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Physico-chemical characteristics and status of available micro and secondary nutrients in soils of agro-ecological-sub-region 6.2 c (K4Dd4) Latur district of Maharashtra

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Abstract
The study of soil survey was carried out during the year 2017-18 to 2018-19 in Nilanga tehsil of Latur district (M.S) India by using GPS techniques in Agro-Ecological-Sub-Region of (AESRs) Latur district namely, AESR 6.2 c (K4Dd4). AESR 6.2 c 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 five soil samples collected from Nilanga tehsil in latur district were analyzed for their fertility and micronutrient status. The exact locations of soil samples were recorded by the help of Global Positioning System (GPS). The result revealed that the soil of Nilanga tehsil shows clay is greater hence it comes under clay type textural classification. All the soil samples neutral to moderately alkaline in reaction (7.50-8.34), electrical conductivity are non–saline (0.12-0.33 dS m^{-1}), low to moderately high in organic carbon (3.86-7.54g kg^{-1}) and calcium carbonate ranged from 4.25- 8.13 per cent and showed soils are moderately calcareous to calcareous in nature. Regarding micro and secondary nutrients, The DTPA-extractable zinc, copper, iron, manganese and boron varies from 0.39-0.87, 3.61-10.08, 18.32-32.00, 30.62-65.94 and 0.28-0.55 mg kg^{-1} with mean of 0.56, 6.04, 28.69, 46.98 and 0.37 mg kg^{-1} respectively, while, exchangeable Ca (14.65-31.45cmol (p^+) kg^{-1}) and Mg (12.12-27.65cmol (p^+) kg^{-1}) with mean of 23.32 and 20.63 cmol (p^+) kg^{-1}respectively, and found sufficient. The available sulphur varies from 10.18-14.58 with mean of 12.43 mg kg^{-1} was found medium in soil. The soils of Nilanga tehsils of Latur districts were 60 and 80 per cent deficient of zinc and boron respectively. However, the copper, iron and manganese were found sufficient, Nutrient indices values were noted high in copper, iron, and manganese and medium in sulphur.

Keywords: Chemical and physical properties, micro and secondary nutrient, 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) [27].
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 use of high analysis fertilizers in exhaustive cropping scheme with minimal use of organic manures (Challa *et al*., 1995) [6].
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.

In India, (Mandal *et al*., 2014) [21] various actions were formulated in the last to justify the soil area into weather areas. Krishnan and Singh (1968) [16] specified soil climatic zones by overlaying wetness indicator and mean air warmth isopleths on wide soil forms of India. Murthy and Pandey (1978) [23] suggested a design with eight AERs based on geography, climate, moist soils and agricultural zones. The two techniques begin of agro-ecological region of the country. Though endure from different constraints. The zones, possessing various geology, temperature and lands in zone. Behind the concept of indicator of wetness adequacy, Subramaniam (1983) [39] specified 29 AEZs with 36 blends of IMA and predominant earth sets of FAO/UNESCO soil charts (1974) [8]. Eastern Himalayas were grouped in one AER. Likewise; Jammu and Kashmir, Himachal Pradesh and northwestern Uttar Pradesh also were grouped into the same region (Velayutham, *et al.* 1999) [41].

Materials and Methods

AESR 6.2 c is characterized by Deccan Plateau, soils is shallow and medium (inclusion deep) black soils, semi- arid dry and situated at Deccan Plateau in between 17° 37' 39"N latitude and 76° 40' 55" E longitude at an altitude of 616 m above msl has been classified under semi-arid dry eco-sub-region.

Geo-referenced surface (0-20 cm depth) soil samples representing different soils were collected Nilanga tehsil during 2017-18 and 2018-19 in Latur 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 Nilanga tehsil. So the sampling sites scattered uniformly in Nilanga tehsils of the Latur district. 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.

The soil textural classifications were measured by Bouyoucos Hydrometer methods as described by Bouyoucos (1979) [4]. Soil pH was determined with the help of pH meter in 1:2.5 soils: water suspension as described by Jackson (1973) [12]. Organic carbon was determined by Walkley and Black wet-oxidation method as described by Nelson and Sommer (1982) [25]. Calcium carbonate was determined by rapid titration method as given by Piper (1966) [32]. 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) [2]. 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) [43].

