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Nutrient status and nutrient index of different land use system in Dharni tehsil of Melghat region in Maharashtra state

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Abstract
A detailed soil survey was carried out at tribal area in Dharni tahasil of Melghat region during the year 2017-2019. In present investigation data on natural resources such as soil fertility and present land use system aspect were generated studied and analyzed. The study covered whole tribal area to identified different landform units to understand the soil heterogeneity as well as the present land use. Twenty four (24) representative soil profiles were selected for sampling and analyzed for pH, Electrical conductivity, Organic carbon, available nitrogen, phosphorous and potassium and available micro nutrient (Zn, Mn, Fe and Cu). The soils were neutral to moderately alkaline in nature and free from soluble salts hazards. Soils are medium in organic carbon. Nutritionally, soils in this high rainfall region showed lower content of available N and P and higher in available K, however, medium to higher in available micronutrient status *viz*. Fe, Mn, Zn and Cu. Nutrient index values showed that available N and P were in low category, OC, $CaCO_3$, available Zn and Fe were moderately high, available Mn was in higher category, however, available K and Cu were very high in nutrient index values in Dharni Tahasil. Thus there is need of proper land use according to capability of land by identifying the constraints for the production of available land. In order to use the land resources optimally on sustainable basis and also adaptation of management practice for increasing the fertility of soil.

Keywords: Soil survey, resources, fertility, sustainability, Melghat

Introduction
Land is the basic component of production systems and meets the basic requirement of all life on the earth. It is a natural resource providing most benefits to human kinds. However, it is a finite vital resource on whose proper use depend the life supporting systems of a country and socioeconomic development of the people (Sehgal, 1990) [9]. Maintaining, the present level of soil productivity and for meeting out the demand of the future, management of soil resources on scientific principles is very important. Therefore, increased emphasis is being laid on soil fertility and developing scientific criteria for land evaluation and interpretation of soils for multifarious land uses. At present productivity of the soil is observed to be reduced at a slow rate but in a continuous phase. Since the climatic attributes of the region are not changing at the faster rate, it is only the soil attributes which are causing reduction in the productivity. The low productivity might be due to the degradation of the land resource and also Imbalanced and inadequate use of chemical fertilizers, improper irrigation and various cultural practices also deplete the soil fertility rapidly (Medhe *et al.*, 2012) [4].
Hence it is necessary to assess the fertility status of soil with the consideration of available nutrients status of soil, proper planning for increasing the productivity of area.

Materials and Methods
The field study was carried out in the Dharni tahasil of Maharashtra. The Dharni lies between 21°33′ and 21°.55’ North latitudes and 76°53′ and 76°.88’ East longitudes. This region boasts of thick forests spread over the Satpura mountain range. The forest has predominantly teak and bamboo. Dharni Tahasil Max. Temp. is ranges from 32^0C to 42^0C and Min. Temp. is ranges from 5^0C to 22^0C. Annual rainfall is 1350 to 1450 mm.The major natural vegetation of the area in general comprises dry deciduous mixed tree species, some grasses and shrubs species
The commonly observed tree species are teak (*Tectona grandis*), palas, *(Butea monosperma)*, ber *(Ziziphus jujuba)*, khair *(Acacia catechu)*, neem *(Azadirata indica)*, babul *(Acacia arabica)*, mango *(Mangifera indica)*, mahua *(Madhuca lalifolia) and* Subabul *(Leucaena leucocephala)*. The major crops grown in the kharif season are soybean *(Glycine max)*, sorghum *(Sorghum bicolor)*, pigean pea *(Cajanus cajan)*, groundnut *(Arachis hypogea)*, maize

(Zea maize), green gram *(Vigna sinesis)* and kutki and also seasame etc. in some area. The main rabi season crops of the area are wheat *(Triticum aestivum)* and chickpea *(Cicer aritium)* grown under irrigation or stored moisture. In summer season where irrigation is more available the crop like moog and groundnut are grown in some area.

