of sampling none of the one sample was categorized as low in status, whereas, 88 per cent of samples were medium and 12 per cent soil samples were high in phosphorus content.

The low content of phosphorus is due to the high clay content and calcareous nature of soil (Khan *et al.* 2007) [9]. Also the high phosphorus fixing capacity of soil prevent readily available form of phosphate in the soil solution. In case of senescence stage of sampling the medium to high status of phosphorus in the soil is due to the heavy application of phosphatic fertilizers and application of organic matter which increases the solubilisation of fixed phosphorus releasing more quantity to the available pool (Perni *et al.* 2005) [16].

Available Potassium

The data on the available potassium in turmeric growing soils of Basmat tahsil is given in Table 8 and the categorization of soils on the basis of available potassium is presented in Table 11 and Fig. 11.

In the sampling of pre sowing stage the available potassium ranged from 405.93 to 587.44 kg ha^{-1} with mean value of 485.99 kg ha^{-1}. The lowest potassium 348.67 kg ha^{-1} was noted in the sample of village Puyani (Budruk) and highest amount of potassium 1027.04 kg ha^{-1} was found in sample of village Palsgaon. The average low potassium reported in village Aadgaon (mean 459.22 kg ha^{-1}) and high available potassium in village Palsgaon (mean 617.12 kg ha^{-1}). All samples are categorized as high in available potassium content. The similar results were reported by Alane *et al.* (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 was probably 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 *et al.* (1998) [10] who showed that the available potassium in semi - arid soils of Maharashtra ranged from 318.0 to 616.0 kg ha^{-1}.

At the time of senescence stage sampling, the available potassium ranged from 582.68 to 769.81 kg ha^{-1} with mean value of 675.36 kg ha^{-1}. The lowest potassium was reported in sample from village Parva (502.84 kg ha^{-1}) and highest potassium was found in sample of village Palsgaon (1209.81 kg ha^{-1}). The average low potassium content reported in village Parva (mean 610.30 kg ha^{-1}) and high in village Palsgaon (mean 820.62 kg ha^{-1}). All the soil samples were high in potassium content. There was increase in potassium content in senescence stage because farmers applied maximum amount of potassic fertilizers. High amount of potassium was recorded earlier by More *et al.* (2010) [24] who showed potassium content of Basmat tahsil soils ranged from 182.10 to 1078.20 kg ha^{-1} with mean value of 513.78 kg ha^{-1}.

Table 8: Available macro nutrient (N, P and K) in turmeric growing soil at pre sowing and senescence stage

Sr. No.	Sample	Pre sowing stage			Senescence stage		
		Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
1	A^{-1}	144.85	13.64	478.24	203.52	21.08	683.03
2	A-2	125.44	15.05	520.80	189.32	22.34	723.41
3	A-3	172.48	11.28	464.89	227.82	18.58	648.25
4	A-4	150.52	9.40	463.68	210.04	19.25	673.51
5	A-5	172.48	11.76	368.48	218.62	18.53	582.00
6	B^{-1}	150.52	12.23	520.55	205.68	21.35	622.73
7	B-2	131.71	17.40	450.24	189.42	26.54	657.35
8	B-3	147.39	18.34	483.84	200.40	25.38	684.57
9	B-4	159.93	13.64	477.12	220.62	22.25	695.05
10	B-5	141.12	18.34	444.64	195.71	24.57	650.52
11	C^{-1}	144.25	8.46	490.56	206.32	17.63	620.17
12	C-2	150.52	9.87	462.56	204.80	16.41	674.14
13	C-3	163.07	11.76	1027.04	225.62	19.32	1209.81
14	C-4	153.66	8.46	541.22	227.21	18.28	670.42
15	C-5	147.39	9.40	480.56	195.53	14.22	502.84
16	D^{-1}	185.02	14.11	380.80	213.72	21.40	603.79
17	D-2	144.25	13.17	527.52	218.35	22.15	736.03
18	D-3	172.48	18.42	515.20	225.47	29.05	718.34
19	D-4	141.12	16.46	551.04	231.51	22.69	758.09
20	D-5	122.30	10.34	464.80	180.45	19.70	680.83
21	E^{-1}	131.71	15.40	420.32	191.25	26.04	575.20
22	E-2	144.25	15.52	464.40	193.74	22.80	586.90
23	E-3	153.66	11.12	567.84	208.91	21.40	768.02
24	E-4	160.40	15.05	472.64	185.43	23.43	688.25
25	E-5	156.08	13.17	500.20	206.31	21.09	651.78
26	F^{-1}	134.84	14.56	507.36	194.91	23.45	700.36
27	F-2	131.71	9.00	540.69	206.42	20.73	561.05
28	F-3	181.88	18.34	562.24	220.49	26.51	757.69
29	F-4	156.08	12.23	348.67	229.60	19.71	750.23
30	F-5	125.44	14.11	441.28	185.38	20.15	630.23
31	H^{-1}	156.08	14.58	467.40	215.92	22.64	624.36
32	H-2	147.39	15.52	450.21	196.94	23.39	613.59