Results and Discussion

Physical properties of soil

Soil Texture

Soil texture is a qualitative classification tool used in both the field and laboratory to determine the classes for agricultural soils based on their physical texture. Soil in different regions shows different texture, the texture of the soil is mostly depends upon the size of particles. Soil texture shows its effect on aeration and root penetration. It also effect on the nutritional status of soil.

In AESR 6**.**2 cit is observed that clay percentage in the soil greater than sand and silt in Nilaga tehsil of Latur district and revealed that 9.33 percent sand, 32.90 percent silt and 57.77 percent clay. Nilanga tehsil of Latur district shows clay is greater hence it comes under clay type textural classification. In Latur district of Marathwada region there is a good rainfall. The higher clay content in soils is allocation to basaltic parent material responsible for greater clay on weathering (Murthy *et al*. 1994) [22].

Soil reaction (pH)

The results pertaining to the soil pH of Nilanga tehsil of Latur district are noted in Table 2. The soil pH of Latur district varied from 7.5 to 8.34 with mean of 7.94 showing neutral to moderately alkaline in reaction. The higher and lower pH was recorded in Nilanga tehsil 8.34 and 7.50 respectively. The alkaline nature of soil is likely to be the presence of adequate free lime in soil (Kaushal *et al*., 1980) [15].The most of the area have alkaline in nature soil in Latur district. The relative high value of pH of these soils might be due to high degree of base saturation (Mali and Raut, 2001) [20].

The slightly alkaline pH of soils as recorded in the present study may ascribe to the calcareous nature of these soils. Similar finding were also noted by Bhargava and Raghupati (1994) [3].

Electrical conductivity (EC)

The data in relation to electrical conductivity of soils reported in Table 2. The EC varied from 0.12 to 0.33 dS $m^{-1}$with mean of 0.24 dS m^{-1}. The EC noticed in Latur district shows that all the soils are non-saline in nature and suitable for healthy plant growth. The EC greater than 1.0 dS m^{-1} showed the hazard of soluble salts justified by Jackson (1967) [13].

The low EC in these soils it may be due to good management of soil and thereby percolation of salt takes place from surface to sub-surface. The same results are in agreement with the findings recorded by Padole and Mahajan (2003) [26].

Organic carbon

The organic carbon contents in soils of Latur district (Table 2) varied from 3.86 to 7.54 g kg^{-1} with mean value of 5.46 g kg^{-1}. The higher organic carbon content (7.54) was observed in sample no. NI-2 and lower in sample no.NI-26 in Nilanga tehsil. There exist large variations in the organic carbon content in soils of Latur district. Organic carbon contents, low to moderately high in Nilanga tehsil of latur district. This might be attributed to the different types of soils, cropping pattern and use of organic manures to different crops. The lowest of organic carbon in Latur district it might be due to loss of organic matter due to high temperature under such prevailing climatic condition in SAT.

Similar findings pertaining to loss of organic matter were reported by Pharande *et al.* 1996 [31], and reported that the variations in organic carbon content in soils it may be due to maximum temperature of Latur district (39^0 C) which is responsible for accelerating the rate of oxidation, as well as very small addition of organic matter and crop residues in the soil.

Free calcium carbonate

The data regarding free calcium carbonate are discussed in Table 2. The $CaCO_3$ of soils varied from the 4.25 to 8.13 per cent with mean of 6.56 which showed that soils are moderately calcareous to calcareous in nature. The highest content of calcium carbonate was recorded in sample no NI-2 (8.13 %) and lowest in sample no NI-5 (4.25) of Nilanga tehsils.

The moderate to calcareous $CaCO_3$ content in the soils it may be due to the presence of $CaCO_3$ in various ratings and in crystal form with hyper thermic temperate regime of Latur district. Similar observations were examined by Ghuge (2002) [9].The high free lime content generally brings risks of lime-induced chlorosis in many crops due to alteration in the availability of essential nutrient specially micronutrients viz. Zn and Fe (Patil *et al.*, 2006) [29].

Micronutrient status in soil

Available zinc

The data pertaining to available zinc in Nilanga Tehsil of AESR 6.2 c in Latur district (Table 3 and Fig. 1). The available zinc varied from 0.39 to 0.87 mg kg^{-1} with mean of 0.56 mg kg^{-1}. The data in Table 4 reported that 60 and 40 percent soil samples were found in low and medium status of zinc respectively. Close analysis of the result showed that the 60 per cent zinc deficiency was observed in Nilanga tehsil of Latur district.