This area is also known as Melghat region, which is located in the physiographic unit *i.e.* eroded valley with the elevation of 316 - 642 meters above mean sea level. *Korku* is the dominant tribes inhabited in this forest region and have small land holding adjoining to forest. The tribal field area of Dharni tahasil was traversed to know physiography, soil heterogeneity as well as the present land use system. On the basis of the visual observations Twenty Four (24) representative profiles were selected on different land use system *viz*., single crop, double crop, scrub land and forest land in area for details soil profile study (Table 1). The horizon wise samples were collected for their analysis of soil fertility parameter. The soil sample was sieve through 100 mesh sieve for estimating organic carbon by Walkley and Black method.

The soil pH and EC was determined in soil suspension (1:2.5 soil: water) by using glass electrode pH meter (Richards, 1954) [8]. The available Nitrogen was determined by alkaline potassium permanganate method as described by Subbaiah and Asija (1956) [11] and available phosphorus was estimated calorimetrically as per the method given by Jackson (1967) [2]. Available potassium was extracted from the soil by using neutral normal ammonium acetate solution. DTPA-extractant (0.005 M Dietylene triamine penta acetic, 0.01m CaCl2 + 0.1 N triethanolamine at pH 7.3) were used for extracting exchangeable iron, copper, manganese and zinc. The concentration of micronutrients in the extract was determined by using Atomic Absorption Spectrophotometer, as outlined by Lindsay and Norwell (1978) [3]. Soil nutrient index was calculated as per six tier system (Rammoorthy and Bajaj, 1969).

Results and Discussion

Physio-chemical properties of soils

Soil pH is very important physio-chemical properties of soil, which influence availability of plant nutrients, microbial activity and plant growth. The soil pH is mostly related to the parent material, climates and topography position which determine soil composition. Soils of Dharni tahasil were neutral to moderately alkaline in nature, the pH values ranging from 7.21 to 8.32. it was observed that, pH of surface soils was lower as compared to subsurface soil and it increased with depth of the pedon except pedon P_{16}. Pedons P_5, P_6, P_7, P_8, P_{13}, P_{14}, P_{19}, and P_{23} showed higher alkalinity, may be due to higher exchangeable sodium content in the lower soil layers. Adelbert Kharlyngdoh *et al.*, (2015) [1] reported that, the pH of the soils of the micro-watershed varied from 4.15 to 5.91 *i.e.* slightly acidic to extremely acidic in reaction and increased with depth which was mainly due to leaching of bases down wards. Most of the pedons P_1, P_2, P_3, P_4, P_9, P_{10}, P_{11}, P_{12}, P_{15}, P_{16}, P_{17}, P_{18}, P_{20}, P_{21}, P_{22}, and P_{24} were neutral in soil reaction which is best suited for most of the crops. Soil electrical conductivity (EC) is a measure of the amount of salts in soil. It is an important indicator of soil health. It affects crop yields, crop suitability, plant nutrient availability and activity of soil microorganisms. Excess salts hinder plant growth by affecting the soil-water balance. Salt levels can increase as a result of cropping, irrigation and land management practices. The data present in table 2 revealed that, the Electrical Conductivity of the Dharni tahasil soils were less than 1 dSm^{-1}, soils are considered non-saline and do not impact most crops and soil microbial processes. In general soils were low in EC which was ranges from 0.10 to 0.37 dSm^{-1}. The lower values of the EC in Dharni tahasil may be due to the fact that, the hilly area receives high rainfall with leads to high runoff of water from high elevation to low elevation which also washed away the dissolved salts in it.

The organic carbon is an indication of organic fractions in soils formed due to microbial decomposition of residues. The presence of organic matter in soil is a symbol of life in soil. It contains, retains and supplies all essential plants nutrients and influence the fertility of soil. It was observed that, the organic carbon content in surface soils of Dharni tahasil was varied from 0.25 to 1.06 per cent, which indicated that soils were medium to high in organic carbon content. In general organic carbon content in soils decreases as depth of the soils increased. The minimum organic carbon in soils was observed in pedon P_{12} scrub land which was 0.25 per cent in upper soils and decreased up to 0.18 per cent in lower levels of the soils. However, maximum organic carbon was observed in pedon P_{20} of forest land cover with grasses vegetation, which was highest 1.06 per cent in surface soils and reduced up to 0.78 per cent in lower soil layers. Relatively higher organic carbon content in soil under forest and fallow land as compared to cultivated land, which may be due to the addition of organic matter through continuous leaf fall and undisturbed condition of the forest land. Most of pedon showed organic carbon decrease with increase in depth, which is mainly due to accumulation of plant residues in the surface. Similar also reported by Sarkar *et al.*, (2001).

