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Studies on evaluation of fertility status of soybean growing area of Latur and its adjacent tahsil

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Abstract
The present investigation entitled "Studies on Evaluation of Fertility Status of Soybean Growing Area of Latur and its Adjacent Tahsil" was carried out with object to know the influence of soil and leaf nutrient status on yield and quality of Soybean during 2024-2025. The collected soil and leaf samples were analyzed for different parameters using standard procedure. 20 villages were selected from four tahsils of latur district. The results obtained are summarized below.

Physico-chemical properties like pH of Nilanga tahsil soil ranged from 7.3-8.5, with average value 7.7. EC of soil was ranged from 0.4-2.6 with average value 1.2. Organic Carbon of Nilanga tahsil soil ranged from 0.15-0.78 per cent with average values 0.49 per cent. Calcium Carbonate of Nilanga tahsil soil ranged from 2-8.3 per cent with average values 4.5per cent.

Available Nitrogen of Nilanga tahsil soil was ranged from 175-314348 kg ha^{-1} with average value 239.68 kg ha^{-1}. Available Phosphorus ranged from 2.47-26.13 kg ha^{-1} with average value 13.76 kg ha^{-1}. Available Potassium ranged from 233-999.4 kg ha^{-1} with average value 729.97 kg ha^{-1}. Available Sulphur ranged from 9.12-38.05 kg ha^{-1} with average value 20.94 kg ha^{-1}. Ex-Ca Nilanga tahsil soil ranged from 8.1-54.8 (cmol(p^+) kg^{-1}) with average values 39.67 (cmol (p^+) kg^{-1}). Ex-Mg Nilanga tahsil soil ranged from 9.45-38 (cmol(p^+) kg^{-1}) with average value 20.05 (cmol (p^+) kg^{-1}).

DTPA micronutrients (Zn, Fe, Cu and Mn) of. Nilanga tahsil soil ranged from 0.12-0.98, 1.7-9.1, 8.1-20.32 and 1.1-9.6 Mg kg^{-1} with average values 0.64, 5.5, 14.52 and 2.92 Mg kg^{-1}.

Total nutrients in Nilanga tahsil (N, P, K, S) ranged from 2.23-4.6, 0.11-0.47, 2.1-6.4 and 0.12-3.8 per cent with average values 3.08, 0.22, 4.89, and 2.69 per cent and (Fe and Zn) ranged from 73-506, 8.1-79.3 ppm with average values 198.2 and 45.27 ppm.

With respect to nutrient index value nilanga tahsil was categorized low in Nitrogen (1.44), Phosphorus (1.36), Manganese (1.64) and Zinc (1.63) content. Medium in Iron (2.16), While High in Potassium (2.48), Sulphur (2.48), Calcium (3), Magnesium (3) and Copper (3).

Keywords: Soybean, soil fertility, nutrient status, leaf analysis

1. Introduction
Soil is a dynamic natural entity found in the upper layers of the Earth's surface, functioning as a crucial interface among the atmosphere, biosphere, hydrosphere, and geosphere. It serves as the foundation for most terrestrial life and is characterized by remarkable complexity. Soil quality encompasses a range of interrelated attributes, including physico-chemical properties such as pH, electrical conductivity, organic carbon, and calcium carbonate, all of which significantly influence the availability of vital nutrients for crop growth. By effectively managing these physico-chemical properties, the availability of essential nutrients in the soil can be enhanced. The presence of macro and micronutrients is critical for soil fertility and directly impacts crop yields. In any given area, crop health depends largely on the availability of soil nutrients and their profiles. These factors underscore the importance of thoroughly examining the physico-chemical composition of agricultural soils. Assessing soil fertility involves measuring the accessible essential nutrients for plants and evaluating the soil's ability to provide a continuous supply of these nutrients to crops.

Tissue tests offer an accurate representation of the nutritional status of plants, as leaf analysis indicates whether the soil can adequately meet the crop's nutrient demands. These tests should be conducted every two to five years, typically after nutrient levels in the leaves have stabilized. It's important to minimize interactions between crop levels in the plant and mineral contamination from sprays. When foliar fertilizers are applied, leaves from "control" plants that have not been treated should be thoroughly cleaned to eliminate any residue. Various factors affect the nutritional makeup of leaves, including soil moisture, texture, fertility, and fertilization techniques, which directly influence nutrient uptake. Additionally, leaf nutritional content can vary based on crop load, plant variety, rootstock, the presence of diseases and pests, weather conditions, and cultural practices such as weed control and pruning. These factors should be considered when analyzing leaf data. Leaf analysis aims to maintain nutrient levels within ideal ranges for optimal quality and yield, and appropriate corrective actions should be taken if any nutrient levels fall outside these ranges.