The deficiency of Zn in Latur district it might be due to fact that under alkaline condition Zn cations charged largely to their oxides or hydroxides and thereby lesser the availability of Zn. Similar outcomes stated by Patil and Sonar (1994) [30].

Available copper

The data regarding the available copper are reported in Table 3. The available copper contents ranged from 3.61 to 10.08 mg kg^{-1} with the mean of 6.04 mg kg^{-1} indicating no deficiency of available copper in Latur district. Data in relation to nutrient status and nutrient indices were presented in Table 4, and resulted that, almost all the soil samples in Latur district were categorized as high. The data in respect of nutrient indices was recorded as 3.00 and comes under high category and there was no deficiency found in available copper in Latur district.

The soils of Latur district content 100 per cent sufficiency of available Cu, it may be due to the presence of Cu minerals like Cuprite and Chalcosite etc. in parent material. The same results are in agreement with the findings reported by Patil and Meisheri (2004) [28].

Patil and Sonar (1994) [30] also reported that in black soils of Maharashtra, available Cu was in the range of 0.58 to 1.7 mg kg^{-1}. Verma *et al.* (2005) [42] also showed that DTPA-Cu ranged from 0.04 to 1.44 mg kg^{-1}. Brar *et al.* (2008) [5] also, showed that the position of available copper from minimum to sufficient with wide variation in Indian soils.

Available iron

The data of available iron in the soils of AESR 6.2 c in Latur district are reported in Table 3. The available iron was reported ranging between 18.32 to 32 mg kg^{-1} with the mean value of 26.89 mg kg^{-1}. The mean tehsilwise available iron was 4.5 mg kg^{-1} indicating no deficiency of available iron in Nilanga tehsil of Latur district.

The data presented in Table 4 showed that the 100.00 per cent soil samples were found in high status of iron in Latur district. The nutrient index of iron in Latur district was also recorded 3.00 which are categorized as high.

The minerals of feldspar, magnetite, hematite and limonite, which binding together constitutes bulk of trap rock in these soils which constitute to increasing the levels of iron in soil were reported by Malewar and Ismail (1999) [19].

The available Fe in the soils of Vertisol order of Maharashtra State, it varied from 3.52 to 19.44 mg kg^{-1} was reported by Pharande *et al.* (1996) [31]. The same findings are also reported with the findings of Hundal *et al.* (2006) [11].

Available manganese

The data pertaining to available manganese in soils of AESR 6.2 c Latur district are reported in Table 3.The available manganese was found varied from 30.62 to 65.94 mg kg^{-1} with mean of 46.98 mg kg^{-1} in Latur district. Latur district showed available manganese in high category. The highest value available manganese was found in Nilanga tehsil of sample no. NI-17 (65.94 mg kg^{-1}) and lowest value of available manganese was recorded in sample no. NI-20 (30.62 mg kg^{-1}) of Latur district.

The data of nutrient status and nutrient index value are reported in Table 4, and showed that 100 per cent soil samples in Latur district were categorized as high and nutrient indices also high (3.00).

The similar findings of available Mn were resulted in the soils of Ladakh (Dwivedi *et al.*, 2005) [7]. Sharma *et al.* (2006) [34] also stated that DTPA extractable Mn in soils ranged to 0.96 to 12.9 mg kg^{-1}.

Available boron

The data in relation to available boron in the soils of Latur district (Table 3 and Fig. 2) was found in the range of 0.28 to 0.55 mg kg^{-1} with mean of 0.37 mg kg^{-1}. The data reveals that 80 percent soil samples in Latur district were found deficient, while, 20.00 per cent soil samples were found in medium with the value of nutrient indices is 1.20 which was found low and reported in Table 4.

In general soils were medium in available boron content the reason for the same is that generally soils derived from granite and basalt has lower content of available boron.

Majority of soils are found deficient in available B status. The maximum quantity of $CaCO_3$ and alkaline pH of soil produce the insufficiency of boron in soils is the major reason of shortage of boron in soil. Sufficiency of boron, it may be due to increase the soil organic matter with the addition of crop residues, animal waste etc.