33	H-3	131.71	12.23	479.36	184.29	20.42	662.08
34	H-4	163.07	11.28	446.88	220.33	19.85	630.24
35	H-5	156.08	8.93	460.00	229.38	15.83	604.67
36	K^{-1}	153.66	9.40	428.36	240.20	18.25	615.06
37	K-2	169.34	12.70	455.84	239.32	18.53	649.36
38	K-3	119.16	11.76	450.23	179.83	17.62	672.58
39	K-4	156.08	10.81	562.24	211.21	18.84	740.56
40	K-5	150.52	7.52	476.00	209.40	14.39	658.97
41	N^{-1}	141.12	13.17	476.00	181.19	21.41	601.46
42	N-2	153.66	18.81	528.64	213.49	28.02	713.31
43	N-3	144.25	13.74	378.24	204.20	23.45	679.23
44	N-4	159.93	13.64	487.20	168.67	19.55	656.01
45	N-5	141.12	14.58	479.36	189.24	20.79	661.28
46	P^{-1}	137.98	7.99	535.36	193.43	15.49	724.05
47	P-2	141.12	11.76	564.48	201.25	19.20	747.38
48	P-3	153.66	12.23	443.52	219.47	20.35	720.31
49	P-4	149.24	13.17	412.60	193.29	22.05	648.23
50	P-5	153.66	9.87	378.20	192.43	17.20	754.04
Mean		149.50	12.88	485.99	205.93	20.87	687.83

Table 9: Categorization of turmeric growing soil on the basis of rating of available nitrogen

Sr. No	Village	No. of sample	Pre sowing stage								Senescence stage							
			Nitrogen (kg ha^{-1})		Low (< 250)		Medium (250-500)		High (> 500)		Nitrogen (kg ha^{-1})		Low (< 250)		Medium (250 -500)		High (> 500)	
			Range	Mean	No	%	No	%	No	%	Range	Mean	No	%	No	%	No	%
1	Aadgaon	5	125.44-172.48	153.16	5	100	-	-	-	-	189.32-227.62	209.87	5	100	-	-	-	-
2	Bori	5	131.71-159.93	146.14	5	100	-	-	-	-	189.42-220.62	202.37	5	100	-	-	-	-
3	Parva	5	144.25-163.07	151.78	5	100	-	-	-	-	195.53-227.21	211.89	5	100	-	-	-	-
4	Palsgaon	5	122.30-185.02	153.03	5	100	-	-	-	-	180.45-240.20	219.19	5	100	-	-	-	-
5	Puyani (khurd)	5	131.71-160.40	149.22	5	100	-	-	-	-	185.43-208.91	197.12	5	100	-	-	-	-
6	Puyani (Budruk)	5	125.44-181.68	145.99	5	100	-	-	-	-	185.38-229.60	207.36	5	100	-	-	-	-
7	Hatta	5	131.71-163.07	150.86	5	100	-	-	-	-	184.29-229.38	209.37	5	100	-	-	-	-
8	Kudala	5	119.16-169.34	149.75	5	100	-	-	-	-	179.83-239.32	210.69	5	100	-	-	-	-
9	Nahad	5	141.12-159.93	148.01	5	100	-	-	-	-	168.67-213.49	191.35	5	100	-	-	-	-
10	Pangra	5	137.98-153.66	147.13	5	100	-	-	-	-	192.43-219.47	199.98	5	100	-	-	-	-
Average			131.08-166.86	149.50	50	100	-	-	-		185.07-225.59	205.93	50	**100**	-	-	-	-

