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Assessment of chemical properties, micro and secondary nutrients status in agro-ecological-sub-region 6.2 a (K4Dd4) Nandurbar district of Maharashtra (M.S)

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Abstract
The study of soil survey was carried out during the year 2017-18 to 2018-19in Nandurbar district (M.S) India by using GPS techniques in Agro-Ecological-Sub-Region (AESRs) of Nandurbar district namely, AESR 6.2 a (K4Dd4). AESR 6.2 a which is characterized by Deccan Plateau, soils is shallow and medium (inclusion deep) black soils, semi- arid dry and length of growing period 180-210 days. 0-20 cm depths of fifteen soil samples were collected from various villages of three tehsils of Nandurbar district were analyzed for their fertility and micro and secondary nutrient status. The exact locations of soil samples as well as latitude, longitude and altitude were recorded by the help of Global Positioning System (GPS). The result revealed that all the soil samples in Nandurbar district are slightly acidic to slightly alkaline in nature (6.45 -7.99), electrical conductivity are non–saline (0.16-0.52 dS m^{-1}), moderate to high in organic carbon (4.67-9.67 g kg^{-1}) and calcium carbonate ranged from 1.45-5.63per cent. Regarding micro and secondary nutrients, the DTPA- extractable zinc, copper, iron, manganese and boron varies from 0.36-2.12, 0.89-7.89, 2.23-33.77, 10.02-35.25 and 0.12-1.50 mg $kg^{-1}$with mean of 1.04,4.00,18.45,23.13 and 0.86 mg kg^{-1} respectively, while, exchangeable Ca (20.44-36.10 cmol (p^+) kg^{-1}) and Mg (11.78-18.72 cmol (p^+) kg^{-1}) was found sufficient. The available sulphur varies from 3.66-40.99 with mean of 24.41 mg kg^{-1} was found sufficient in soil. Significant and positive correlation with DTPA- Cu and OC whereas, the relation between pH and $CaCO_3$ were positively correlated. The DTPA-Fe showed negative correlation with soil pH (r=-0.209), $CaCO_3$ (r=-0.100) and Zn (r=- 0.052) and positive relation with O.C. (r=0.023). The DTPA-Fe content positive and significant correlation with DTPA-Mn (r=0.525**) and DTPA-Cu(r=0.583**). The soils of Nanburbar, Navapur and Shahada tehsils of Nanburbar districts were 20, 13 and 27 per cent deficient of zinc, iron and boron respectively. However, copper and manganese was found sufficient. Nutrient indices values were noted high in copper, iron, manganese and sulphur and medium in boron.

Keywords: Chemical properties, micro and secondary nutrient, correlation, GPS, nutrient indices

Introduction
Agriculture is the backbone of Indian economy and it provides employment to large population. However, it is not considered as profitable enterprise. Many reasons may be put forth for this as casual components like decreases fertility of cultivated land, introduction of high yielding varieties of different crops, use of high analysis fertilizer and apply of agricultural technology for exploding their able have led to wide spread deficiencies of secondary and micronutrients elements in Indian soils (Patil and Shingte, 1982) [24].

India has attained self-sufficiency in food grain which is mostly attributed to huge input agriculture in post green revolution period. But the food grain production during last decade is almost plateauing and the production is not in tune with the level of input applied. This, call for holistic approach and sustainability in food grain production and shall be looked in close relationship with soil productivity.

Soils classification of Maharashtra state are poor to moderate in fertility rate which is controlled by genic, morphological, physical, chemical and biological features. Micronutrients have emerged as a wide spread deficiency in Indian soils particularly Zn deficiency in Maharashtra, due to continual cropping, soil and water losses, percolation losses and with the x (Challa *et al*., 1995) [7].

The Maharashtra state has humid to per humid type climate in Konkan and Western Ghats, Semiarid type in Central and Western Maharashtra, while sub-humid type in eastern part of the state. The annual rainfall in the state varies from 450 mm in the rain shadow area to 6000 mm in Western Ghats of which 80 per cent is received from June to September. Konkan and western ghat areas have a water surplus limited to June to October with growing period of more than 210 days. While rain shadow areas of western and central Maharashtra have very few months of water surplus with growing period of 90 to 150 days. In eastern part of the state, the growing period ranges from 150 to 180 days.

