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PN Magare
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

BK Farkade
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Deven Deshmukh
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Corresponding Author
PN Magare
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Assessment of micro and secondary nutrient indices in soils of Amravati District under Agro-Ecological-Sub-Region 6.3 a (K5Dm4) (Maharashtra)

PN Magare, BK Farkade and Deven Deshmukh

Abstract
The study of soil survey was carried out during the year 2017-18 to 2018-19 in Amravati district (M.S) India by using GPS techniques in Agro-Ecological-Sub-Region (AESRs) of Amravati district namely, AESR 6.3 a (K5Dm4). AESR 6.3 a is characterized by Deccan Plateau, dominantly black soils, hot semi-arid and length of growing period 180-210 days, moderately well drained soil. For this purpose 15 representative soil samples (0-20 cm) were collected from different villages of three tehsils of Amravati district. These soil samples were analysed for soil properties and micronutrient fertility status of soil. The exact locations of soil samples as well as latitude, longitude and altitude were recorded by the help of Global Positioning System (GPS).The soils under the study of Amravati district were alkaline in nature, safe in limit of electrical conductivity and moderately calcareous to calcareous in nature.However,DTPA-Cu, Fe and Mn was recorded in high quantity, while DTPA-Zn medium ranged.The DTPA- Zn indicated negative and significant relationship with $CaCO_3$ (r= -0.317*) while, DTPA-Zn was positively and significant correlation with B (r=0.632**). Exchangeable Ca was found sufficient while, exchangeable Mg and available S were found in medium. According to nutrient index value of the soils of Amravati district were found in medium category for available Zn, Fe, boron and sulphur while high with respect to available Cu and Mn.

Keywords: Soil fertility, Soil Nutrient Index, Zn, Fe, Mn, Cu, B and S

Introduction

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 use of high analysis fertilizers in exhaustive cropping scheme with minimum use of organic manures (Challa *et al*., 1995) [6].

The Maharashtra state has 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 micronutrients are also important just like macronutrients. Arnon and Stout (1939) [1] articulated the deficiency 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. Micronutrient deficiencies that appear to be localized at present era may expand geographically in the near future posing threat to the production system (Bhuyan *et al*., 2014) [5]. As such it is important to estimate and monitor the micronutrient status/deficiencies in different agro ecological sub regions to forecast potential micronutrient problems in order to evaluating fertility status of different soil crop situation. Keeping these in view and also lack of information on micronutrients status to identify the emerging micronutrient deficiency or toxicity in the soils, therefore a comprehensive study was undertaken to know the micronutrient indices and its fertility status in soils of Amravati district.

Materials and Methods

AESR 6.3 a is characterized by Deccan Plateau, dominantly black soils, hot semi- arid and length of growing period 180-210 days, moderately well drained soil and situated at Deccan Plateau in between 21° 32' 616"N latitude and 77° 25' 340" E longitude at an altitude of 363m above msl of Dharni, 21° 15' 295"N latitude and 77° 26' 545" E longitude at an altitude of 401m above msl of Achalpur and 21° 07' 425"N latitude and 77° 11' 600" E longitude at an altitude of 307 m above msl of Anjangaon Surji tehsils has been classified under hot semi-arid ecosystem.

Geo-referenced representing surface (0-20 cm depth) soil samples were collected tehsil wise during 2017-18 and 2018-19 of Amravati 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 tahsils of the 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. Soil pH was determined with the help of pH meter in 1:2.5 soils: water suspension as described by Jackson (1973) [10]. Organic carbon was determined by Walkley and Black wet-oxidation method as described by Nelson and Sommer (1982) [21]. Calcium carbonate was determined by rapid titration method as given by Piper (1966) [29].The micronutrients in these soil samples were extracted with DTPA solution (Lindsey and Norvell, 1978) [15]. 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) [8]. 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) [23].

Results and Discussion

Chemical properties of soil

Soil reaction (pH)

The soil pH of Amravati district were (Table 1 and fig.1) ranged from 6.30 to 8.66 with mean values of 7.73 showing moderately acidic to moderately alkaline in reaction. The highest pH was noted in Nimdari-2 village of Achalpur tehsil (8.66) while lowest in Matkur village of Dharni tehsil (6.30). The alkaline reaction of soil it might be due to the presence of sufficient free lime content in soil (Kaushal *et al*., 1980) [14]. The most of the area have alkaline soil in Amravati district. Similar findings were noted by Kadu (2007) [12]. The pH is higher due to increase in accumulation of exchangeable sodium and calcium carbonate. In semi-arid region, since rainfall is less as compared to annual evapo-transpiration, leaching of insoluble carbonates and bicarbonates of calcium could not be possible under such situation.