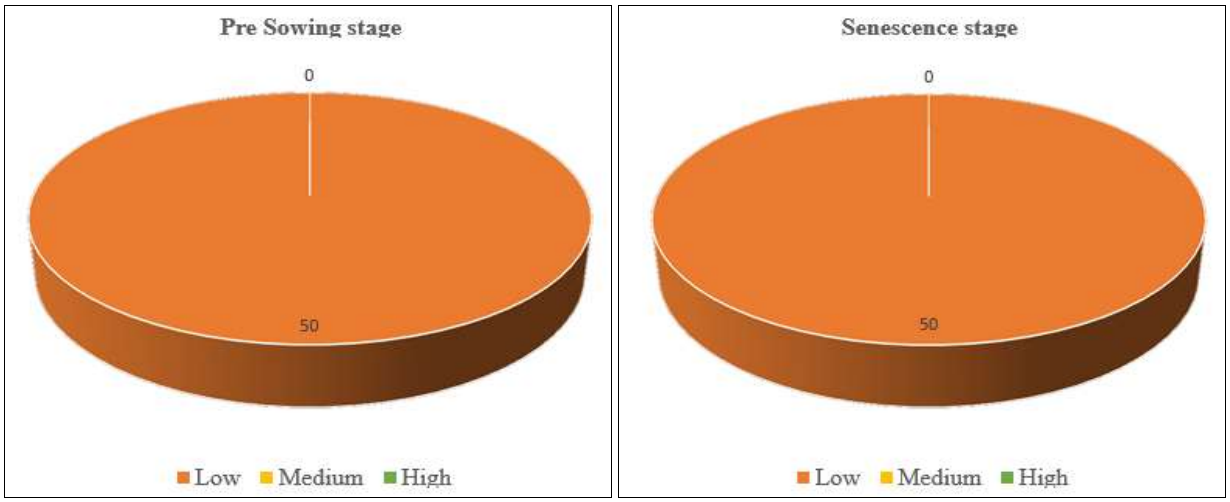


Fig 9: Categorization of turmeric growing soil on the basis of available nitrogen

Table 10: Categorization of turmeric growing soil on the basis of available phosphorous

Sr. no	Village	No. of sample	Pre sowing stage								Senescence stage							
			Phosphorus (kg ha^{-1})		Low (< 10)		Medium (10 -25)		High (> 25)		Phosphorus (kg ha^{-1})		Low (< 10)		Medium (10 -25)		High (> 25)	
			Range	Mean	No	%	No	%	No	%	Range	Mean	No	%	No	%	No	%
1	Aadgaon	5	9.40 - 15.05	12.23	1	20	4	80	-	-	18.53 - 22.34	19.95	-	-	5	100	-	-
2	Bori	5	12.23-18.34	15.99	-	-	5	100	-	-	21.35 - 26.54	24.01	-	-	3	60	2	40
3	Parva	5	8.46.-11.76	09.59	4	80	1	20	-	-	14.22 - 19.32	17.18	-	-	5	100	-	-
4	Palsgaon	5	10.34-18.42	14.50	-	-	5	100	-	-	19.70 - 29.05	22.99	-	-	4	60	1	20
5	Puyani (khurd)	5	11.12-15.52	14.05	-	-	5	100	-	-	21.09 - 26.04	22.96	-	-	4	60	1	20
6	Puyani (Budruk)	5	9.00 - 18.34	13.65	1	20	4	80	-	-	19.71 - 26.51	22.11	-	-	4	80	1	20
7	Hatta	5	8.93 -15.52	12.50	1	20	4	80	-	-	15.83 - 23.39	20.43	-	-	5	100	-	-
8	Kudala	5	7.52 - 12.70	10.44	2	40	3	60	-	-	14.39 - 18.84	17.53	-	-	5	100	-	-
9	Nahad	5	13.17-18.81	14.79	-	-	5	100	-	-	19.55 - 28.02	22.65	-	-	4	80	1	20
10	Pangra	5	7.99 - 13.17	11.04	2	40	3	60	-	-	15.49 - 22.05	18.86	-	-	5	100	-	-
Average			9.82 - 15.77	12.88	11	22	39	78	-	-	16.59 – 24.21	20.87	-	-	44	88	6	12