2. Materials and Methods

Nilanga taluka is one of the ten talukas (subdivisions) of Latur district in Maharashtra, India. It is located in the Marathwada region of the state. The taluka has 152 villages. Nilanga town, the administrative center of the taluka. The town is situated at an average elevation of 631 meters (2,070 ft) above sea level. Latur district, including Nilanga, lies on the Balaghat Plateau, with elevations ranging from 540 to 638 meters. To evaluate the soil fertility of Nilanga Tahsil surface soil samples (0-30 cm) were collected. The latitude and longitude of location were recorded at the time of soil sample collection, All the collected soil samples will be brought to the laboratory and dried under shade by spreading on white glazed sheets and covered with white coloured paper to avoid contamination with the extraneous material. After drying, a part of each sample meant for analysis were ground with wooden mortar and pestle, passed through a 0.5 mm sieve and preserved in paper bags with proper labeling for further estimation of primary nutrients. All necessary precautions were taken as outlined by (Jackson 1973) [8] was carefully followed to avoid contamination. The tissue samples were collected at flowering stage of soybean during August-September 2024. The collected leaf samples were brought to the laboratory. The samples were air dried on perfectly clean surface at room temperature for 2-3 days in dust free atmosphere free from any kind of contaminants. Samples were placed in oven at 60°C for 48 hrs. and grinded in an electric stainless steel mill using 0.5 mm sieve. Then the samples were placed in oven to dry for few hours more till constant weight and stored in well stopper plastic jars for analysis. pH, EC and OC were determined by standard procedure (Jackson, 1973) [8]. The Nutrient Index was calculated as per the formula suggested by (Ramamurthy and Bajaj, 1969) [20]. The nutrient status of the study area was estimated, delineated and categorized on the basis of the NIV. The secondary and micronutrient status of soybean growing area of Latur and its adjacent Tahsil depicted on a thematic map. A soil fertility map was prepared by using (Ramamurthy and Bajaj, 1969) [20] soil nutrient index.

3. Results and Discussion

3.1. Physico-chemical properties of soils of Soybean growing area of Nilanga Tahsil

The data (Table 1) indicated that, pH of soils of Soybean growing area of Nilanga Tahsil ranged from 7.3 to 8.5 with mean value of 7.7, SE 0.06 and CV 4.08%. The soil sample NU-5, NA-2 and NP-5 collected from Ansarwada, Umerga and Palapur village showed the lowest pH (7.3) while, the highest value (8.5) was recorded in soil samples NH-5collected from Hadga village, respectively. The soils were neutral to alkaline in reaction. On the basis of categorization of soil samples, out of 25 samples, 7 were neutral (28%) and 18 samples were alkaline (72%) in reaction. (Table 2).

The data revealed that the EC of soils of Soybean growing area varied between 0.4 to 2.6 dSm^{-1} with mean value of 1.2 dSm^{-1}, SE 0.14 and CV 56.01%. The soil sample NP-4 and NY-2 collected from Palapur, Yelamwadi villages showed the lowest EC (0.4 dSm^{-1}) however, the highest value (2.6 dSm^{-1}) was recorded in soil samples NU-3 and NU-5 which collected from Umerga village, respectively (Table 1). As per categorization of soils of Soybean growing areas, out of 25 samples 12 (48%) samples were shows No deleterious effect on crops, 9 (36%) Critical for germination and 4 (16%) found Critical for salt sensitive crops (Table 2).

The organic carbon content in soils ranged from 0.15 to 0.78 per cent an average value of 0.49 per cent, SE 0.04 and CV 42.91%. The soil samples NU-5 collected from Umerga village, respectively showed the lowest organic carbon content (0.15%). While, the highest value (0.78%) was recorded in soil sample NY-3 from Yelamwadi village (Table 1). On the basis of categorization of organic carbon content of soils of Soybean growing area, out of 25 samples, 11 (44%) soil samples were categorized as low in organic carbon content, 14 (56%) were medium with respect to organic carbon content (Table 2).

The calcium carbonate content in soils ranged from 2 to 8.3 per cent with mean value of 4.5 per cent, SE 0.31 and CV 35.27%. The lowest calcium carbonate content (2%) was recorded in soil sample NA-5 collected from Ansarwada village whereas, the highest calcium carbonate content (8.3%) was recorded in the soil sample NU-1 collected from Umerga village (Table 1). Out of 25 soil samples, 3 (12%) soil samples were No calcareous, 15 (60%) Calcarious and 7 (28%%) soil samples were rated as highly calcareous (Table 2).

Table 1: Physico-chemical properties of soils of Soybean growing area of Nilanga Tahsil.

Nilanga					
Sr. No.	**Sample No.**	**pH**	**EC (dSm^{-1})**	**OC (%)**	**$CaCO_3$ (%)**
1.	NH 1	8.1	2.6	0.34	4.4
2.	NH 2	7.9	0.8	0.47	4.1
3.	NH 3	7.7	0.8	0.33	3.8
4.	NH 4	8.2	0.8	0.76	4
5.	NH 5	8.5	1.7	0.44	4.5
6.	NU 1	7.7	1.7	0.58	8.3
7.	NU 2	7.6	0.8	0.38	4.8
8.	NU 3	7.5	2.6	0.27	3.8
9.	NU 4	7.7	0.5	0.72	3.1
10.	NU 5	7.3	2.6	0.15	4.8
11.	NA 1	7.5	0.6	0.51	5.9

12.	NA 2	7.3	1.4	0.65	6.7
13.	NA 3	7.4	1.2	0.29	3.1
14.	NA 4	7.7	0.7	0.37	3.8
15.	NA 5	7.9	0.6	0.72	2.4
16.	NP 1	8.1	0.9	0.22	2
17.	NP 2	7.9	0.8	0.73	2.2
18.	NP 3	7.7	1.7	0.67	3.7
19.	NP 4	7.6	0.4	0.71	3.1
20.	NP 5	7.3	1.4	0.68	7.7
21.	NY 1	7.7	1.4	0.15	6
22.	NY 2	8.1	0.4	0.37	5.1
23.	NY 3	7.5	1.6	0.78	4.5
24.	NY 4	8.1	2.6	0.26	4.9
25.	NY 5	8.1	1.5	0.73	5.8
Range		7.3-8.5	0.4-2.6	0.15-0.78	2-8.3
Mean		7.7	1.2	0.49	4.5
S.E.		0.06	0.14	0.04	0.31
C.V. (%)		4.08	56.01	42.91	35.27