Singh *et al.* (2005) [36] resulted that hot water soluble boron in soils of Bihar varied to 0.04 to 7.67 mg kg^{-1} with mean value of 0.91 mg kg^{-1}. Patil and Shingte (1982) [27] also reported that boron availability in drought prone area of Pune region of Maharashtra and ranged from 0.14 to 2.7 mg kg^{-1}.

Secondary nutrient status in soil

Available sulphur

The data pertaining to available sulphur in Nilanga tehsils of Latur district are reported in the Table 3. The available sulphur observed varied from 10.18 to 14.58 mg kg^{-1} with mean value of 12.43 mg kg^{-1}. The available sulphur in Latur district showed 100 per cent soil samples in medium category. Nutrient indices of available sulphur were 2.00 which are categorized as medium in Table 4.

However, availability of available sulphur is directly commensurate to the organic matter content of the soil. The similar results were found by Jat and Yadav (2006) [14] in soils of Entisols of Jaipur District, Rajasthan and Singh and Singh (2007) [37] in soils of mid-Western Uttar Pradesh. The result showed most of the soils are adequate in range, it may be due to moderate to high content of organic carbon in soil and fine texture of soils.

Pradeep *et al.* (2006) [33] studied the nutrient contents of some groundnut growing soils of upper Krishna command area, Karnataka and observed that the available sulphur ranged from 4.32 to 20.12 mg kg^{-1} while Kumar *et al.* (2009) [17] evaluated the nutrient status in Santhal Paraganas area of Jharkhand and sulphur found to range from 2.80 to 17.60 mg kg^{-1}.

Exchangeable calcium

The data pertaining to exchangeable calcium in tehsils of Latur district are reported in Table 3. The exchangeable calcium in Latur district was found to vary from 14.65 to 31.45 cmol (p^+) kg^{-1} with mean of 23.32 cmol (p^+) kg^{-1}.

The similar trends also reported by Nayak et al. (2006) [24] in Vertisol order in Vidarbha region and Tripathi and Sawarkar (2007) [40] in soils of Vertisol order and pedons of Kygreater plateau in Jabalpur District. The higher amount of exchangeable Ca content found in soils under study it may be due to high amount clay particles and calcareous nature of soil and no leaching of bases.

Shetty *et al.* (2008) [35] reported that the exchangeable calcium ranged from 1.9 to 5.5 cmol (p^+) kg^{-1} in maize growing areas of Southern Karnataka. While, Srinivasan *et al.* (2013) [38] noticed exchangeable calcium varied from 0.49 to 1.90 cmol (p^+) kg^{-1} in cashew growing soils of coastal Karnataka.

Exchangeable magnesium

The data pertaining to exchangeable magnesium in Latur district are reported in Table 3.The exchangeable magnesium in Latur district was found to vary from 12.12 to 27.65 cmol (p^+) kg^{-1} with mean of 20.63cmol (p^+) kg^{-1}.

All soil samples of Nilanga tehsils were found 100 per cent sufficiency of exchangeable magnesium. The highest exchangeable magnesium 27.65 [c mol (p^+) kg^{-1}] was recorded in sample no. NI-26 in Nilanga tehsil of Latur district and lowest 12.12 [cmol (p^+) kg^{-1}] in sample No. NI-20 in Nilanga tehsil of Latur district. The similar results were recorded by Nayak *et al.* (2006) in black soil of Vertisol order in Vidarbha region. The sufficiency of magnesium it may be due to its genesis in the semiarid area. The sufficiency of exchangeable Mg is due to no leaching of bases.

Shetty *et al.* (2008) [35] reported exchangeable magnesium varied from 0.9 to 3.7 cmol (p^+) kg^{-1} in maize growing areas of southern transition zone of Karnataka, Whereas, Behera and Shukla (2014) [1] observed that the exchangeable magnesium ranged from 0.22 to 1.12 cmol (p^+) kg^{-1}.