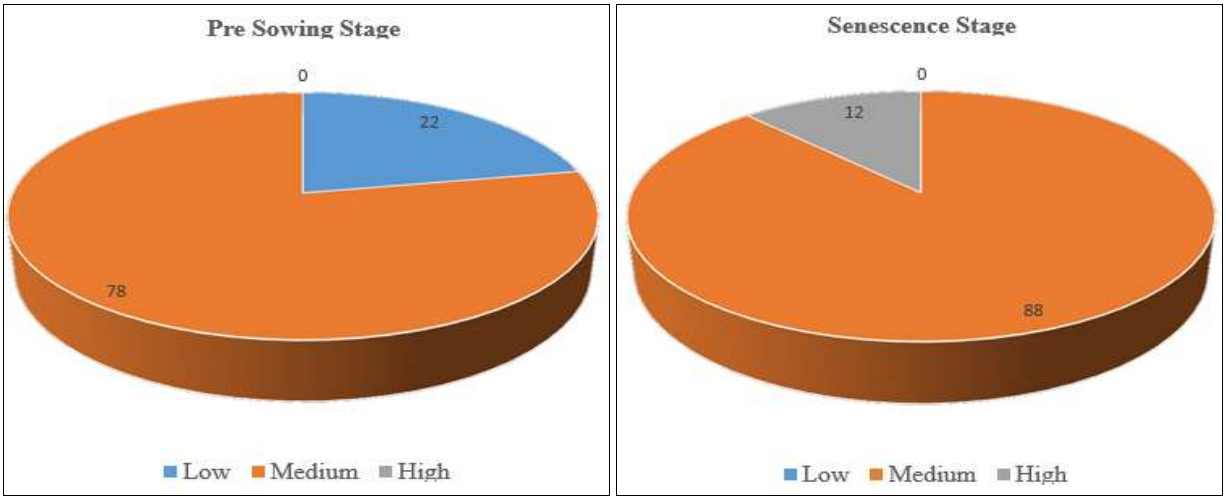


Fig 10: Categorization of turmeric growing soils on the basis of available phosphorus

Table 11: Categorization of turmeric growing soil on the basis of rating of available potassium

Sr. No	Village	No. of sample	Pre sowing stage								Senescence stage							
			Potassium (kg ha^{-1})		Low (< 150)		Medium (150 -300)		High (> 300)		Potassium (kg ha^{-1})		Low (< 150)		Medium (150 -300)		High (> 300)	
			Range	Mean	No	%	No	%	No	%	Range	Mean	No	%	No	%	No	%
1	Aadgaon	5	368.48-520.8	459.22	-	-	-	-	5	100	582.00 - 723.41	662.04	-	-	-	-	5	100
2	Bori	5	444.64-520.55	475.28	-	-	-	-	5	100	622.73- 695.05	662.04	-	-	-	-	5	100
3	Parva	5	380.80-541.22	471.14	-	-	-	-	5	100	502.84- 674.14	610.30	-	-	-	-	5	100
4	Palsgaon	5	464.80-1027.04	617.12	-	-	-	-	5	100	680.83 -1209.81	820.62	-	-	-	-	5	100
5	Puyani (khurd)	5	420.32-567.84	485.08	-	-	-	-	5	100	533.38 - 768.02	643.32	-	-	-	-	5	100
6	Puyani (Budruk)	5	348.67-562.24	480.04	-	-	-	-	5	100	561.05- 757.69	679.91	-	-	-	-	5	100
7	Hatta	5	446.88-479.36	460.77	-	-	-	-	5	100	518.63- 662.08	626.98	-	-	-	-	5	100
8	Kudala	5	428.36-562.24	474.53	-	-	-	-	5	100	615.06- 740.56	667.30	-	-	-	-	5	100
9	Nahad	5	378.24-528.64	469.88	-	-	-	-	5	100	562.37-713.31	662.25	-	-	-	-	5	100
10	Pangra	5	378.20-564.48	466.84	-	-	-	-	5	100	648.00 – 754.04	718.80	-	-	-	-	5	100
Average			405.93-587.44	485.99	-	-	-	-	50	100	582.68-769.81	687.83	-	-	-	-	50	100