Table 1: Geo-referencing of soils pedons selected for study area

Sr. No.	Land use system	Pedon	Name of Village	Latitude	Longitude	MSL (Meter)
1)	Single cropping system	P_3	Jambukara	$21^0$31.34.33”	$77^0$05.52.68”	397
2)		P_8	Bairagad	$21^0$41.16.69”	$77^0$02.58.89”	346
3)		P_9	Sawalkheda	$21^0$41.28.95”	$77^0$04.25.53”	349
4)		P_{10}	Kakramal	$21^0$33.27.78”	$77^0$00.12.89”	347
5)		P_{19}	Ambadi	$21^0$30.06.70”	$76^0$50.21.53”	316
6)	Double cropping system	P_1	Mangia	$21^0$30.30.59”	$77^0$10.36.32”	419
7)		P_4	Ghota	$21^0$34.59.75”	$77^0$03.32.02”	389
8)		P_{13}	Talai-Diya	$21^0$33.57.57”	$76^0$54.06.79”	323
9)		P_{14}	Rani-Tambhori	$21^0$30.02.89”	$76^0$52.55.75”	327
10)		P_{15}	Khadki-Kalam	$21^0$21.50.71”	$76^0$40.26.15”	344
11)		P_{16}	Sawlikheda	$21^0$22.13.29”	$76^0$42.07.19”	334
12)		P_{22}	Biju dhawdi	$21^0$27.59.58”	$76^0$58.03.05”	642
13)		P_{23}	Kusumkot	$21^0$32.25.45”	$76^0$53.03.42”	324
14)		P_{24}	Chakarda	$21^0$34.36.31”	$76^0$00.28.27”	348
15)	Triple	P_5	Nanduri	$21^0$29.55.77”	$77^0$05.58.41”	422

16)	cropping system	P_6	Kara	21^{0}29.49.05”	77^{0}00.15.22”	427
17)		P_7	Kolupur	21^{0}31.57.53”	77^{0}00.28.28”	352
18)		P_{18}	Zilpi	21^{0}27.58.55”	76.48”11.59”	316
19)		P_{21}	Baru	21^{0}28.50.55”	76^{0}56.26.49”	351
20)	Scrub land	P_2	Kotha	21^{0}30.56.42”	77^{0}05.36.23”	422
21)	Scrub land	P_{11}	Chipoli	21^{0}34.03.75”	77^{0}01.12.64”	368
22)	Scrub land	P_{12}	Takarkheda	21^{0}33.06.31”	77^{0}54.46.53”	340
23)	Scrub land	P_{17}	Sadra badi	21^{0}26.45.93”	76^{0}47.29.62”	353
24)	Forest land	P_{20}	Chitri	21^{0}35.59.80”	77^{0}10.32.12”	395