Table 2: Categorization of soil samples for physico-chemical properties in Nilanga Tahsil.

pH	**Category**	**Acidic**	**Neutral**	**Alkaline**	
	No. of samples	00	07	18	
	%	00	28	72	
EC	**Category**	**No deleterious effect on crops**	**Critical for germination**	**Critical for salt sensitive crops**	**Injurious to most crops**
	No. of samples	12	09	04	00
	%	48	36	16	00
Organic carbon	**Category**	**Low**	**Medium**	**High**	
	No. of samples	11	14	00	
	%	44	56	00	
$CaCO_3$	**Category**	**No Calcarious**	**Calcarious**	**High Calcarious**	
	No. of samples	03	15	07	
	%	12	60	28	

With respect to soils of Nilanga tehsil, Soil were shows pH range neutral to alkaline in reaction. The alkaline reaction is probably due to the presence of sufficient free lime content (Kaushal *et al*, 1986) [11] and basalt alluvial parent material rich in alluminosilcate alkaline earth from which these soils are derived. (Challa *et al*, 1998) [3] similar type of finding were reported by Waghmare *et al.* (2008) [27] recorded that the soils of Ausa tahsil ranged from 7.05 to 8.9 with an average value of 8.07.

The values of EC obtained in analysis were found in desirable range as proposed by Richard and Cambell (1948) [22], when EC exceed 4 dSm^{-1}, the salt present become harmful to the crop growth. Ajgaonkar and Patil (2017) [1] reported that the EC were ranged from 0.20 to 1.70 dSm^{-1} from the soils of Aurangabad district. These values of EC are safe for crop growth. Ushashri *et al.* (2019) [25] found that the EC ranged from 0.02 to 1.48 dSm^{-1} in soil samples collected from Bhudargad tahsil of Kolhapur district.

The data further revealed that overall soil samples were low to medium in organic carbon content. Reason behind the existence of variation in organic carbon content as Lower to medium range might be due to high temperature of Latur District (up to 41.5) and good aeration in the soil increased the rate of oxidation of organic matter resulting reduction of organic carbon content. Inadequate supply of organic manures and use of imbalanced chemical fertilizers along with poor agricultural management practices like soil tillage, mono or diversified cropping pattern, burning of trashes after harvesting etc. Kashiwar *et al.* (2019) [10] noticed that the organic carbon content ranged from 2.7 to 8.6 g kg^{-1} from the soils of Sakoli tahsil of Bhandara district.

According to categorization, it was observed that soils of Soybean growing area of selected villages were calcareous to highly calcareous in nature. It might be due to relatively more accumulation of $CaCO_3$ in soils and associated black soil may be partly associated with their recent origin with rich in alkali earth and partly due to calcification process prevalent in this region (Joshi, 2000) [9]. Similar finding of calcium carbonate (13.0 to 156.0 g kg^{-1}) was recorded in swell shrink soils of Vidharbha region (Padole and Mahajan, 2003) [15].

3.2. Status of primary nutrients in soils of Nilanga Tahsil.

The data (Table 3) revealed that there was wide range of variation in the available nitrogen in these soils. It ranged from 175 to 314 kg ha^{-1} with mean value of 239.38 kg ha^{-1}, SE 10.34 and CV 21.56%. The minimum available nitrogen content (175 kg ha^{-1}) was observed in soil sample NP-5 collected from Palapur village whereas, the maximum content (314 kg ha^{-1}) was recorded in soil sample NY-3 collected from Yelamwadi village. The data (table 4) further showed that 14 (56%) soil samples were found low while 11 (44%) medium in available nitrogen.

The available phosphorus content of soil samples ranged from 2.47 to 26.13 kg ha^{-1} with an average value of 13.76 kg ha^{-1}, SE 1.09 and CV 39.89%. The lowest content (2.47 kg ha^{-1}) of available P was recorded in soil sample NH-5 collected from Hadga village whereas, the highest content (26.13 kg ha^{-1}) was recorded in soil NP-5 collected from Palapur village (Table 3). Out of 25 samples, 16 (64%) soil samples were found low while, 9 (36%) samples were found medium in available phosphorus content (table 4)

The data (Table 3) indicated that available K content in soils Soybean growing area of Nilanga Tahsil varied from 223 to 999.4 kg ha^{-1} with a mean value of 729.97 kg ha^{-1}, SE 50.84 and CV 34.82%. The lowest available potassium (223 kg ha^{-1}) was noted in soil sample NH-3 collected from Hadga village whereas, the highest available potassium (999.4 kg ha^{-1}) was recorded in soil sample NP-5 collected from Palapur village. Out of 25 soil samples, 4 (16%) samples were Medium and 21(84%) samples were high in potassium content (Table 4)