The agro-ecological-sub-region methodologies enable normal ground administration options to establish on the ground of a catalogue of ground means and in valuation of biophysical constraints and ability. The term of agro-ecological zone (AEZ) for increasing rainfall efficiency, preservation of original origin and methods of long-term agriculture within rain-fed condition is important. This strive, topmost preference is establish to evaluates ground origins and its segments; certainly soil, water and climate to develop an integral scheme to use of finest of scientifically technique and awareness for farming advancement. The most assignment to progress Agro Ecological Zones is to establish a close consistent soil weather condition that is suitable for ability genetically manifestations in condition of establishment of a certain band of crops and species and their subsistence and the AEZ-ground dissemination of agro-technology.

The primary objective of creating AESR is to outline a similar earth device, which will conduct equal under a given group of governance usage taxation on a specific land use. For crop scheduling, this view is moreover smaller to the behavior of a polygon of AESR, for specimen, for cotton or rice or wheat productivity. AESR concept in rain-fed scheme is mostly basis on available moist content in soil to sustain crops between raining facts and later expiration of the rainfall 78 mha (53% of the net cultivated area). Rain-fed agriculture provides 85% of the coarse cereals, 83% of the pulse and 70% of the oilseed production away from 66% cotton fibre output as reported by Bhattacharyya *et al.* (2014) [5].

The micronutrients are also important just like macronutrients. Arnon and Stout (1939) [1] articulated the insufficiency of some minerals either macro or micro may be abolished only with addition of very specific minerals and not by replacement of enough amounts. It also related to quote Liebig's law which states that the crop grow and establishment and final production is restricted by the minerals current in trace available amount. Although, soil can act as a physical filter by its sieving action, a chemical filter by absorbing and deposition of chemical substances, and a biological filter by decomposing organic substances, it does not have endless capacity to play such tasks.

Materials and Methods

AESR 6.2 a is characterized by Deccan Plateau, soils is shallow and medium (inclusion deep) black soils, semi- arid dry and situated at Deccan Plateau in between21° 22' 11"N latitude and 77° 13' 74" E longitude at an altitude of 221m above msl of Nandurbar, 21° 02' 46"N latitude and 74° 11' 80" E longitude at an altitude of 495m above msl of Navapur and 21° 37' 89"N latitude and 74° 31' 95" E longitude at an altitude of 176 m above msl of Shahada tehsils has been classified under semi-arid dry eco-sub-region.

Geo-referenced surface (0-20 cm depth) soil samples representing different soils were collected tehsilwise during 2017-18 and 2018-19in three tehsil of Nandurbar district. The latitude, longitude and altitude of sampling sites in the study area were recorded with the help of Geographical Positioning System (GPS). The grid survey (5 km interval) of district was carried out, and soil samples from different cropping systems in homogeneous area were selected. The villages were selected randomly in each district. So the sampling sites scattered uniformly in each tehsils of the district. The geo-referenced soil samples were collected from twenty three representative district including Nandurbar district of Maharashtra. The soil samples from each agro-ecological-sub-region (AESRs) will be selected carefully and categorized in each AESR. The information on soil type, cropping pattern and weather data of this agro-eco-sub-region will be collected. The soil samples were collected with the help of wooden peg. The samples were air dried and ground using wooden mortar and pestle and passed through 2.0 and 0.5 mm sieves. The sieved soil samples were stored in cloth bags with proper labeling for subsequent analysis. The soils were analyzed for different parameters.