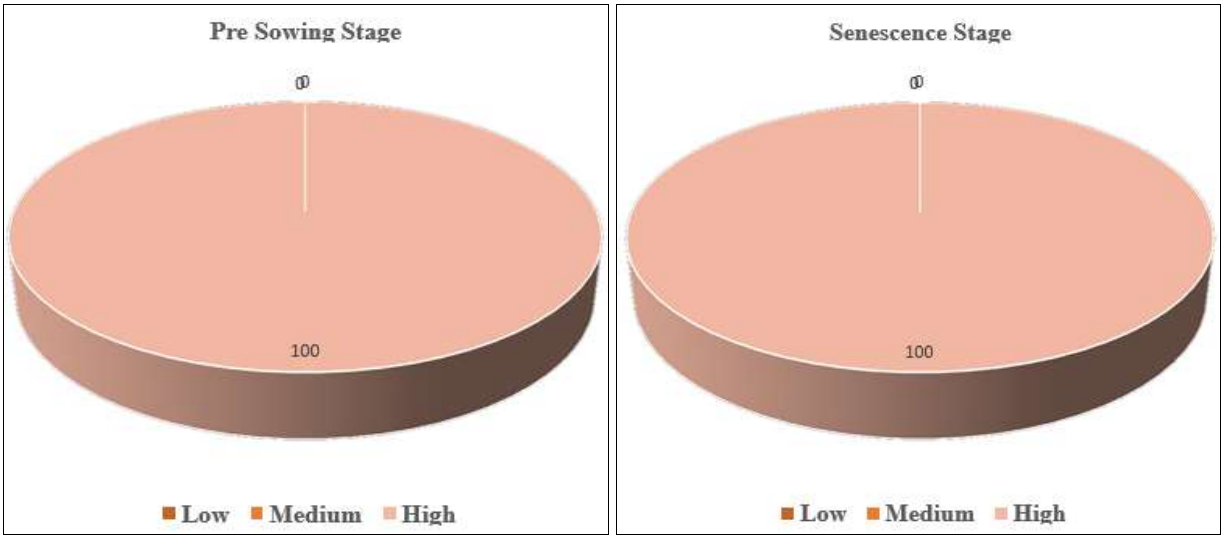
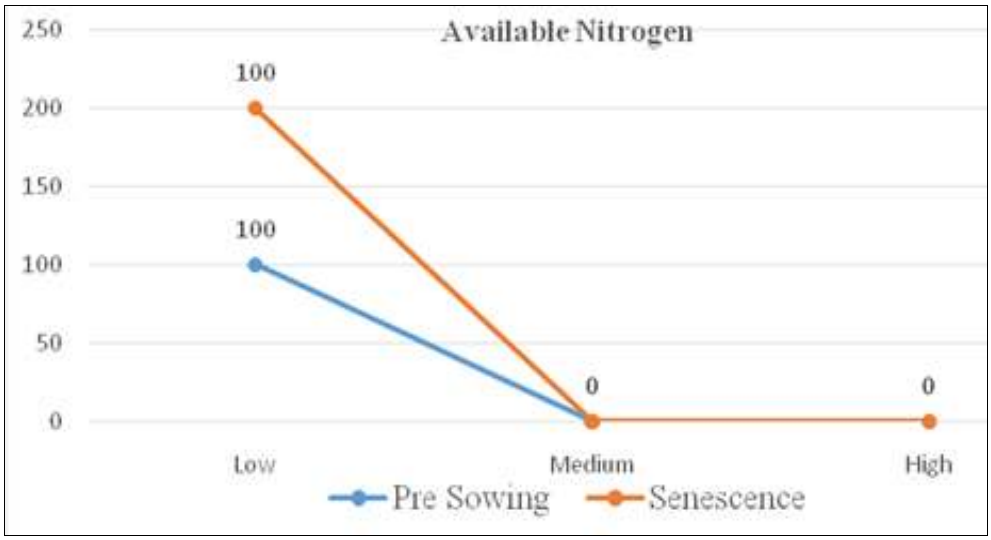
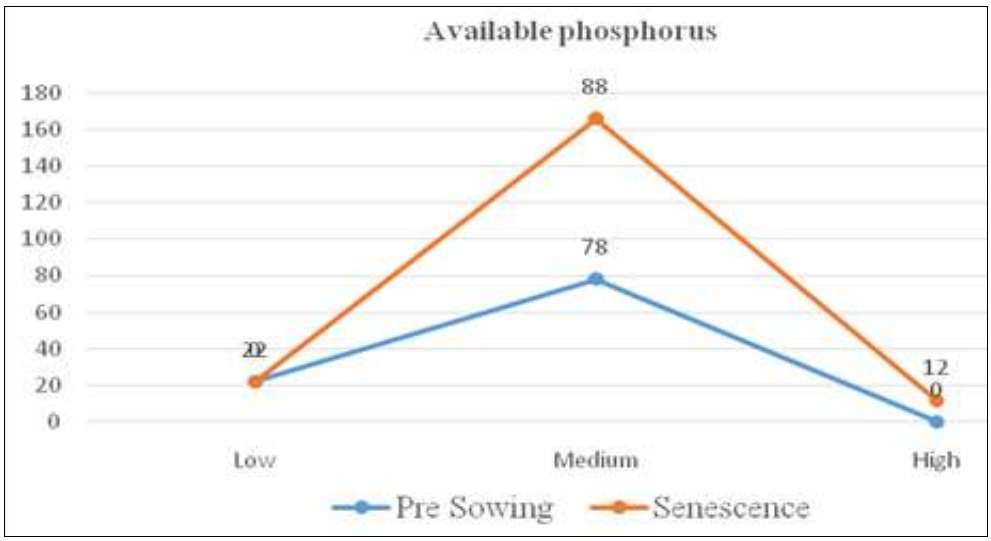