Table 3: Status of primary nutrients in soils of Nilanga Tahsil

Nilanga				
Sr. No.	**Sample No.**	**N (kg ha^{-1})**	**P (kg ha^{-1})**	**K (kg ha^{-1})**
1	NH 1	272	9.12	499
2	NH 2	290	7.78	244
3	NH 3	289	11.84	233
4	NH 4	288	11.8	994
5	NH 5	283	2.47	247
6	NU 1	284	9.48	248
7	NU 2	187	21.76	884
8	NU 3	190	16.32	927.6
9	NU 4	192	11.33	714
10	NU 5	191	25.63	813.2
11	NA 1	189	12.79	826
12	NA 2	193	13.44	858.8
13	NA 3	191	13.39	982.4
14	NA 4	194	16.72	940
15	NA 5	193	9.42	893.2
16	NP 1	292	6.17	490.8
17	NP 2	291	12.47	783.2
18	NP 3	312	19.47	986
19	NP 4	198	14.18	884.8
20	NP 5	175	26.13	999.4
21	NY 1	295	17.86	795.2
22	NY 2	201	13.72	682
23	NY 3	314	15.35	851.2
24	NY 4	199	12.72	789.6
25	NY 5	289	12.7	682.8
Range		175-314	2.47-26.13	233-999.4
Mean		239.68	13.76	729.97
S.E.		10.34	1.09	50.84
C.V. (%)		21.56	39.89	34.82

Table 4: Categorization of soil for primary nutriets in Nilanga Tahsil.

Available N	**Category**	**Low**	**Medium**	**High**
	No. of samples	14	11	00
	%	56	44	00
Available P	**Category**	**Low**	**Medium**	**High**
	No. of samples	16	09	00
	%	64	36	00
Available K	**Category**	**Low**	**Medium**	**High**
	No. of samples	00	04	21
	%	00	16	84

Thus based on Soils of Nilanga Tahsil. Nitrogen shows Low to high in range. The lower content of available nitrogen in these soils are associated with, Low content of organic matter and low total nitrogen reserve and in term C:N ratio of immobilized form of nitrogen (Malewar, 1995) [12]. These results are in confarmatory with results reported by Waghmare and Takhankar (2007) [26] in soils of Ausa and Nilanga tahsil of Latur district where N content ranged from 102.22 to 385.72 kg ha^{-1} and 100.3 to 366.91 kg ha^{-1}, respectively.

It was infered from the value that all soil samples were low to medium in available phosphorus. The low available phosphorus might be due to the higher phosphorus fixing capacity of black cotton soils of Latur district that prevent the soil phosphorus to come in soil solution. The swell - shrink soils of Maharashtra were very low to high in available phosphorus content as reported by Patil and Sonar (1994) (17). Similarly, available P ranged from 10.0 to 19.1 kg ha^{-1} in soils of Marathwada region (Waikar *et. al*. 2004) [28].

Further data revealed that the potassium content in soils of Soybean growing area categorized as Medium to high. The high content of K is due do presence of potassium rich mineral in soil and associated black soils (Gajbe *et al*. 1976) [5]. Chaudhari and Kadu (2007) [4] reported that the available K of soil with an average value of 428.2 kg ha^{-1} was recorded in soils of Dhule tahsil of Dhule district.

3.3. Status of secondary nutrients in soils of Nilanga Tahsil.

The available Sulphur content of soils ranged from 9.12 to 38.05 kg ha^{-1} with an average value of 20.94 kg ha^{-1}, SE 1.56 and CV 37.23%. The lowest content (9.12 kg ha^{-1}) of available Sulphur was recorded in sample NU-2 collected from Umerga village whereas, the highest content (38.05 kg ha^{-1}) was recorded in soil sample NP-5 collected from Palapur village (Table 5). Out of 25 soil samples, 2 (8%) samples were found low while, 9 (36%) samples were found medium and 14 (56%) high in available Sulphur content (Table 6).

The exchangeable calcium varied from 8.1-54.8 cmol kg^{-1} with a mean value of 39.67 cmol kg^{-1}, SE 3.07 and CV 38.79%. The lowest exchangeable calcium (8.1 cmol kg^{-1}) was found in the village of Hadga (sample no. NH-1), while the highest exchangeable calcium (54.8 cmol kg^{-1}) was found in the villages of Palapur and Yelamwadi (sample no.NP-5 and NY-1) (Table 5). Out of 25 soil samples from, all 25 samples (100%) had a high exchangeable calcium content (Table 6).

The status of exchangeable magnesium in the soils of studied area was ranged from 9.45-38 cmol (p^+) kg^{-1} with the mean value of 20.09 cmol (p^+) kg^{-1}, SE 1.49 and CV 37.29%. The minimum exchangeable magnesium (9.45 cmol (p^+) kg^{-1}) was observed in the village of Hadga (sample no NH-4) whereas maximum exchangeable magnesium (38 cmol (p^+) kg^{-1}) was observed in Palapur village (sample no NP-1) (Table 5). Among the 25 soil samples, all 25 samples (100%) were in the high category. (Table 6).

Table 5: Status of secondary nutrients in soils of Nilanga Tahsil.