Soil pH was determined with the help of pH meter in 1:2.5 soils: water suspension as described by Jackson (1973) [13]. Organic carbon was determined by Walkley and Black wet-oxidation method as described by Nelson and Sommer (1982) [23]. Calcium carbonate was determined by rapid titration method as given by Piper (1966) [26]. DTPA- micronutrient was determined by using 0.005 M DTPA adjusted at pH 7.3. The soil samples were shaked in temperature controlled incubator for 2 hrs with constant temperature 25°C and 120 rpm. The suspensions were filtered through Whatman No. 42 filter paper. The aliquot was used for analysis. The concentration of Zn, Cu, Fe and Mn was recorded on Atomic Absorption Spectrophotometer (AAS) as per procedure given by Lindsay and Norvell (1978) [18]. Available boron determined by 0.01 M $CaCl_2$extract with Azo-Methane–H method given by Berger and Troug (1939) [4]. Exchangeable Calcium and Magnesium were determined by NH_4OAc extract using Atomic Absorption Spectrophotometer as per procedure given by Hesse (1971) [10]. The DTPA-micronutrients status areas were delineated into low, medium and high based on their limits. The nutrient indices were calculated by using formula given by Parkar (1951) [38].

Results and Discussion

Chemical properties of soil

Soil reaction (pH)

The result revealed that the soil pH (Table 1) of Nandurbar district varies from 6.45 to 7.99 with mean of 7.54 locating slightly acidic to slightly alkaline in nature. The highest pH was recorded in Nandurbar tehsil (7.99) in sample no. NB-1 while low in Shahada tehsil (6.45) in sample no. SD-10. The alkaline nature of soil it might be due to the availability of adequate free lime status in soil (Kaushal *et al*., 1980) [16]. The most of the area have alkaline soil in Nandurbar district.

The result showed that, the soils were slightly acidic to slightly alkaline it may be due to be influence of origin, parent material, precipitation and undulating topography. The similar findings of observations for soil pH were also reported by Mahashabde and Patel (2012) [19] in soils of Shirpur Tehsil of Dhule District.

Electrical conductivity (EC)

The electrical conductivity of soils varies from 0.16 to 0.52 dS m^{-1} with mean of 0.38 dS m^{-1}. The EC observed in Nandurbar district shows that all the soils were non-saline in

nature and suitable for plant growth reported in Table 1. The EC greater than 1.0 dS m^{-1} showed the venture of soluble salts specified by Jackson (1967) [12]. The similar findings were reported by Golhar and Chaudhari (2013) [9] at Chalisgaon Tehsil of Jalgaon District, Maharashtra.

Organic carbon

The results in respect of organic carbon content in soils of Nandurbar district (Table 1) varied from 4.67 to 9.67 g kg^{-1} with average value of 7.18 g kg^{-1}. The tehsil wise organic carbon modification could be noticed. This might be allocation to the different types of soils, cropping pattern and use of organic manures to different crops. The overall content of organic carbon was observed to be moderate to high in Nandurbar district.

Moderate to moderately high organic carbon content it may be due to maximum temperature widespread during the summer under the semi-arid climate of Nandurbar district which favors for maximum rate of degradation of organic matter in soil.

Another reason for high availability of organic carbon in soils it may be due to thick vegetation and humid climate. This leads to addition of organic residues in the soil. The same natures of observations were recorded for organic carbon by Chaudhari and Kadu (2007) [8] in soils of Dhule Tehsil of Dhule District.

Free calcium carbonate

The result in respect of free calcium carbonate (Table 1) of soils varied from 1.45 to 5.63 per cent with mean of 3.55 which indicates that soils are slightly calcareous to calcareous in nature. The highest content of calcium carbonate was recorded in Nandurbar tehsil (5.63 %) followed by same (4.88 %) tehsils.

The high free lime content generally brings risks of lime-induced chlorosis in many crops due to alteration in the accessibility of essential nutrient specially micronutrients viz. Zn and Fe (Patil *et al.*, 2006) [25]. The similar nature of observation for $CaCO_3$ in soils by Golhar and Chaudhari (2013) [9] at Chalisgaon Tehsil of Jalgaon District, Maharashtra.