Fig 11: Categorization of turmeric growing soil on the basis of available potassium





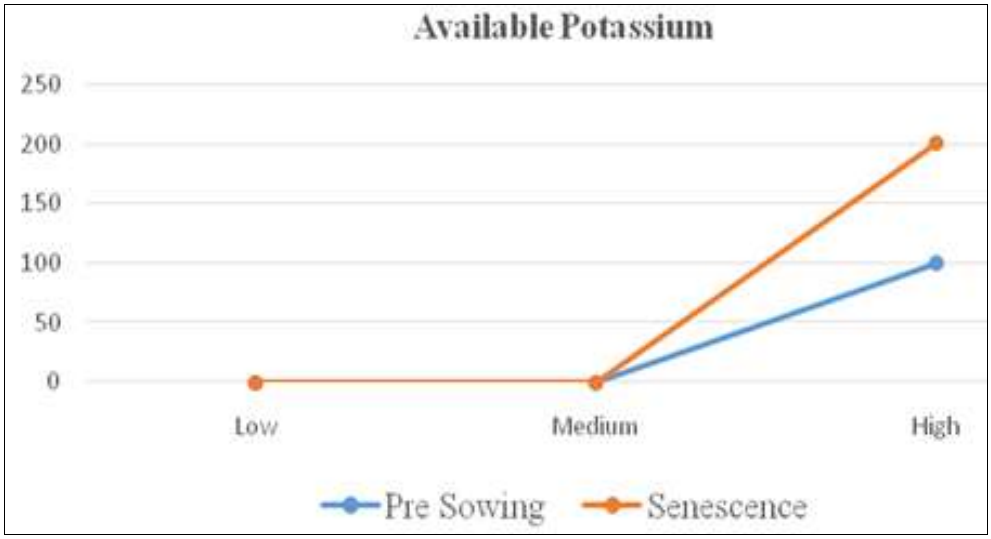


Fig 12: Variation in available primary nutrients at pre sowing and senescence stage of turmeric

Correlation between chemical properties and available nutrients at pre sowing and senescence stage

Various soil properties are associated with the availability of nutrient.