Table 2: Nutrient status of soil in Dharni tahasil

Depth (cm)	**pH (1:2.5) soil:water**	**EC (dSm^{-1})**	**Organic carban (%)**	**Available nutrients (kg ha^{-1})**			**Micronutrients (mg kg^{-1})**			
				N	**P**	**K**	**Zn**	**Fe**	**Mn**	**Cu**
Pedon-1: Mangia-*Fine clayey, smectitic, hyperthermic,Vertic Haplustepts*										
0-19	7.26	0.30	0.87	342.6	29.00	392.0	0.87	5.50	8.77	1.92
19-47	7.31	0.20	0.70	276.6	25.28	358.4	0.67	5.10	7.20	1.72
47-68	7.44	0.15	0.40	160.2	22.07	235.2	0.37	4.10	5.77	1.51
Pedon-2: Kotha- *Loamy, smectitic, hyperthermic, Vertic Haplustepts*										
0-18	7.30	0.24	0.65	257.2	18.87	616.0	0.59	4.40	7.20	1.82
18-49	7.39	0.22	0.56	222.3	14.69	504.0	0.53	4.00	6.50	1.65
49-77	7.70	0.17	0.45	179.6	10.65	481.6	0.42	3.80	5.20	1.40
77-95	7.60	0.15	0.37	148.6	7.99	459.2	0.36	3.00	4.90	1.43
Pedon- 3: Jambukara- *Loamy, smectitic, hyperthermic, Vertic Haplustepts*										
0-15	7.28	0.28	0.69	272.7	17.30	604.8	0.58	5.00	5.90	1.12
15-42	7.33	0.22	0.61	241.7	14.53	492.2	0.55	4.80	7.10	0.99
42-66	7.35	0.17	0.37	148.6	11.66	414.4	0.48	4.00	4.20	0.52
Pedon-4: Ghota - *Fine, loamy, mixed, hyperthermic, Typic Haplustepts*										
0-21	7.30	0.21	0.85	334.8	29.58	347.2	0.76	4.90	8.10	2.35
21-53	7.37	0.17	0.69	272.7	24.37	246.4	0.73	3.90	7.10	2.04
53-90	7.50	0.15	0.46	183.5	19.09	224.0	0.55	3.10	5.60	1.42
Pedon-5:Nanduri-*Fine Clayey,smectitic, hyperthermic, Vertic Haplustepts*										
0-19	8.15	0.36	0.64	253.3	15.60	459.2	0.78	4.30	6.30	1.89
19-49	8.28	0.27	0.60	237.8	12.50	336.0	0.65	3.90	6.10	1.68
49-78	8.32	0.30	0.49	195.1	10.48	280.0	0.59	3.60	6.80	1.32
78-84	8.35	0.26	0.38	152.4	7.48	225.5	0.46	3.00	5.20	1.48
Pedon-6: Kara - *Fine clayey, smectitic, hyperthermic, Typic Haplusterts*										
0-16	8.20	0.26	0.63	249.4	16.10	459.2	0.75	5.24	9.02	1.98
16-42	8.10	0.25	0.61	241.7	13.40	380.8	0.63	4.85	8.50	0.80
42-79	8.25	0.30	0.57	226.2	12.90	324.8	0.55	4.31	6.20	1.56
79-98	8.30	0.20	0.38	152.44	9.40	302.4	0.43	3.92	4.90	1.39
Pedon-7: Kolupur - *Fine clayey, smectitic, hyperthermic,Typic Haplusterts*										
0-21	8.10	0.30	0.88	346.4	28.70	571.2	0.75	4.49	5.10	1.98
21-47	8.15	0.35	0.72	284.4	25.70	492.8	0.48	4.11	4.97	2.16
47-76	8.23	0.33	0.37	148.6	7.50	392.0	0.62	4.43	4.20	2.42
76-95	8.30	0.25	0.22	90.4	4.50	291.2	0.39	4.10	3.72	1.85
Depth (cm)	**pH (1:2.5) soil:water**	**EC (dSm^{-1})**	**Organic carban (%)**	**Available nutrients (kg ha^{-1})**			**Available micronutrients (mg kg^{-1})**			
				N	**P**	**K**	**Zn**	**Fe**	**Mn**	**Cu**
Pedon-8:Bairagad - *Fine clayey, smectitic, hyperthermic, Typic Haplusterts*										
0-20	8.20	0.32	0.67	265.7	14.50	515.2	0.72	5.00	8.84	1.50
22-54	8.25	0.35	0.60	238.8	12.87	436.8	0.65	4.64	7.33	1.00
54-95	8.22	0.27	0.49	196.1	9.31	380.8	0.54	4.30	6.30	0.91
95-109	8.30	0.25	0.30	122.4	6.95	278.4	0.45	3.90	5.10	0.85
Pedon-9:Sawalkheda -*Fine clayey,smectitic,hyperthermic,Vertic Haplustepts*										
0-18	7.26	0.23	0.66	262.1	16.40	425.6	0.70	5.54	8.10	1.90
18-48	7.31	0.21	0.57	227.2	13.35	392.0	0.61	4.85	7.00	1.20
48-83	7.40	0.16	0.46	184.5	9.31	336.0	0.47	4.35	5.90	0.95
83-100	7.43	0.14	0.25	103.0	5.98	280.0	0.51	3.92	4.80	0.80
Pedon-10:Kakramal-*Fine loamy, smectitic, hyperthermic, Vertic Haplustept*										
0-19	7.30	0.22	0.64	254.3	15.41	616.0	0.82	5.60	9.04	2.35
19-44	7.38	0.20	0.55	219.4	12.22	504.0	0.56	5.10	7.90	2.04
44-72	7.39	0.17	0.45	180.6	10.11	403.2	0.28	4.90	8.50	1.50
72-88	7.42	0.13	0.22	103.0	7.30	324.8	0.24	3.70	6.20	1.00
Pedon-11: Chipoli - *Fine loamy, smectitic, hyperthermic, Typic Ustorthents*										
0-20	7.21	0.23	0.39	157.3	8.95	336.0	0.26	8.10	4.50	0.85
20-41	7.29	0.21	0.25	103.0	5.33	246.4	0.15	7.50	3.60	0.79
Pedon-12:Takarkheda-Fine Loamy-skeletal, smectitic, hyperthermic,Typic Ustorthents										
0-20	7.24	0.17	0.25	94.2	5.18	201.6	0.37	9.20	5.10	1.8
20-54	7.32	0.21	0.18	72.6	3.10	168.0	0.32	8.00	4.00	1.6