Micronutrient status in soil

Available zinc

The data of available zinc in various talukas of AESR 6.2 a Nandurbar district (Table 2 and Fig. 1) was observed between 0.36 to 2.12 mg kg^{-1} with mean of 1.04 mg kg^{-1}. The nutrient status of zinc (Table 3) in Nandurbar district were recorded 20, 67 and 13 per cent soil samples in low, medium and high category respectively. Close scrutiny of the data, showed that, the 20 percent zinc deficiency was observed in Nandurbar district and the nutrient index of zinc is 1.93 which is medium category

The similar findings were reported by Katkar and Patil (2010) [15] in soils of Vidarbha region of Maharashtra. The deficiency in available Zn it may be due to alkaline soil reaction and minimum organic matter status in soil, which acts as natural sequestering factor, The sufficiency of Zn is due to acidic pH and moderate to high organic carbon. Singh (2004) [35] also reported that, the DTPA-exactactable zinc status in Indian soil ranged from 0.1 to 5.9 mg kg^{-1}.

Available copper

The results of available copper in soils are (Table 2) varying from 0.89 to 7.89 mg kg^{-1} with mean of 4.00 mg kg^{-1}. The mean talukawise available copper showed no deficiency in almost all tehsils of Nandurbar district, it could be noticed that, in Nandurbar district maximum soil samples were categorized as high. The result in relation to nutrient indices are reported in Table 3 and revealed that nutrient indices value is 3.00 which is in high. The result showed that all the samples were adequate in available copper.

The results confirm the earlier findings were reported by Pulakeshi *et al.* (2012) [28] in soils of Mantagani village in north Karnataka. The sufficiency of available copper in soils of Nandurbar district it might be due to synergistic effect of soil properties like pH, EC and OC which have governing role in accessibility of Cu. Brar *et al.* (2008) [6] also showed the status of available copper from minimum to sufficient with wide variation in Indian soils.

Available iron

The results in respect of available iron in the soils of AESR 6.2 a Nandurbar district are reported in Table 2 and fig 2. The available iron in Nandurbar district was varied from 2.23 to 33.77 mg kg^{-1} with mean of 18.45 mg kg^{-1}. Most of the soils were observed under high category and very few soil samples having low to medium iron content.

The nutrient status of Fe reported in Table 3 and showed that the 13, 33 and 54 per cent soil samples were in low, medium and high status of iron in Nandurbar district. The deficiency of Fe was observed 13 per cent, while nutrient index of iron in Nandurbar district was recorded 2.40 which are categorized as medium.

The result showed that soils were deficient in an iron; it may be due to unavailability of iron under alkaline condition. The accessibility of iron is due to slightly acidic condition and availability of organic matter in soil. The similar results of Fe was reported by Nagendran and Angayarkanni (2010) [21] in soils of cumbum valley, Tamil Nadu. Meena *et al.* (2006) [20] noticed that available iron ranked from 2.23 to 14.16 mg kg^{-1} in Tonk district of Rajasthan.

Available manganese

The data in respect of available manganese in soils of AESR 6.2 a Nandurbar district are (Table 2)ranged from 10.02 to 35.25 mg kg^{-1} with mean of 23.13 mg kg^{-1} in Nandurbar district. The maximum available manganese was observed in Nandurbar tehsil of sample no. NB-15 (35.25 mg kg^{-1}), followed by Navapur taluka of sample no. NP-3 (34.78 mg kg^{-1}) of Nandurbar district.

Table 3 showed almost all tehsils of Nandurbar district showed available manganese in high category and it could be noticed that 100 per cent sufficiency of available manganese. The sufficiency of available manganese it may be due to high organic matter content under favorable soil reaction. Also the sufficient content of NPK is accountable for accessibility of manganese in soil. The similar results were supported by Hundal *et al.* (2006) [11]. Sharma *et al.* (2006) [30] also noted that DTPA extractable Mn in soils ranged from 0.96 to 12.9 mg kg^{-1}.