Electrical conductivity (EC)

The electrical conductivity of Amravati district were (Table 1) showed all the soils were non-saline indicating optimum range which is suitable for plant growth. Contrarily, EC greater than 1.0 dS m^{-1} showed the threat of soluble salts specified by Jackson (1967) [11]. Similar findings were reported by Waikar *et al*. (2004) [37] they found that slightly higher EC in the soils it might be due to formation of soils from basaltic parent material rich in basic cation.

Organic carbon

The organic carbon content in soils (Table 1 and fig.1) ranged from 3.98 to 7.35 g kg^{-1} with the mean value of 5.62 g kg^{-1} indicating tehsil wise organic carbon variation. This might be attributed to the different types of soils, cropping pattern and use of organic manures to different crops. The overall content of organic carbon was found to be low to moderately high in Amravati district which showed that the application of organic manures to different crop by the farmers might be reduced. In Dharni tehsil the organic carbon content was noticed in moderately high category. The high content of organic carbon status soils it might be due to thick vegetation and humid climate helps to preserve soil organic carbon. The surface of any soil normally received continuous fresh addition of organic matter due to residues as well as this layer also receives addition of organic matter in the form of FYM and compost, it could be the reason for higher content of organic carbon in surface layer. The low content of organic carbon it might be due to loss of organic carbon through the process of oxidation under prevailing climatic condition especially in the soils of arid and semiarid climate. Similar findings of organic carbon were investigated by Patil *et al*. (2008) [26] at Pune.

Free calcium carbonate

The free calcium carbonate in soils of Amravati district (Table 1 and fig. 1) varied from the 2.38 to 9.88 per cent with the mean of 5.79 which indicates that soils are moderately calcareous to calcareous in reaction. The high status of calcium carbonate was recorded in Nimdari-3 village of Achalpur (9.88%) followed by Kumbhargaon-4 village in Anjangaon (9.63%) tehsils. 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) [25]. Deb *et al.*, 2009 [7] the high calcium carbonate is harmful as it reduces the concentration of micronutrient cation in soil to such a level that a sensitive plant may suffer from the deficiency of micronutrients.

Micronutrient status in soil

Available zinc

The data of available zinc in various talukas of AESR 6.3 a Amravati district (Table 1 and fig. 2) was found in the range of 0.33 to 2.34 mg kg^{-1} with mean value of 1.31 mg kg^{-1}. In Table 37, Amravati district 27, 47 and 27 per cent soil samples are found in low, medium and high nutrient status respectively, indicating about 74 per cent soil samples were low to medium in available zinc. The nutrient index of available zinc was found to be 2.13 which imply that the available zinc status was mostly medium in range. The similar findings were stated by Katkar and Patil (2010) [13] in the soils of Vidarbha region of Maharashtra.

The deficiency in available Zn it might be due to alkaline soil reaction and low organic matter status in soil, which play as natural chelating agent. In Amravati district some of the areas of different tehsils found soils are slightly acidic pH and moderate to high organic carbon causes the sufficiency of Zn was found. Meenakshi *et al.* (2005) [18] noted the similar trends of DTPA-Zn, status in soils of Patiala District.

Available copper

The available copper in soils of Amravati district (Table 1) found that copper varied from 0.78 to 5.42 mg kg^{-1} with the mean of 3.37 mg kg^{-1}. No deficiency was found almost all talukas of Amravati district and recorded in Table 02 and also indicated that, maximum soil samples were categorized as high and high nutrient index (2.93) was observed in copper. The data showed that all the samples were sufficient in available copper. Similar findings were also recorded by Pulakeshi *et al.* (2012) [32] in soils of Mantagani village in north Karnataka. The sufficiency of available copper in soils of Amravati district it might be due to interactive effect of soil properties like pH, EC and OC which have role in regulating availability of Cu. Patil and Sonar (1994) [28] also observed similar findings in related to available Cu in swell-shrink soils of Maharashtra, and in the range of 0.58 to 1.7 ppm.