Sr. No.	Sample No.	S ($kgha^{-1}$)	Exch Ca^{++} (cmol (p^+)kg^{-1})	Exch Mg^{++} (cmol (p^+)kg^{-1})
1	NH 1	13.38	8.1	17.42
2	NH 2	14.32	9.9	23.3
3	NH 3	12.37	34.1	12.05
4	NH 4	14.13	47.7	9.45
5	NH 5	12.12	19.1	22.62
6	NU 1	17.42	44.8	34.27
7	NU 2	9.12	37.8	14.87
8	NU 3	18.09	54.2	26.38
9	NU 4	21.1	35.4	30.95
10	NU 5	23.4	51.4	21.7
11	NA 1	25.2	51.7	13.7
12	NA 2	26.4	48.2	13
13	NA 3	32.2	54.2	23.8
14	NA 4	22.45	52.3	9.7
15	NA 5	20.65	34.6	17.9
16	NP 1	18.2	9.3	38
17	NP 2	9.42	46	26.9
18	NP 3	23.48	51.6	24.6
19	NP 4	21.65	38.6	17.6
20	NP 5	38.05	54.8	19
21	NY 1	32.4	54.8	15.6
22	NY 2	22.62	18.8	11
23	NY 3	34.27	48.3	20.5
24	NY 4	14.87	52.4	22.5
25	NY 5	26.38	33.7	14.5
Range		9.12-38.05	8.1-54.8	9.45-38
Mean		20.94	39.67	20.05
SE		1.56	3.07	1.49
CV		37.23	38.79	37.29

Table 6: Categorization of soils for secondary nutrients in Nilanga Tahsil

Available S	**Category**	**Low**	**Medium**	**High**
	No. of samples	02	09	14
	%	8	36	56
Exchangeable Ca^{++}	**Category**	**Low**	**Medium**	**High**
	No. of samples	00	00	25
	%	00	00	100
Exchangeable Mg^{++}	**Category**	**Low**	**Medium**	**High**
	No. of samples	00	00	25
	%	00	00	100

Based on Nilanga data, The available sulphur shows low to high in range. This might be expected due to the presence of Fe and Al oxides in surface soils. Similar results were also reported by Medhe *et al.* (2012) [13] and Kashiwar *et al*. (2019) [10].

The high status of exchangeable calcium and Magnesium in these soils may be a result of the dry and semidry environments causing an accumulation of metallic cations in calcareous soil. Calcium is the main cation on the soil exchange complex and in the soil solution because limestone, calcite is the parent material. Ravte (2008) [21] reported that the exchangeable calcium and magnesium content from Ausa tahsil of Latur district were ranged from 11.05 to 50.7 and 2.6 to 28.9 cmol (P+) kg^{-1}, with a mean value of 31.67 and 18.2 cmol (P+) kg^{-1}. Similar findings were also reported by Bacchewar and Gajbhiye (2011) [2].

3.4. DTPA- Micronutrient status in soils of Nilanga Tahsil

The DTPA-Zn content in soils was varied from 0.12 to 0.98 mg kg^{-1} with an average value 0.64 mg kg^{-1}, SE 0.05 and CV 46.08%. The minimum Zn content (0.12 mg kg^{-1}) was recorded in soil samples NH-1 and NH-4 collected from Hadga village, respectively, Whereas, the maximum content (0.98 mg kg^{-1}) was recorded in samples NA-1 collected from Ansarwada village (Table 7). The data (Table 8) further revealed that among 25 samples, 7 (28%) samples were low, 18 (72%) were medium in zinc content.

The data pertaining to Fe varied from 1.7 to 9.1 mg kg^{-1} with an average value of 5.5 mg kg^{-1}, SE 0.58 and CV 53.06%. in soils of selected villages of Latur district. The lowest value (1.7 mg kg^{-1}) was observed in soil sample NH-1 collected from Hadga village. Whereas, the highest value (9.1 mg kg^{-1}) was recorded in soil sample NU-3, NP-2, NP-5 and NY-3 collected from Umerga, Palapur and Yelamwadi villages (Table 7). As per the categorization of soil samples, out of 25 samples, 9 (36%) were low, 3 (12%) were medium and 13 (52%) were high in available Fe content (Table 8).

DTPA-Cu varied from 8.1 to 20.32 mg kg^{-1} with an average value 14.52 mg kg^{-1}, SE 0.70 and CV 24.16%. The lowest available Cu content (8.1 mg kg^{-1}) was noted in soil sample NH-5 collected from Hadga village. Whereas, the highest available Cu content (20.32 mg kg^{-1}) was noted in soil sample NH-1 collected from Hadga village (Table 7), respectively. All 25

(100%) soil samples were high in copper content (Table 8).

The data on DTPA-Mn showed that, it was varied from 1.1 to 9.6 mg kg^{-1} with an average value 2.92 mg kg^{-1}, SE 0.51 and CV 88.96% in soils of Soybean growing of Latur district. The lowest content (1.1 mg kg^{-1}) of Mn was observed in orchard soil NH-4 and NP-3 collected from Hadga and Palapur villages while, the highest value (9.6 mg kg^{-1}) was recorded in soil sample NU-2 collected from Umerga village (Table 7). According to categorization of soil samples, out of 25 samples, 13 (52%) Low, 8 (32%) soil samples were medium in manganese content and 4 (16 per cent) were found to be high with respect to manganese content. (Table 8).