Available boron

Regarding the data of available boron in soils of Nandurbar district are (Table 2 and Fig.3) ranged from 0.12 to 1.5 mg kg^{-1} with mean of 0.86 mg kg^{-1}.The data reveals that the available boron observed deficient in Shahada tauka of SD-40 no. of sample (0.12 mg kg^{-1}) followed by Navapur tauka in sample No NP-3and NP-47 (0.38 mg kg^{-1}) and (0.48 mg kg^{-1}) respectively. Data in relation to nutrient deficiency of B was

found 27.00 per cent and the nutrient index was observed in medium (2.66) in Nandurbar district reported in Table 3.
The data indicate that the most of the soils observed sufficiency in available boron it may be due to rising level of soil organic matter and slight decline it may be due to inaccessibility of boron in alkaline pH of soil. Similar results were recorded by Arora and Chahal (2014) [2] in alkaline alluvial soils of Punjab.
Singh *et al.* (2005) [34] observed that water soluble boron in soils of Bihar varied from 0.04 to 7.67 mg kg^{-1} with average of 0.91 mg kg^{-1}. Patil and Shingte (1982) [24] reported that boron accessibility in drought prone area of Pune region of Maharashtra ranged from 0.14 to 2.7 mg kg^{-1}.

Secondary nutrient status in soil

Available sulphur

The data pertinent to sulphur in three tehsils of Nandurbar district are reported in Table 2 and fig.4. The available sulphur varied from 3.66 to 40.99 mg kg^{-1} with mean of 24.41mg kg^{-1}. InTable 3 the available sulphur status in Nandurbar district was showed 7, 20 and 73 per cent in low, medium and high category respectively. The high nutrient index (2.66) was observed in Nandurbar district. 7 per cent soil sample observed in deficient, while 20 and 73 per cent was sufficient in available sulphur. It could be due to moderate to high status of organic carbon and fine texture of soils.
Pradeep *et al.* (2006) [27] revealed the nutrient status of some groundnut growing soils of upper Krishna command area, Karnataka. They observed that the available sulphur varied from 4.32 to 20.12 mg kg^{-1} while Kumar *et al.* (2009) [17] surveyed the nutrient status in Santhal Paraganas areas of Jharkhand and sulphur observed to be range from 2.80 to 17.60 mg kg^{-1}.
Srinivasan *et al.* (2013) [36] revealed dispersion of macro and micronutrients in areas of South Kannada district of coastal Karnataka and resulted that sulphur in the soil varied from 6.25 to 20 mg kg^{-1}.

Exchangeable calcium

The data pertaining to exchangeable calcium in tehsils of Nandurbar district are reported in the Table 2. The exchangeable calcium in Nandurbar district was observed to vary from 20.44 to 36.1 cmol (p^+) kg^{-1} with mean of 26.57 cmol (p^+) kg^{-1}. Considering critical limit of available calcium is 20 cmol (p^+) kg^{-1}, all the soil samples were found 100 per cent sufficient in exchangeable calcium.
The sufficiency of exchangeable Ca it may be due to no percolation losses of bases. The same vogues were also noted by Nayak *et al.* (2006) [22] in black soil in Vertisol order in Vidarbha region.
Shetty *et al.* (2008) [32] stated that, exchangeable calcium varied from 1.9 to 5.5 cmol (p^+) kg^{-1} in maize growing areas of Southern Karnataka. While Srinivasan *et al.* (2013) [36]. They noticed exchangeable calcium ranged from 0.49 to 1.90 cmol (p^+) kg^{-1} in cashew growing areas of coastal Karnataka.

Exchangeable magnesium

The data in relation to exchangeable magnesium in Nandurbar district are reported in the Table 2.The exchangeable magnesium in Nandurbar district was observed to vary from11.78 to 18.72 cmol (p^+) kg^{-1} with mean of 15.15 cmol (p^+) kg^{-1}. Nandurbar district were found 100 percent sufficiency in exchangeable magnesium, as the critical limit of exchangeable magnesium is 10 cmol (p^+) kg^{-1}.The similar results were observed in swell-shrink soils of Nagpur District by Nayak *et al.(*2006) [22]. Shetty *et al.* (2008) [32] reported exchangeable magnesium ranged from 0.9 to 3.7 cmol (p^+) kg^{-1} in maize growing areas of southern transition zone of Karnataka, Whereas, Behera and Shukla (2013) [3] observed that the exchangeable magnesium ranges from 0.22 to 1.12 cmol (p^+) kg^{-1}.