Potential reserve of any element is a primary function of and nature of the clay. The soil characteristics play an important role in the transformation of nutrients. The soil reaction is one of the important property which affect the plant growth. Further, soil organic matter content is generally considered as the index of soil fertility and sustainability.

The data on correlation at pre sowing and senescence stage of turmeric growing soils of 10 villages of Basmat tahsil is presented in Table 12.

From the data it is observed that soil pH showed the positive but non-significant correlation with available K (r = 0.028). Bharteey *et al.* (2017) [3] also reported that there were positive correlation with available K (r = 0.224). The available P was negatively correlated with soil pH (r = -0.080). Similar results noted by Singh *et al.* (2013) [18] because at highest pH calcium can precipitate with phosphorus as calcium phosphate and reduces phosphorus availability. Soil pH shows negative correlation with available N but not reach the level of statistical significance.

At the time of senescence stage the soil pH shows the positive correlation between available P (r = 0.062). Similar results were reported by Bharteey *et al.* (2017) [3] in soils of Mirzapur, where soil pH positively but non-significantly correlated with available P (r = 0.74).

The electrical conductivity showed the negative correlation with available phosphorus (r = - 0.223) and potassium (r = - 0.210). Similar correlations were reported by Singh *et al.* (2013) [18].

At senescence stage, electrical conductivity showed the positive but non- significant correlation with available K (0.019). Waikar *et al.* (2014) [22] reported that the potassium showed significant positive correlation with EC (r = 0.142*) and this was due to the interlayer collapse of clay mineral structure.

The data indicated that organic carbon was positively but non-significantly correlated with all parameters under study. Organic carbon positively correlated with available nitrogen (r = 0.037), available phosphorus (r = 0.126) and potassium (r = 0.18) Similar correlation was reported by the Waikar *et al.* (2014) [22].

In case of senescence stage the organic carbon was positively correlated with all parameters. The positive relationship between organic carbon and other all nutrients is might be due to the release of essential elements in soil by the organic matter decomposition after specific reactions. This indicate the importance of organic matter in increasing the availability of nutrients in soil (Verma *et al.* 2016) [21].

The calcium carbonate was positively correlated with available nitrogen (r = 0.025) at pre sowing stage of turmeric growing soils sampling. Similar result was reported by Waikar *et al.* (2014) [22]. The calcium carbonate was positively correlated with available N (r = 0.015) and negatively correlated with available P (r = -0.120) and K (r = -0.093) at senescence stage. The similar results was given by Alane *et al.* (2010) [1].

Table 12: Correlation between chemical properties and available nutrients in turmeric growing soils at pre sowing stage and senescence stage

	Pre-Sowing stage				Senescence stage			
	pH	**EC**	**Org. C**	**$CaCO_3$**	**pH**	**EC**	**Org. C**	**$CaCO_3$**
Avail. N	-0.145	- 0.109	0.037	0.025	-0.014	-0.145	0.184	0.015
Avail. P	-0.080	-0.223	0.126	-0.073	0.062	-0.183	0.001	-0.120
Avail. K	0.028	-0.210	0.148	-0.006	-0.113	0.019	0.223	-0.093

5% significance * 1% significance **

Conclusion

The turmeric growing soils in Basmat tahsil showed pH of the soil was normal to slightly alkaline in nature. Electrical conductivity of the soil in safe limit for crop growth and organic carbon status was low to medium. The $CaCO_3$ was non-calcareous to calcareous in nature. Low nitrogen, low to medium phosphorus and high potassium content in these soil. At senescence stage phosphors increased from medium to high range in these turmeric growing soils. The organic carbon showed the positive correlation with other nutrients at both, pre sowing and senescence stage.