Table 7: DTPA- Micronutrient status in soils of Nilanga Tahsil

Nilanga					
Sr. No.	**Sample No.**	**DTPA- Zn (Mg kg^{-1})**	**DTPA- Fe (Mg kg^{-1})**	**DTPA- Cu (Mg kg^{-1})**	**DTPA- Mn (Mg kg^{-1})**
1.	NH 1	0.12	1.7	20.32	8.6
2.	NH 2	0.26	2.2	18.32	1.3
3.	NH 3	0.66	7.1	17.8	2.1
4.	NH 4	0.12	2.1	18.44	1.1
5.	NH 5	0.14	3.2	8.1	1.2
6.	NU 1	0.85	2.1	9.22	1.3
7.	NU 2	0.74	2.1	10.18	9.6
8.	NU 3	0.55	9.1	12.01	1.4
9.	NU 4	0.94	2.1	9.82	3.8
10.	NU 5	0.82	8.1	10.42	7.6
11.	NA 1	0.98	7.1	13.14	1.5
12.	NA 2	0.54	8.1	14.12	1.2
13.	NA 3	0.96	6.1	12.48	3.7
14.	NA 4	0.45	5.1	11.9	2.1
15.	NA 5	0.96	6.1	13.5	1.2
16.	NP 1	0.73	8.1	15.3	2.7
17.	NP 2	0.85	9.1	14.46	2.1
18.	NP 3	0.88	2.1	16.2	1.1
19.	NP 4	0.45	2.1	15.8	2.7
20.	NP 5	0.88	7.1	13.4	3.6
21.	NY 1	0.56	9.1	14.89	1.1
22.	NY 2	0.88	8.1	16.02	1.4
23.	NY 3	0.65	9.1	19.3	1.2
24.	NY 4	0.92	2.3	20.01	1.6
25.	NY 5	0.13	8.1	18.06	7.8
Range		0.12-0.98	1.7-9.1	8.1-20.32	1.1-9.6
Mean		0.64	5.5	14.52	2.92
SE		0.05	0.58	0.70	0.51
CV		46.08	53.06	24.16	88.96

Table 8: Categorization of soil for DTPA-Micronutrients in Nilanga Tahsil.

DTPA- Zn (Mg kg^{-1})	**Category**	**Low**	**Medium**	**High**
	No. of samples	07	18	00
	%	28	72	00
DTPA- Fe (Mg kg^{-1})	**Category**	**Low**	**Medium**	**High**
	No. of samples	09	03	13
	%	36	12	52
DTPA- Cu (Mg kg^{-1})	**Category**	**Low**	**Medium**	**High**
	No. of samples	00	00	25
	%	00	00	100
DTPA- Mn (Mg kg^{-1})	**Category**	**Low**	**Medium**	**High**
	No. of samples	13	08	04
	%	52	32	16

Zinc shows low to Medium range in soils of Nilanga tahsil. Low content of zinc, might be because the zinc cations are heavily charged to their oxides or hydroxides in an alkaline environment, which reduces the zinc's availability. Similar findings were also found to be confirmatory with Meena *et al.* (2006) [14], Gosavi and Chaudhari (2016) [7].

It is seen from the result that soil samples were low to high in Fe content. High content of Fe due to the presence of Fe in the octahedral layer of silicate clays, especially those with clay minerals with a 2:1 composition (Smectite). Fertilizer applications with Fe content cause the release of Fe from the clay under specific soil conditions, increasing the concentration of Fe in the soil solution. Similar results were reported by Kashiwar *et al.* (2019) [10].

DTPA Copper shows high in soils. High copper concentrations may result from the presence of chalcocite and cuprite minerals in soils and basaltic parent materials. Shinde (2007) [23] reported that the DTPA-extractable copper content was ranged from 0.32 to 17.5 mg kg-1 and 0.74 to 9.42 mg kg-1 from Udgir and Deoni tahsils in Latur district. Similar findings were also reported by Meena *et al*. (2006) [14].

Mostly Mn shows medium to high in range. The high Mn status in these soils might be due to the, these soils have higher ferromagnesium mineral concentrations than soils derived from basaltic parent minerals, or it might be because these soils have more magnetic mineral pressure. Waghmare and Takankhar (2007) [26] found that the DTPA extractable manganese content ranged from 1.23 to 13.57 mg kg-1 with an average value of 7.57 mg kg-1 from soils in Ausa tahsil of Latur district. Similar results were also reported by Pradeep *et al.* (2006) [18].

3.5. Total nutrient content in Soybean plant of Nilanga Tahsil (N, P, K, S, Fe and Zn)

Total nitrogen content of Soybean leaves varied from 2.23 to 4.6 per cent with an average of 3.08 per cent, SE 0.17 and CV 27.88%. The lowest amount of total nitrogen (2.23%) was recorded in leaves samples NP-5 collected from Palapur village whereas, the highest amount (4.6%) was recorded in leaves sample NY-3 collected from Yelamwadi village (Table 9). On the basis of categorization (Table 10), among 25 samples, 13 (52%) leaves samples was Low in total N content and 12 (48%) medium in total N content.

Total phosphorus content of Soybean leaves ranged from 0.11 to 0.47 per cent with an average of 0.22 per cent, SE 0.02 and CV 47.87%. The less amount of total P (0.11 per cent) was noted in leaves sample NH-5 collected from Hadga village, respectively. However, the high amount of total P (0.47%) was recorded in leaves NP-5 collected from Palapur village (Table 9). The data further revealed that Out of 25 leaves samples (Table 10), 14 (56%) samples were categorized as low and 11 (44%) samples medium in total phosphorus content in Soybean leaves.

Total potassium content of Soybean leaves varied from 2.1 to 6.4 per cent with a mean value 4.89 per cent, SE 0.24 and CV 25.11%. The minimum content of total K (2.1%) was recorded in leaves samples NU-2 collected from Umerga village. Whereas, maximum content (6.4%) was recorded in leaves samples NP-5 collected from Palapur village (Table 9). Out of 25 leaves samples 18 (72%) leaves samples were low and 7 (28%) Medium in total potassium content (Table 10).