Relationship of soil properties with available micro and secondary nutrients

The correlation among various soil properties in AESR 6.2 indicates that, pH was significantly and positively correlated with $CaCO_3$ (r=0.297**) and negatively correlated with Cu (r=-0.337**) and S (r=-0.236*), the organic carbon however non-significantly correlated with all properties and DTPA-micro nutrients except that DTPA-Cu (r=0.256*), where there exists a significant and positive correlation with organic carbon. The significant and positive correlation with DTPA-Cu and OC whereas, the relation between pH and $CaCO_3$ were positively correlated. Similar types of correlations were confirmatory by Thangasamy *et al.* (2005) [37] in red and black soils of Andhra Pradesh. The relation between pH and $CaCO^3$ were positively correlated (r=0.297**).
Similar types of correlations were confirmatory by Thangasamy *et al.* (2005) [37] in red and black soils of Andhra Pradesh. In AESR 6.2, calcium carbonate play role in regulating B, Zn and Cu accessibility in soil as it is evidenced from highest correlation coefficient of $CaCO_3$ and DTPA-Zn, Cu and B. Among micro nutrients DTPA-Cu, Fe Mn and B correlated significantly indicating synergism among these micronutrients. The DTPA-Fe showed negative correlation with soil pH (r=-0.209), $CaCO_3$ (r=-0.100) and Zn (r=-0.052) and positive correlation with O.C. (r=0.023). The DTPA-Fe content positive and significant correlation with DTPA-Mn (r=0.525**) and DTPA-Cu(r=0.583**).
The available Fe decreased significantly with rise in pH and $CaCO_3$. The DTPA-Zn showed negative and significant correlation with $CaCO_3$ (r= -0.228*). Similar results were reported by Katkar *et al.* (2013) [14]. A negative correlation of available Zn with soil pH (r =-0.089). The negative correlation with soil pH it may be due to their hastiness as hydroxides and carbonates consequently making them immobile and unavailable to the plants. Similar findings were reported by Shinde (2007) [33] while, it is observed positive correlation with organic carbon (r = 0.019). This could be allocating to the presence of organic matter that produce the Zn from the parent material and rise their solubility. The identical findings were also stated by Sharma *et al.* (2003) [31]. pH of soil was significantly and negatively correlated with DTPA- Cu and S which is evident by (r=-0.337**) and (r=-0.236*) respectively. This might be due to organic carbon forms soluble complexes with micronutrients which subsequently become available to plants Shah and Andrabi (2010) [29].

Conclusion

From the study it could be concluded that the soil of Nandurbar, Shahada and Navapur tehsils of Nandurbar district were slightly acidic to slightly alkaline in nature and normal in electrical conductivity medium to high in organic carbon and slightly calcareous to calcareous in calcium carbonate. Zn (20 %), Fe (13 %) B (27 %) and S (7 %) deficiency was observed, while Cu and Mn, were observed in sufficient range. The soils were sufficient in exchangeable Ca and Mg and available sulphur. Significant and positive correlation

with DTPA-Cu and OC whereas, the relation between pH and $CaCO_3$ were positively correlated. The DTPA-Fe content positive and significant correlation with DTPA-Mn (r=0.525**) and DTPA-Cu(r=0.583**).The high nutrient index value was observed in Cu, Fe, Mn and S, while, medium in Zn and B in Nandurbar district.