Available iron

The available iron in the soils of AESR 6.3 a of Amravati district noted in Table 1 and fig.2and found in the range of 5.26 to 26.52 mg kg^{-1} with the mean of 13.40 mg kg^{-1}. Soil nutrient status were found 73 per cent in medium and 27 per cent in high category. There was no deficiency of iron found in Amravati district. The nutrient status and nutrient index of iron were recorded as medium (2.26) in Table 2. The sufficiency of available iron in soil, it might be due to high organic matter content in the soil. The higher content of iron in soils of Amravati district is due to slightly acidic condition and organic matter status present in soil. The similar output of Fe was found by Nagendran and Angayarkanni (2010) [19] in soils of cumbum valley, Tamil Nadu.

Available manganese

The data in respect of available manganese in soils of AESR 6.3 a Amravati district are presented in Table 1 and found to vary from 5.68 to 35.41 mg kg^{-1} with mean of 16.21 mg kg^{-1} in Amravati district. The maximum available manganese was found in village of Taroda-1 in Anjangaon-Surgi taluka (35.41 mg kg^{-1}), followed by Nimdari-2 village of Achalpur taluka (22.52 mg kg^{-1}) of Amravati district. In Table 2 found that 13 and 87 per cent soil samples were categorized as medium and high nutrient status while, high (2.86) nutrient index was observed. The sufficiency of available manganese it might be due to high organic matter content under optimum soil reaction. Also the sufficient content of NPK is responsible for availability of manganese in soil. The similar results were reported by Katkar & Patil (2010) [13] in soils of Vidarbha region.

Available boron

Table 1 and fig. 2 indicated the boron status of soils of Amravati district and found in the range of 0.18 to 1.32 mg kg^{-1} with mean of 0.70 mg kg^{-1}. The data reveals that the available boron found deficient (0.18 mg kg^{-1}) in Ambada-1 village of Achalpur tehsil followed by Dhodra-2 village of Dharni taluka (0.21 mg kg^{-1}). The deficiency of boron was found 33 per cent and the nutrient index value of boron was medium (1.86) in Amravati district (Table 2). The high amount of $CaCO_3$ in soil and alkaline pH it might be due to deficiency of boron occur in soil.

Sufficiency of boron it might be due to high soil organic matter content. The data indicate that the majority of soils found sufficient in available boron it might be due to increased level of soil organic matter and slight deficiency can be due to high pH which makes B unavailable under such soil. Similar findings were observed by Arora and Chahal (2014) [2] in alkaline alluvial soils of Punjab. Similar findings were found by Patil and Shingte (1982) [24] in boron availability in the soils of Pune region of Maharashtra and boron ranged from 0.14 to 2.7 mg kg^{-1}.

Secondary nutrient status in soil

Available sulphur

The data of available sulphur (Table 1 and fig.3) ranged from 9.58 to 29.99 mg kg^{-1} with mean of 18.04 mg kg^{-1}. Nutrient status of sulphur (Table 2) was showed 7, 60 and 33 per cent in low, medium and high category respectively. The nutrient index of S was observed in medium (2.77). The sufficiency of sulphur found all tehsils of Amravati district. The data showed most of soils were sufficient in range; it might be due to moderate to high organic carbon status and fine texture (clay) of soils. The similar findings were found by Nayak *et al.* (2006) [20] in swell-shrink soils of black soil (Vertisol order) in Vidarbha region. Pradeep *et al.* (2006) [30] studied the nutrient status of some groundnut growing soils of upper Krishna command area, Karnataka and found that the available sulphur ranged from 4.32 to 20.12 mg kg^{-1}.

Exchangeable calcium

The highest exchangeable calcium 40.11 [cmol (p^+) kg^{-1}] was found in soil of Narayanpur-1 village of Anjangaon-Surji tehsil, while, lower was 14.45 [cmol (p^+) kg^{-1}] found in soil of Matkur-4 village of Dharni tehsil (Table 1). The similar findings of exchangeable calcium were also found by Nayak *et al.* (2006) [20] in swell-shrink soils of Vidarbha region.