Pedon-13: Talai Diya - *Fine smectitic, hyperthermic,Typic Haplusterts*										
0-19	8.15	0.30	0.90	355.2	28.57	526.4	0.84	6.24	9.10	1.82
19-44	8.22	0.36	0.72	285.4	23.67	425.6	0.72	5.84	7.90	1.76
44-78	8.30	0.38	0.57	227.2	14.05	358.4	0.65	4.90	6.80	1.62
78-100	8.32	0.22	0.35	145.7	8.20	302.4	0.50	4.00	5.40	1.72
100-120	8.30	0.20	0.27	110.8	6.20	280.0	0.47	3.85	5.80	1.50
Pedon-14: Ranitambhori - *Fine smectitic, hyperthermic, Typic Haplusterts*										
0-18	8.20	0.27	0.88	347.44	27.68	537.6	0.82	6.10	8.50	1.30
18-38	8.27	0.30	0.69	273.72	22.74	380.8	0.70	5.60	7.90	1.00
38-81	8.30	0.34	0.55	119.40	15.29	347.2	0.64	5.10	6.50	0.85
81-105	8.32	0.22	0.37	149.56	11.18	302.4	0.48	4.20	5.20	0.72
Pedon-15:Khadki Kalam-*Fine clayey,smectitic, hyperthermic, Vertic Haplustepts*										
0-20	7.30	0.24	0.84	331.9	25.74	501.6	0.80	5.40	9.50	1.40
20-46	7.35	0.22	0.72	285.4	20.85	468.0	0.62	5.30	8.10	1.20
46-70	7.57	0.17	0.43	172.8	11.24	356.8	0.56	4.20	7.10	0.99
70-81	7.59	0.15	0.25	103.0	9.33	201.6	0.37	4.50	6.20	0.81
Depth (cm)	**pH (1:2.5) soil:water**	**EC (dSm^{-1})**	**Organic carban (%)**	**Available nutrients (kg ha^{-1})**			**Micronutrients (mg kg^{-1})**			
				N	**P**	**K**	**Zn**	**Fe**	**Mn**	**Cu**
Pedon-16: Sawalikheda -*Clay (skeletal), smectitic, hyperthermic, Typic Ustorthents*										
0-18	7.22	0.22	0.52	207.76	14.57	414.4	0.76	5.28	4.53	1.20
18-53	7.13	0.19	0.37	149.56	7.04	235.6	0.52	5.16	5.20	1.00
Pedon-17: Sadrabadi - Loamy, smectitic, hyperthermic, Typic Ustorthents										
0-18	7.25	0.21	0.37	149.56	8.42	224.0	0.46	4.30	6.58	0.90
18-38	7.22	0.23	0.16	68.08	4.34	201.6	0.35	3.90	4.10	0.75
Pedon-18: Zilpi - *Fine clayey, smectitic, hyperthermic, Typic Haplustepts*										
0-17	7.29	0.20	0.71	281.5	25.68	392.0	0.78	5.76	8.50	1.60
17-46	7.36	0.17	0.63	250.4	16.63	246.4	0.60	4.62	6.90	2.00
46-63	7.41	0.16	0.40	161.2	9.93	184.4	0.45	3.55	5.40	2.52
Pedon-19:Ambadi- *Fine clayey, smectitic, hyperthermic, Typic Haplusterts*										
0-17	8.22	0.33	0.66	262.1	18.48	593.6	0.82	5.20	8.50	1.95
17-32	8.27	0.37	0.61	242.7	13.97	448.0	0.76	4.60	7.60	1.02
32-52	8.28	0.31	0.47	188.4	9.17	369.9	0.62	4.50	6.40	0.82
52-80	8.36	0.30	0.29	118.5	7.2	265.0	0.42	4.10	4.30	0.49
Pedon-20:Chitri-*Clayey-skeletal,smectitic, hyperthermic, Typic Ustorthents*										
0-18	7.60	0.21	1.06	407.6	29.96	345.6	0.89	8.00	9.10	1.40
18-38	7.77	0.14	0.78	308.6	20.73	245.0	0.66	6.90	9.10	1.00
Pedon-21: Baru- *Fine smectitic, hyperthermic, Typic Ustorthents*										
0-15	7.62	0.11	0.97	285.4	20.85	468.0	0.62	5.30	8.10	1.20
15-37	7.73	0.09	0.67	272.7	24.37	246.4	0.76	3.90	7.10	2.04
Pedon-22:Biju Dhawdi- *Fine Loamy, smectitic, hyperthermic,Typic Ustorthents*										
0-22	7.32	0.10	0.67	272.7	17.30	604.8	0.58	5.00	5.90	1.12
22-53	7.30	0.07	0.64	172.8	11.24	356.8	0.56	4.20	7.10	0.99
Pedon-23:Kusumkot- *Fine clayey, smectitic, hyperthermic,Typic Haplusterts*										
0-18	8.22	0.30	0.88	347.4	27.20	460.2	0.78	5.70	8.20	1.20
18-42	8.29	0.38	0.64	254.3	19.95	416.4	0.75	5.30	7.80	1.25
42-90	8.32	0.27	0.41	165.1	7.54	250.4	0.38	4.30	4.90	0.92
Pedon-24 Chakarda- Fine smectitic, hyperthermic, Typic Ustorthents										
0-7	7.50	0.16	0.58	231.0	15.7	414.4	0.59	6.50	9.40	1.10