Table 1: Soil chemical properties in AESR 6.2 a Nandurbar (K4Dd4) district of Maharashtra

AESR	Sample No.	Soil Properties			
		pH	EC dS m^{-1}	OC (g kg^{-1})	$CaCO_3$ (%)
6.2 a Nandurbar					
Nandurbar	NB-1	7.99	0.39	5.38	4.88
	NB-15	6.78	0.16	7.10	3.69
	NB-21	7.60	0.34	6.92	5.63
	NB-32	7.41	0.31	5.48	4.59
	NB-44	7.90	0.23	5.96	4.13
Navapur	NP-3	7.89	0.37	4.67	1.88
	NP-16	7.81	0.43	7.52	3.00
	NP-27	6.88	0.28	6.88	3.71
	NP-36	7.69	0.44	8.73	3.13
	NP-47	7.33	0.43	8.50	2.81
Shahada	SD-4	7.83	0.51	7.67	3.63
	SD-10	6.45	0.31	8.80	2.18
	SD-21	7.93	0.52	7.89	4.43
	SD-30	7.75	0.51	6.58	1.45
	SD-40	7.88	0.51	9.67	4.18
	Min.	6.45	0.16	4.67	1.45
	Max.	7.99	0.52	9.67	5.63
	Mean	7.54	0.38	7.18	3.55

Table 2: Micro and secondary nutrient status in AESR 6.2 a Nandurbar (K4Dd4) district of Maharashtra

AESR	Sample No.	Micronutrients					Secondary Nutrients		
		Zn	Cu	Fe	Mn	B	S (mg kg^{-1})	Ex. Ca	Ex. Mg
		(mg kg^{-1})						cmol (p+) kg^{-1}	
6.2 a Nandurbar									
Nandurbar	NB-1	0.92	2.18	29.28	18.12	1.10	31.22	25.17	14.23
	NB-15	1.18	4.85	30.66	35.25	0.89	29.16	21.37	11.78
	NB-21	1.11	1.08	20.08	19.66	1.45	29.67	28.23	17.71
	NB-32	0.87	0.89	3.54	10.02	0.28	38.45	20.44	13.20
	NB-44	1.05	1.12	10.35	34.38	1.22	32.18	23.79	12.23
Navapur	NP-3	1.10	3.28	33.77	27.22	0.38	20.00	29.30	13.78
	NP-16	1.00	5.38	28.12	34.78	0.96	11.39	25.12	16.66
	NP-27	0.36	7.89	32.12	29.35	0.84	14.22	30.27	17.36
	NP-36	2.12	5.12	28.59	10.12	1.12	25.86	26.41	14.13
	NP-47	0.48	4.70	19.55	29.00	0.48	10.63	36.10	18.72
Shahada	SD-4	0.66	5.28	6.67	24.88	0.77	3.66	28.38	16.32
	SD-10	0.41	6.08	2.23	10.11	0.89	30.42	22.12	14.10
	SD-21	1.58	4.48	15.78	10.10	1.50	23.82	28.17	17.78
	SD-30	1.88	3.00	7.77	33.21	0.98	40.99	26.42	15.12
	SD-40	0.89	4.69	8.38	20.80	0.12	24.48	27.29	14.23
	Min.	0.36	0.89	2.23	10.02	0.12	3.66	20.44	11.78
	Max.	2.12	7.89	33.77	35.25	1.5	40.99	36.1	18.72
	Mean	1.04	4.00	18.45	23.13	0.86	24.41	26.57	15.15

Table 3: Per cent sample deficient, nutrient status and nutrient indices in Agro ecological sub-region 6.2 a (K4Dd4) Nandurbar district of Maharashtra

AESR	No. of Sample	Per cent sample Deficient	Number of samples			Nutrient Indices	Fertility rating
			Low	Medium	High		
1	2	3	4	5	6	7	8
6.2 a Nandurbar							
Available Zn		20	3 (20)	10 (67)	2 (13)	1.93	Medium
Available Cu		0	0 (0)	0 (0)	15 (100)	3.00	High
Available Fe	15	13	2 (13)	5 (33)	8 (54)	2.40	High
Available Mn		0	0 (0)	0 (0)	15 (100)	3.00	High
Available B		53	4 (27)	6 (40)	5 (33)	2.06	Medium
Available S		0	1 (7)	3 (20)	11 (73)	2.66	High