Tripathi and Sawarkar (2007) [36] reported that the higher amount of exchangeable Ca content found in soils under study might be due to high clay content and calcareous parent material. Shetty *et al.* (2008) [34] found that the exchangeable calcium ranged from 1.9 to 5.5 cmol (p^+) kg^{-1} in maize growing areas of Southern Karnataka.

Exchangeable magnesium

Table 1 showed highest exchangeable magnesium 20.10 [cmol (p^+) kg^{-1}] was found at Narayanpur-1 village of Anjangaon-Surji tehsil and lowest 7.98 [cmol (p^+) kg^{-1}] found at Matkur village of Dharni tehsil. The similar results were observed by Nayak *et al.* (2006) [20] in swell-shrink soils of Vidarbha region. Shetty *et al.* (2008) [34] found exchangeable magnesium varied from 0.9 to 3.7 cmol (p^+) kg^{-1} in areas of southern transition zone of Karnataka, Whereas, Behera and Shukla (2013) [3] observed the exchangeable magnesium varies from 0.22 to 1.12 cmol (p^+) kg^{-1}.

Correlation coefficient

In AESR 6.3 (Table 03) soil pH significantly and positively correlated with organic carbon (r=0.628**), Zn (r=0.471**) and B (r=0.647**) and negatively correlated with $CaCO_3$ (r=-0.279*), Cu (r=-0.339*), Fe (r=-0.461**) and S (r=-0.639**). On the contrarily, the organic carbon was significantly correlated with all the DPTA-micronutrients except the DTPA-Mn. Among all the micronutrients, boron significantly correlated with all the DTPA-micronutrients, organic carbon and $CaCO_3$ as well, except that DTPA-Mn. Available S was significantly and negatively correlated with organic carbon (r=-0.726**). Similar correlation findings were reported by Pandey *et al.* (2000) [22]. DTPA-Zn was positively and significantly correlated with organic carbon (r=0.710**) and B (r=0.632**). The availability of micronutrient was increased with increasing organic carbon in soil may be because formation of chelating compounds. These chelates are soluble organic compounds that bound with metals such as Fe, Zn, Cu and Mn increasing their solubility and availability in soil (Tisdale *et al.*, 1997) [35].

Yadav and Meena (2009) [38] found that the availability of zinc increased significantly with increased in organic carbon (r = 0.710**). On the other hand, the availability of zinc was reduced significantly with arise in $CaCO_3$ (r = -0.317*). DTPA-Fe contents were significantly and negatively correlated with pH (r= -0.461**). It might be due to trailed to the development of insoluble higher oxides of Fe at higher pH and adsorption of Fe on the surface of $CaCO_3$ particles. Similar findings were reported by Patil *et al.* (2003) [27]. The DTPA-Fe content positive and significant correlation with DTPA-Mn (r=0.318*) and DTPA-Cu (r=0.288**). The decrease in availability of zinc with increasing calcium carbonate in soil it might be due to attributed to enhanced soil pH. The availability of Mn ($Mn^{2+)}$ in soil varies with pH. This low Mn availability in soil with increasing level of $CaCO_3$ may also be association with high soil pH. The maximum soil pH of also favors the formation of less available organic complexes of Mn (Tisdale *et al.*, 1997) [35]. The DTPA-Zn had negative correlation with $CaCO_3$(r=- 0.317*) and positively correlated with organic carbon (r=0.710**). Prasad and Gajbhiye (1999) [31] also found similar findings. The correlation between pH and Fe was found significantly but negatively correlated (r = -0.461**), while positive correlation was observed with organic carbon(r = 0.628**). Similar results of correlation were found by Meena *et al.* (2012) [17]. pH is highly significant and negative correlation with S (r=-0.639**) followed by Fe (r=-0.461**) and Cu (r=-0.339*). This might be due to organic carbon forms soluble complexes with micronutrients which subsequently become available to plants (Shah and Andrabi, 2010) [33]. It could be observed that iron and micronutrients are decline with the increase in pH of the soil. pH also non-significantly negative correlated with Mn (r=-0.044). Close scrutiny of the correlation of micronutrient with organic carbon in soil noticed that availability of micronutrients improve significantly with increase in organic carbon. Thus, regular application of organic matter to the soil is important for maintaining the level of organic carbon in soil to optimum level, which ultimately helps in supply of micronutrient continuously to the crops. Availability of DTPA-extractable micronutrients in presence of higher content of organic carbon is due to chelation of this metallic cation with humic substances in organic matter (Mandal *et al.* 2005) [16].