Total Sulphur content in leaves ranged from 0.12 to 3.8% with a mean value of 2.69%, SE 0.26 and CV 49.72%. The less amount of total S (0.12%) was noted in leaves sample NU-2 collected from Umerga village. However, the high amount of total S (3.8%) was noted in leaves sample (NU-1, NA-1, NA-3 and NP-5) collected from Umerga, Ansarwada and Palapur villages (Table 9). Out of, 25 soybean leaves samples, 3 (12%) samples low, 5 (20%) leaves samples were medium, while 17 (68%) leaves samples high in Sulphur content (Table 10).

Total Iron content in leaves sample ranged from 73 to 506 ppm with a mean value of 198.2 ppm, SE 32.19 and CV 81.22%. The less amount of total Fe (73 ppm) was noted in leaves sample NH-1 collected from Hadga village. However, the high amount of total Fe (506 ppm) was noted in leaves sample LH-3 collected from Hadga village (Table 9). Out of, 25 soybean leaves samples, 11 (44%) samples low, 9 (36%) leaves samples were medium, while 5 (20%) leaves samples high in Iron content (Table 10).

Total zinc content in leaves sample ranged from 8.1 to 79.3 ppm with a mean value of 45.27, SE 3.65 and CV 40.38%. The less amount of total Zn (8.1 ppm) was noted in leaves sample NH-1 collected from Hadga village. However, the high amount of total Zn (79.3 ppm) was noted in leaves sample NA-1 collected from Ansarwada village (Table 9). Out of, 25 soybean leaves samples, 4 (16%) samples low and 21 (84%) leaves samples were medium in zinc content (Table 10).

Table 9: Total nutrient content in Soybean plant of Nilanga Tahsil. (N, P, K, S, Fe and Zn).

Nilanga							
Sr. No.	**Sample No.**	**Total N (%)**	**Total P (%)**	**Total K (%)**	**Total S (%)**	**Total Fe (ppm)**	**Total Zn (ppm)**
1.	NH 1	3.11	0.14	4.5	3.6	73	8.1
2.	NH 2	3.32	0.12	5.2	2.2	185	9.9
3.	NH 3	3.42	0.16	5.2	3.4	506	34.1
4.	NH 4	4.45	0.16	6.3	3.4	502	47.7
5.	NH 5	4.12	0.11	5.4	0.29	81	19.1
6.	NU 1	3.76	0.14	3.2	3.8	161	44.8
7.	NU 2	2.32	0.32	2.1	0.12	86	37.8
8.	NU 3	2.34	0.28	3.2	3.4	82	54.2
9.	NU 4	2.32	0.15	5.2	3.2	161	35.4
10.	NU 5	2.34	0.38	6.3	2.6	86	51.4
11.	NA 1	2.31	0.13	4.2	3.8	82	79.3
12.	NA 2	2.34	0.15	3.2	3.7	161	48.2
13.	NA 3	2.35	0.16	2.6	3.8	86	54.2
14.	NA 4	2.34	0.23	5.4	3.4	182	52.3
15.	NA 5	2.36	0.14	4.2	0.21	86	74.6
16.	NP 1	4.36	0.13	5.1	3.6	161	51.7
17.	NP 2	4.21	0.34	6.3	3.4	81	76
18.	NP 3	3.63	0.37	5.8	0.12	506	51.6
19.	NP 4	2.41	0.21	5.2	0.29	502	38.6
20.	NP 5	2.23	0.47	6.4	3.8	175	54.8
21.	NY 1	3.6	0.42	4.2	3.2	89	54.8
22.	NY 2	4.2	0.24	5.2	3.2	91	18.8
23.	NY 3	4.6	0.24	6.3	3.4	506	48.3
24.	NY 4	2.34	0.15	6.3	2.2	172	52.4
25.	NY 5	2.42	0.16	5.2	3.2	152	33.7
Range		2.23-4.6	0.11-0.47	2.1-6.4	0.12-3.8	73-506	8.1-79.3
Mean		3.08	0.22	4.89	2.69	198.2	45.27
SE		0.17	0.02	0.24	0.26	32.19	3.65
CV		27.88	47.87	25.11	49.72	81.22	40.38

Table 10: Categorization of samples based on nutrient content in soybean plants of Nilanga Tahsil.

Total N	**Category**	**Low**	**Medium**	**High**
	No. of samples	13	12	00
	%	52	48	00
Total P	**Category**	**Low**	**Medium**	**High**
	No. of samples	14	11	00
	%	56	44	00
Total K	**Category**	**Low**	**Medium**	**High**
	No. of samples	00	18	07
	%	00	72	28
Total S	**Category**	**Low**	**Medium**	**High**
	No. of samples	03	05	17
	%	12	20	68
Total Fe	**Category**	**Low**	**Medium**	**High**
	No. of samples	11	09	05
	%	44	36	20
Total Zn	**Category**	**Low**	**Medium**	**High**
	No. of samples	04	21	00
	%	16	84	00

Thus, based on overall data of study area. It indicating that majority of Soybean plant samples showed low to medium in Nitrogen, Phosphorus and Zinc content. These results confirm the findings reported by Ghatala *et al* (2004) [6] studied the nutrient concentration in pomegranate Plant of Jaipur district, Rajasthan and reported that nitrogen concentration in leaves ranged from 0.65 2.35 per cent. Singh and Kumar (2012) [24] found that P contents ranged from 0.184 to 0.276 per cent in Pomegranate leaves. (Parwe 2013) [16] who found that Zn in plant was 50.0 to 90.2 mg kg^{-1} in pomegranate orchards of Beed district.