Table 3: Nutrient status of soil in Dharni tahasil

Parameters	**Range**	**Mean**	**Ratings**					
			VL	**L**	**M**	**MH**	**H**	**VH**
No. of Samples: 24								
pH	7.16-8.29	7.67	-	-	-	-	-	-
EC(dSm^{-1})	0.01-0.37	0.24	-	-	-	-	-	-
O.C.(g kg^{-1})	0.26-0.91	0.70	00	03 (13)	02 (8)	11 (46)	07 (29)	01 (4)
$CaCO_3$ %	4.7-9.9	6.8	00	00	11 (46)	13 (54)	00	00
N (kg ha^{-1})	94.20-407.60	273.73	01 (4)	13 (54)	10 (42)	00	00	00
P (kg ha^{-1})	5.18-29.58	19.7	05 (21)	19 (79)	00	00	00	00
K (kg ha^{-1})	201-616	455.30	00	01.(4)	01 (4)	01 (4)	02 (8)	19 (80)
Fe (mg kg^{-1})	4.3-9.2	5.46	00	04 (16)	19 (80)	01 (4)	00	00
Mn(mg kg^{-1})	5.1-9.40	7.58	00	00	00	09 (37)	15 (63)	00
Zn (mg kg^{-1})	0.26-0.90	0.70	01 (4)	06 (25)	17 (71)	00	00	00
Cu (mg kg^{-1})	0.85-2.35	1.56	00	00	00	00	07 (29)	17 (71)