Table 1: Soil chemical properties, micro and secondary nutrient status in AESR 6.3 a Amravati (K5Dm4) district of Maharashtra

AESR	Sample No.	Soil Properties				Micronutrients (mg kg^{-1})					Secondary Nutrients		
		pH	EC dS m^{-1}	OC (g kg^{-1})	$CaCO_3$ (%)	Zn	Cu	Fe	Mn	B	S (mg kg^{-1})	Ex. Ca	Ex. Mg
6.3 a Amravati												cmol (p^+) kg^{-1}	
Dharni	Barupani-3	7.43	0.22	7.27	6.63	0.37	4.00	9.95	21.22	0.72	14.70	22.37	11.34
	Dhodra-2	6.60	0.29	5.65	2.38	1.23	5.42	5.42	14.58	0.21	9.58	20.43	9.48
	Rambag-6	7.42	0.23	6.18	8.63	2.18	2.36	18.24	7.27	0.48	20.48	21.61	10.33
	Jutpani-4	6.51	0.27	7.35	4.50	1.77	3.87	20.47	5.68	1.32	19.28	17.50	8.11
	Matkur-4	6.30	0.18	7.16	5.13	0.33	4.37	15.25	11.28	1.12	24.99	14.45	7.98
Achalpur	Nimdari-2	8.66	0.19	4.35	7.70	0.45	2.35	11.52	22.52	0.88	11.46	33.28	18.17
	Nimdari-3	7.89	0.41	4.76	9.88	1.95	3.48	14.28	17.24	0.36	22.58	28.33	11.77
	Parsapur-4	8.59	0.39	6.64	8.38	1.38	4.52	9.68	20.25	0.60	29.60	33.47	17.80
	Ambada-1	8.23	0.31	4.59	5.65	2.17	1.58	7.42	18.78	0.18	21.29	30.65	16.81
	Ambada-2/6	8.03	0.35	5.53	2.38	0.94	3.00	12.22	21.42	0.96	18.36	29.80	13.12
Anjangaon-Surgi	Hasnapur-1	8.14	0.23	4.59	3.88	0.55	4.10	26.52	11.78	0.57	17.06	31.32	15.13
	Taroda-1	7.91	0.18	4.29	3.48	2.34	3.12	18.49	35.41	1.12	18.41	28.40	12.89
	Lakhanwadi-6	7.88	0.21	3.98	4.13	1.77	4.51	14.24	14.25	0.69	13.21	30.31	18.17
	Kumbhargaon-4	8.07	0.20	5.88	9.63	0.98	0.78	5.26	8.78	0.92	14.41	38.23	17.18
	Narayanpur -1	8.29	0.24	6.17	4.48	1.25	3.10	12.10	12.74	0.38	10.28	40.11	20.10
	Min.	6.3	0.18	3.98	2.38	0.33	0.78	5.26	5.68	0.18	9.58	14.45	7.98
	Max.	8.66	0.41	7.35	9.88	2.34	5.42	26.52	35.41	1.32	29.99	40.11	20.10
	Mean	7.73	0.26	5.62	5.79	1.31	3.37	13.40	16.21	0.70	18.04	28.01	13.89
	S.D	0.73	0.07	1.15	2.52	0.69	1.23	5.82	7.52	0.34	6.20	7.36	4.00

Table 2: Per cent sample deficient, nutrient status and nutrient indices in agro ecological-sub-region 6.3 a (K5Dm4)

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
6.3 a Amravati							
Available-Zn	15	27	4 (27)	7 (47)	4 (27)	2.13	Medium
Available-Cu		0	0 (0)	1 (7)	14 (93)	2.93	High
Available-Fe		0	0 (0)	11 (73)	4 (27)	2.26	Medium
Available-Mn		0	0 (0)	2 (13)	13 (87)	2.86	High
Available-B		33	5 (33)	7 (47)	3 (20)	1.86	Medium
Available-S		7	1 (7)	9 (60)	5 (33)	2.27	Medium