Table 1: Particle size distribution (%) of AESR 6.2 c ((K4Dd4) agro-ecological-sub-regions of Latur district of Maharashtra

AESR	Taluka	Sample No	Particle size distribution (%)			Textural class
			Sand	Silt	Clay	
1	2	3	4	5	6	7
6.2 (K4Dd4)						
6.2 c Latur	Nilanga	NI-2	9.33	32.90	57.77	Clay

Table 2: Soil chemical properties in AESR 6.2 c Latur (K4Dd4) district of Maharashtra

AESR	Sample No.	Soil Properties			
		pH	EC dS m^{-1}	OC (g kg^{-1})	$CaCO_3$ (%)
6.2 c Latur					
Nilanga	NI-2	7.88	0.12	7.54	8.13
	NI-5	8.34	0.18	4..37	4.25
	NI-17	7.78	0.33	5.10	5.42
	NI-20	7.50	0.29	6.46	6.88
	NI-26	8.22	0.32	3.86	8.13
	Min.	7.5	0.12	3.86	4.25
	Max.	8.34	0.33	7.54	8.13
	Mean	7.94	0.24	5.46	6.56

Table 3: Micro and secondary nutrient status in AESR 6.2 c Latur (K4Dd4) district of Maharashtra

AESR	Sample No.	Micronutrients (mg kg^{-1})					Secondary Nutrients		
		Zn	Cu	Fe	Mn	B	S (mg kg^{-1})	Ex. Ca	Ex. Mg
6.2 c Latur								cmol (p^+) kg^{-1}	
Nilanga	NI-2	0.41	6.22	31.87	44.58	0.55	13.13	25.87	23.56
	NI-5	0.52	4.77	21.58	51.10	0.29	11.84	31.45	25.32
	NI-17	0.39	10.08	32.00	65.94	0.41	12.42	17.22	14.52

	NI-20	0.87	3.61	18.32	30.62	0.34	14.58	14.65	12.12
	NI-26	0.63	5.55	30.72	42.66	0.28	10.18	27.45	27.65
	Min.	0.39	3.61	18.32	30.62	0.28	10.18	14.65	12.12
	Max.	0.87	10.08	32.00	65.94	0.55	14.58	31.45	27.65
	Mean	0.56	6.04	26.89	46.98	0.37	12.43	23.32	20.63

Table 4: Per cent sample deficient, nutrient status and nutrient indices in Agro ecological sub-region 6.2 c (K4Dd4)

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 c Latur	05						
Available Zn		60	3(60)	2(40)	0(0)	1.40	Low
Available Cu		0	0(0)	0(0)	5(100)	3.00	High
Available Fe		0	0(0)	0(0)	5(100)	3.00	High
Available Mn		0	0(0)	0(0)	5(100)	3.00	High
Available B		80	4(80)	1(20)	0(0)	1.20	Low
Available S		0	0(0)	5(100)	0(0)	2.00	Medium

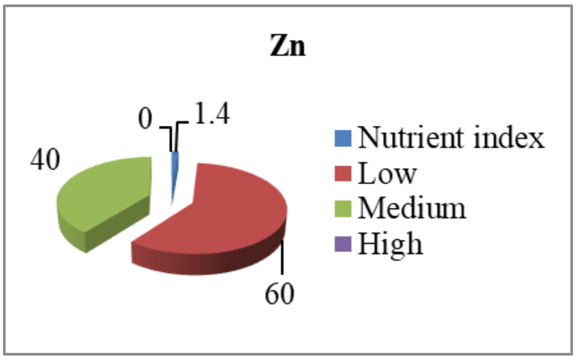

Fig1: Status of available zinc (%) in Nilanga tehsil

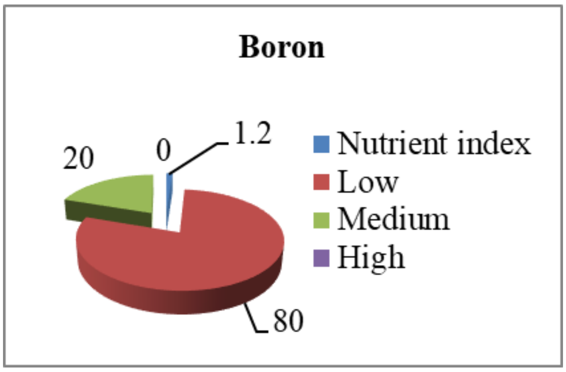

Fig 2: Status of available B (%) in Nilanga tehsil

From the study, it can be concluded that, soils of Nilanga tehsil was found clayey in texture, neutral to moderately alkaline in reaction, non saline in nature, low to moderately high in organic carbon and moderately calcareous to calcareous in calcium carbonate. The soils were categorized as low in zinc and boron, high in copper, iron and manganese, medium in available sulphur and sufficient in exchangeable calcium and magnesium.

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