References

1. Alane KV. Physico-chemical characteristics and nutrient status of soils from Aundha and Kalmnuri Tahsils of Hingoli district [dissertation]. Parbhani: VNMKV, Agricultural University; c2010.
2. Ammannawar PB, Kondvilkar NB, Palwe CR. Mapping of DTPA extractable micronutrients and their relationship with soil properties in Pathardi tahsil of Ahmednagr district (MS). Int J Chem Stud. 2017;5(5):2213-2217.
3. Bharteey PK, Singh YV, Sharma PK, Manish Kumar,

Avinash Kumar. Available macronutrient status and their relationship with soil physico-chemical properties of Mirzapur district of Uttar- Pradesh, India. Int J Microbiol Appl Sci. 2017;6(7):2829-2837.
4. Gajbe MV, Lande MG, Varade SB. Soils of Marathwada. J Maharashtra Agric Univ. 1976;1(2-6):55-59.
5. Ghuge SD. Evaluation of nutrient status of selected citrus orchard of Aurangabad district by soil and plant analysis [dissertation]. Parbhani: VNMKV; c2002.
6. Jackson ML. Soil Chemical Analysis. New Delhi: Prentis Hall of India Pvt. Ltd.; c1978.
7. Kawade AD, Ravankar HN, Padole VR. Physico-chemical properties and classification of salt affected soils of Keliveli (Dist- Akola) from Purna valley. J Soil Crops. 2005;15(1):139-143.
8. Kadte AJ, Perke DS, Kale PS. Economics of turmeric production in Sangali district of MH, India. Int J Curr Microbiol Appl Sci. 2018;Special issue-6:2279-2284.
9. Khan Ariff MA, Begum Hameedunisa. Nutrient status and soil properties of calcareous soils of young acid lime orchard of Nellor district of Andhra Pradesh. Int J Agric Sci. 2007;3(1):254-255.
10. Malewar GU, Dhamak AL, Syed Ismail. Inter-relationship of forms of Fe with properties of soils of semi-arid area of Northern Marathwada. J Maharashtra Agric Univ. 1998;23(2):199-201.
11. More SS, Shinde SE, Bankar RT, Kapse VD. Fertility status of soils from Basmat tahsil in Hingoli district. Trends Biosci. 2016;9(8).
12. Nirawar GV, Mali CV, Waghmare MS. Physico chemical characteristics and status available N, P and K in soils from Ahemedpur tahsil of Latur district. Asian J Soil Sci. 2009;4(1):130-134.
13. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. U. S. Department of Agriculture Circular 939. c1954.
14. Panse VG, Sukhatme PN. Statistical Methods for Agricultural workers. New Delhi: IARI; 1985:145-156.
15. Piper CS. Soil and Plant Analysis. Bombay: Hans Publication; 1966.
16. Perni J. Studies on nutrient status of turmeric growing soils of Guntur district [dissertation]. Acharya N G Ranga Agricultural University; 2005.
17. Rekhawar BV, Mali CV, Mali AC. Potassium release characteristics of different soils from oil seed dominated area in Latur district state level seminar on soil health management for enhanced agricultural production organize by PCISS M AU Parbhani; 2002. p. 35.
18. Singh YP, Raghubanshi RJ, Tiwari, Motsara S. Distribution of Available Macro and Micronutrients in Soils of Morena District of Madhya Pradesh. J Multidisciplinary Advance Res. 2013;3(1):01-08.
19. Subbiah BV, Asija GL. Rapid procedure for the estimation of available nitrogen in soil. Curr Sci. 1956;25:259-260.
20. Tur NS, Sharma PK, Nayyar VK. Mapping of micronutrient status and multi micronutrient deficiency in Patila district using frontier technology. J Soils Crops. 2008;18:1-6.
21. Verma RR, Srivastva TK, Singh KP. Fertility status of major sugarcane growing soils of Punjab, India. J Indian Soc Soil Sci. 2016;64(4):427-431.
22. Waikar SL, Mandavgade RR, Dhamak AL, Patil VD. Assessment of Major Soil Indices and their Relation with some Physico-chemical Soil Properties of Northern Tahsils (Jintu, Selu and Pathri) of Parbhani District. J Res Agric Anim Sci. 2014;2(11).
23. Lanada EB, Lee JA, More SJ, Cotiw-an BS, Taveros AA. A longitudinal study of sows and boars raised by smallholder farmers in the Philippines. Prev Vet Med. 2005;70:95-113.
24. Strasser P, Koh S, Anniyev T, Greeley J, More K, Yu C, *et al*. Lattice-strain control of the activity in dealloyed core–shell fuel cell catalysts. Nature chemistry. 2010 Jun;2(6):454-460.