Table 4: Relationship of soil properties with available micro and secondary nutrients

	pH	OC	$CaCO_3$	Zn	Cu	Fe	Mn	B	S
pH	1								
OC	-0.202^{NS}	1							
$CaCO_3$	0.297**	-0.185^{NS}	1						
Zn	-0.089^{NS}	0.019^{NS}	-0.228*	1					
Cu	-0.337**	0.256*	-0.279*	0.044^{NS}	1				
Fe	-0.209^{NS}	0.023^{NS}	-0.100^{NS}	-0.052^{NS}	0.583**	1			
Mn	0.044^{NS}	0.016^{NS}	-0.059^{NS}	-0.186^{NS}	0.486**	0.525**	1		
B	-0.204^{NS}	0.047^{NS}	-0.295*	0.341**	0.072^{NS}	0.149^{NS}	0.066^{NS}	1	
S	-0.236*	-0.131^{NS}	-0.144^{NS}	-0.037^{NS}	-0.129^{NS}	0.054^{NS}	-0.205^{NS}	0.074^{NS}	1

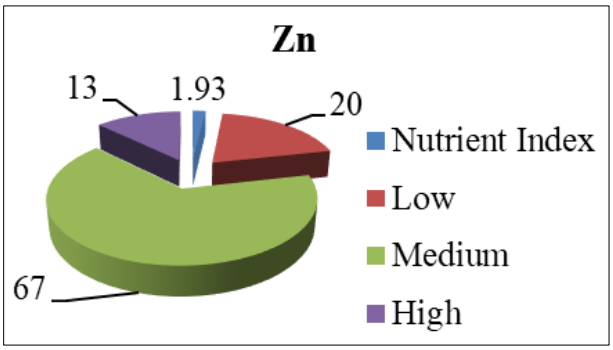

Fig1: Status of available zinc in Nandurbar district

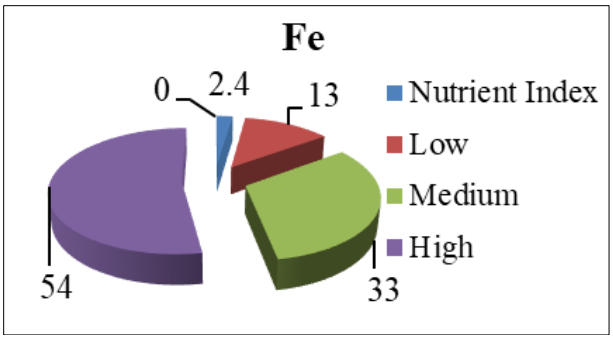

Fig 2: Status of available Fe in Nandurbar district

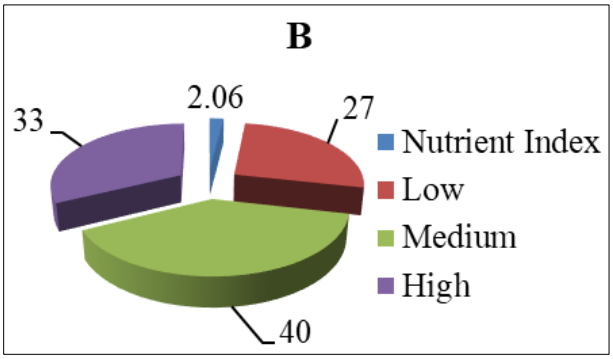

Fig 3: Status of available B in Nandurbar district

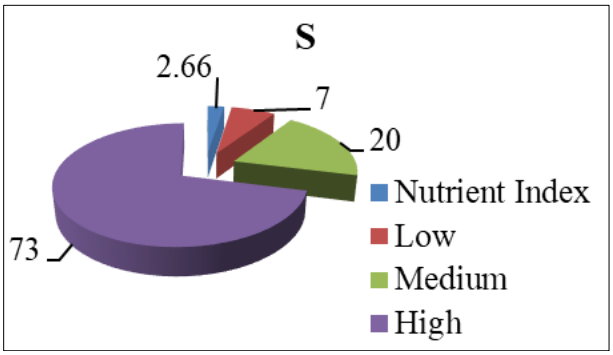

Fig 4: Status of available S in Nandurbar district

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