Table 4: Nutrient Index Values of soil in Dharni tahasil

Elements	NIV	Category
OC (g kg^{-1})	2.02	Moderately High
$CaCO_3$ (%)	1.77	Moderately High
Avail. N (kg ha^{-1})	1.18	Low
Avail. P (kg ha^{-1})	0.89	Low
Avail. K (kg ha^{-1})	2.77	Very High
Avail. Fe (mg ha^{-1})	1.43	Moderate
Avail. Mn (mg ha^{-1})	2.31	High
Avail. Zn (mg ha^{-1})	1.35	Moderate
Avail. Cu (mg ha^{-1})	2.85	Very High

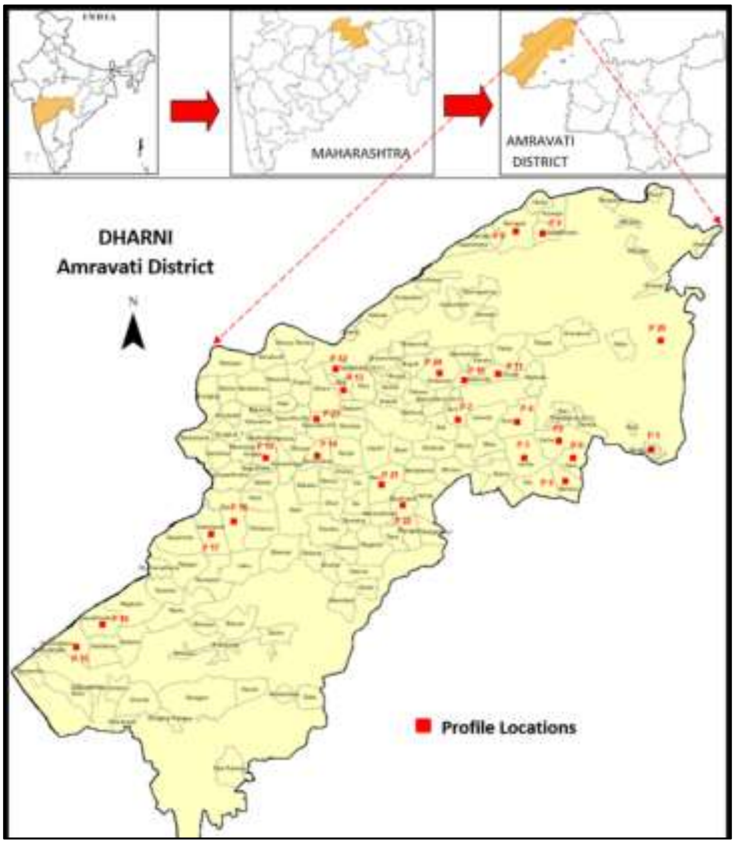

Fig 1: Soil profile location map of study area in Dharni tahasil

Nasre *et al.*, (2013) [5] also reported that the lowest organic carbon content (4.2 g kg-1) was observed in surface soils occurring on foot slopes and alluvial plain, whereas, the soils occurring on escarpments with forest cover showed the highest organic carbon content (28.7 g kg-1).