Table 3: Relationship of soil properties with available micro and secondary nutrients in AESR 6.3 of Maharashtra State

	pH	OC	$CaCO_3$	Zn	Cu	Fe	Mn	B	S
pH	1								
OC	0.628^{**}	1							
$CaCO_3$	-0.279^{*}	-0.283^{*}	1						
Zn	0.471^{**}	0.710^{**}	-0.317^{*}	1					
Cu	-0.339^{*}	-0.371^{**}	0.230^{NS}	-0.373^{**}	1				
Fe	-0.461^{**}	-0.596^{**}	0.079^{NS}	-0.485^{**}	0.288^{*}	1			
Mn	-0.044^{NS}	0.048^{NS}	-0.172^{NS}	0.125^{NS}	0.100^{NS}	0.318^{*}	1		
B	0.647^{**}	0.742^{**}	-0.344^{*}	0.632^{**}	-0.432^{**}	-0.529^{**}	0.039^{NS}	1	
S	-0.639^{**}	-0.726^{**}	0.198^{NS}	-0.725^{**}	0.415^{**}	0.537^{**}	-0.082^{NS}	-0.774^{**}	1

n = 55 (n= number of observations) * Significant at p=0.05 level: ** Significant at p=0.01 level

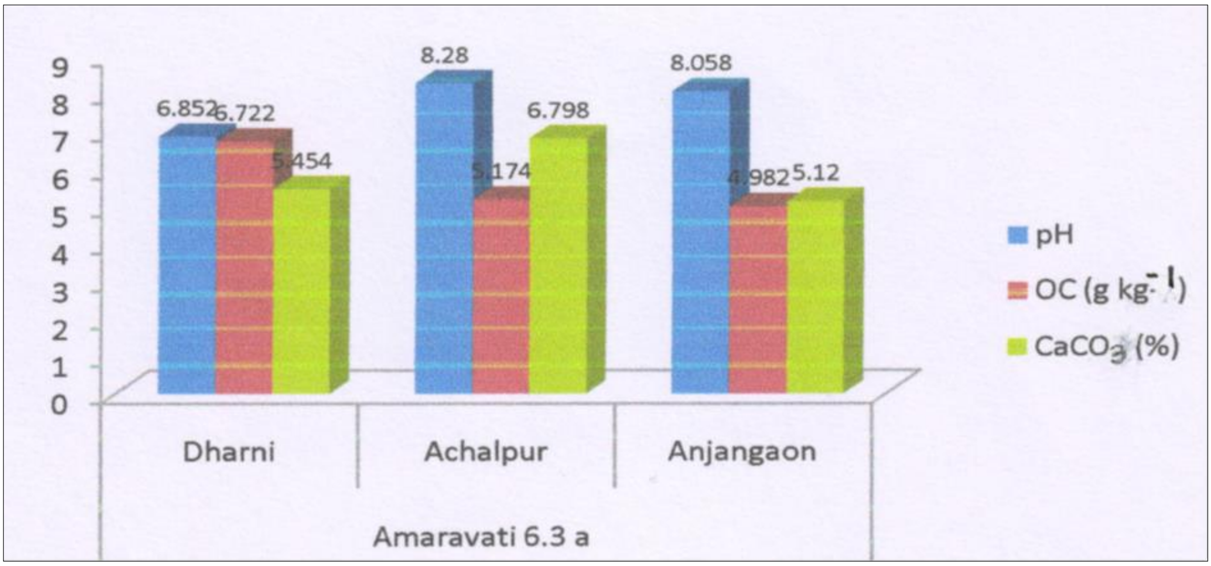

Fig 1: Soil Chemical properties in AESR 6.3 a Amravati district

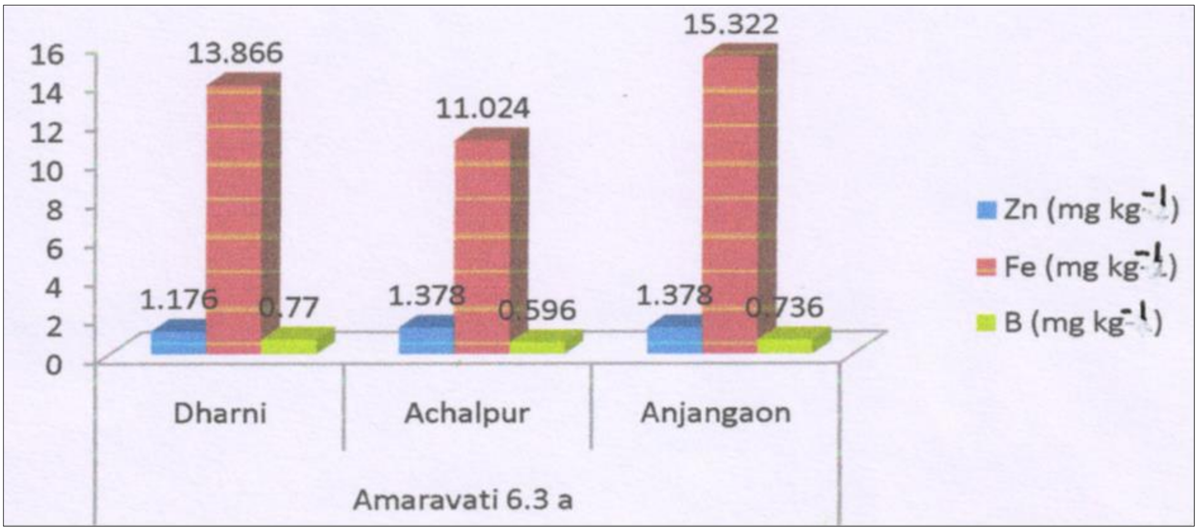

Fig 2: Micronutrient status in AESR 6.3 a Amravati district

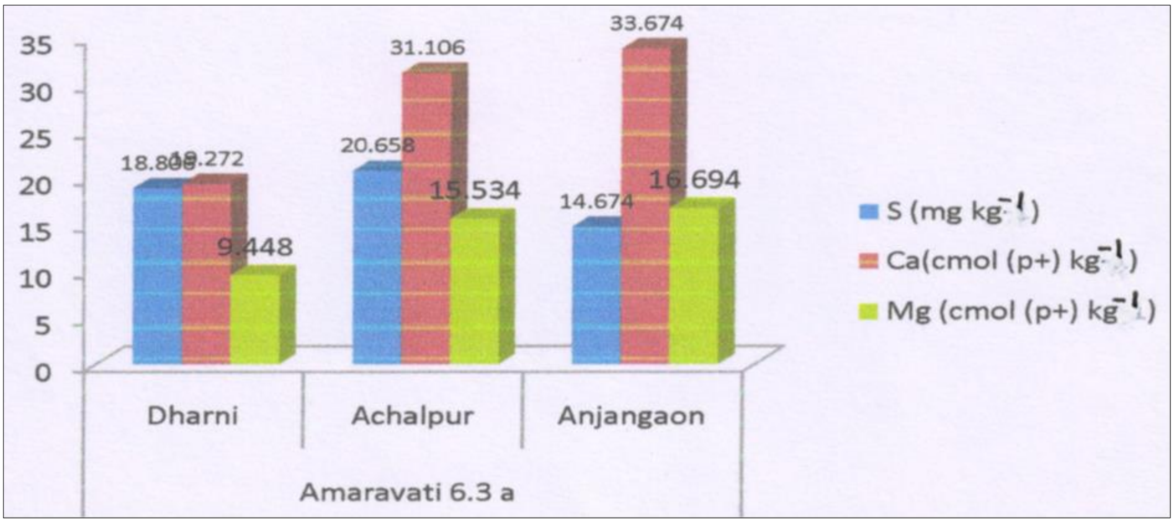

Fig 3: Secondary nutrient status in AESR 6.3 a Amravati district

Conclusion

From the study it could be concluded that the soil of Dharni, Achalpur and Anjangaon Surji tehsils of Amravati district were alkaline in nature and normal in electrical conductivity, low to moderately high in organic carbon and moderately calcareous to calcareous in calcium carbonate. The deficiencies of micro and secondary nutrients were to the extent of 27, 33 and 7 per cent in Zn, B and S respectively in the soil of Amravati district. The soil of Amravati district was sufficiently high in copper, iron and manganese. Exchangeable Ca was found sufficient while, exchangeable Mg and available S were found in medium. The DTPA- Zn indicated negative and significant relationship with $CaCO_3$ (r= -0.317*) while, DTPA-Zn was positively and significant correlation with B (r=0.632**). Cu and Mn showed high nutrient index, while, medium in case of zinc, iron boron and sulphur.

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