Total Potassium content of Soybean leaves mostly categorized medium to high in range. These results are in resemblance with the findings of (Raghupati and Bhargava 1998) [19]. (Parwe 2013) [16] found that K contents ranged from 1.02 to 9.71per cent.

The total Sulphur content in Soybean leaves showed low to high in range. These results are in resemblance with the findings of (Raghupati and Bhargava 1998) [19]. Total Iron content of Soybean leaves mostly categorized low to high in range. (Parwe 2013) [16] observed the range of iron in leaves was 124.0 to 3.10.0 mg kg^{-1} in pomegranate plant leaves of Beed district.

4. Soil nutrient index in soils of Nilanga tahsil.

On the basis (Table 11and Fig 1) of resulted nutrient index value, soils from Nilanga tahsil was categorized low in Nitrogen (1.44), Phosphorus (1.36), Manganese (1.64) and Zinc (1.63) content. Medium in Iron (2.16), While High in Potassium (2.48), Sulphur (2.48), Calcium (3), Magnesium (3) and Copper (3). These nutrient index values were calculated as per the formula given by (Ramamoorthy and Bajaj 1969) [20].

Table 11: Nutrient index values of soils of Nilanga tahsil of Latur district.

Sr. No.	Soil Nutrients	Nilanga	
		NIV	Category
1	Nitrogen	1.44	Low
2	Phosphorus	1.36	Low
3	Potassium	2.48	High
4	Sulphur	2.48	High
5	Calcium	3	High
6	Magnesium	3	High
7	Zinc	1.63	Low
8	Iron	2.16	Medium
9	Copper	3	High
10	Manganese	1.64	Low

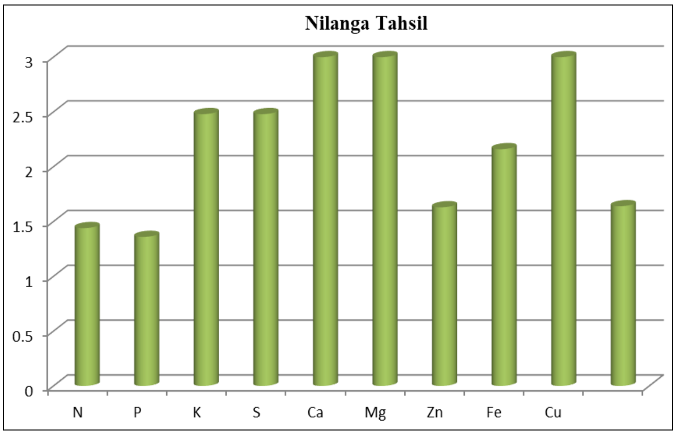

Fig 1: Nutrient index values of soils of Nilanga tahsil of Latur district

5. Fertility map

The nutrient status of the study area was estimated, delineated and categorized on the basis of the NIV. Villegewise Primary, secondary and micronutrient status of soybean growing area of Latur and its adjacent Tahsil depicted on a thematic map. (Table 12 and Fig 2).

Table 12: Village wise soil fertility status of Nilanga tahsil.

No	Villeges	N	P	K	S	Ca	Mg	Zn	Fe	Cu	Mn
1	Hadga	Low	Low	High	Medium	High	High	Low	Low	High	Medium
2	Umerga	Low	Medium	High	Medium	High	High	Medium	Medium	High	Low
3	Ansarvada	Low	Low	High	High	High	High	Medium	Medium	High	Low
4	Palapur	Medium	Medium	High	Medium	High	High	Medium	Medium	High	Medium
5	Yelamwadi	Medium	Low	High	High	High	High	Medium	Medium	High	Low

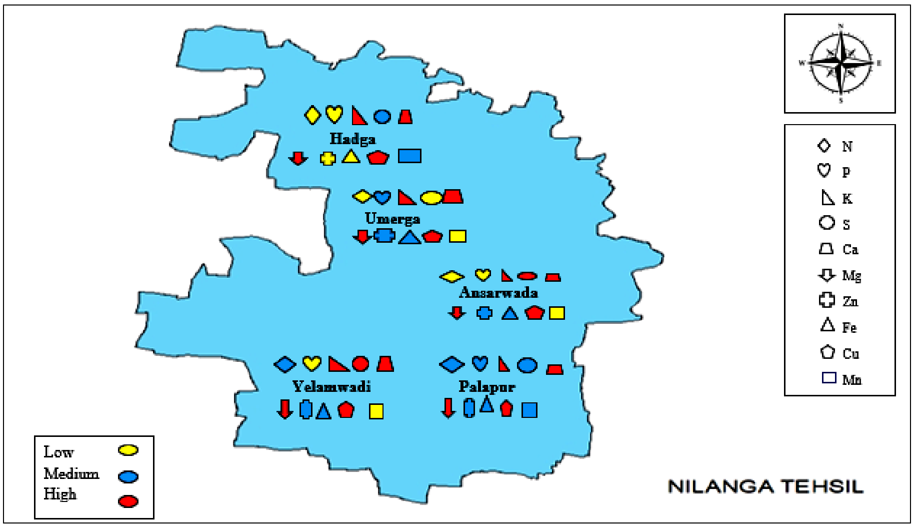

Fig 2: Fertility status of Soybean growing area of Nilanga tahsil.

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