Nutrient status of soils

Available macro and micro nutrients horizon wise in pedon are discussed and presented in table 2. Nitrogen is the most vital major nutrient required by plants for proper growth and development. Soils of study area are medium in available nitrogen and nitrogen content in surface soil ranged from 94.20 kg ha^{-1} to 407.58 kg ha^{-1}. The data revealed that, lowest average N content (94.20 kg ha^{-1}) was found in pedon (P_{12}). Whereas, the highest average nitrogen content (407.58 kg ha^{-1}) was noticed in pedon (P_{20}). The available nitrogen was higher in surface soils as compared to subsoil layers. This might be due to the higher content of organic carbon and most of the microbial activities are dominant in the surface soils. Similar results were also reported by Sharma and Bali (2000) and Todmal *et al*. (2008) [12]. In general, the soils were medium in available nitrogen content. The variation in available nitrogen content in soils could be attributed to the differences in their physiographic as well as the differential cultivation and management of these soils (Vedadri and naidu, 2018).

Phosphorus is the second most important major nutrient required by plants after nitrogen for proper growth and development. Soils of study area are very low to low in available phosphorus. Phosphorus content in soils of Dharni tahasil varied between 5.18 to 29.58 kg ha^{-1} in surface soil layer. It was observed from the data (Table 2) that phosphorus content (5.18 kg ha^{-1}) was lowest in pedon P_{12} and highest (29.96 kg ha^{-1}) in pedon P_{20}. The declined trend of phosphorus with depth may due to higher fixation of available P by clay,which prevents phosphorus to come into readily available from in soil solution. Similar findings were also reported by Todmal *et al*. (2008) [12]. The phosphorus content is seen to be increasing with reduction in slope and elevation, indicating higher phosphorus content in soils of pediment and valley which may also be attributed to higher clay content in these soils. Low available phosphorus content of these soils could be attributed to their high fixing capacity which prevents phosphorus to come into readily available form in the soil solution.

Potassium is the third important major nutrient required by plants for their proper growth and development after nitrogen and phosphorus. Potassium is absorbed by plants and helps in building of protein and photosynthesis. Soils of study area were high to very high in available potassium. Available potassium content in soils of Dharni tahasil varied from 201 kg ha^{-1} to 616 kg ha^{-1} (Table 2). It was observed from the data that potassium content was lowest (201 kg ha^{-1}) in pedon P_{12} and highest (616 kg ha^{-1}) in pedon P_2 & P_{10} The potassium content also increased with the clay content. This may be attributed to the K-rich minerals occurring in the soil (Pal, 1985) [6] & (Zalte *et al*.,2018) [14] and the relative immobility of this element on account of fixation by clay (Mica i.e Biotote & Muscovite) Most of the surface soils had higher available potassium content which might be due to more intense weathering of potash bearing minerals, generation of leaf litter from different crops in cropping systems, release of labile K from organic residues, application of K fertilizers and upward translocation of K from lower depth with capillary rise of ground water (Patil *et al.,* 2008) [7]. The soils of Dharni tahasil were high to very high in potassium content. It is lower in soils at higher elevation and slope as compared to those located on lower elevation and slope. The potassium content also increased with the clay content. This may be attributed to the K-rich minerals occurring in the soil (Pal, 1985) [6] and the relative immobility of this element on account of fixation by clay.

The assessment of soil resource for micronutrient contents, as precise as possible would be much advantageous to planners, extension workers and individual farmers. The results revealed that, available Zn, Fe, Mn and Cu contents were varied from 0.26 to 0.90 mg kg^{-1}, 4.3 to 9.2 mg kg^{-1}, 4.50 to 9.50 mg kg^{-1} and 0.85 to 2.35 mg kg^{-1}, respectively in surface soils. Availability of micronutrients decreased with depth. An increasing content of micronutrient was observed with increasing the fineness of texture and organic carbon. Similar findings were also reported by Gajbhiye *et al.,* (1993) on shallow to deep black soils of Maharashtra. In general, the decreasing trend of these micronutrients content was observed in all the soils, which might be due to decreasing trend of organic carbon and may be because of manures and fertilizers application to the surface soils. Nutrient index values of available nitrogen and phosphorous are low. Organic carbon, calcium carbonate, available zinc and available iorn are moderately high in nutrient index values. Available manganese is high in nutrient index values. Available potassium and available copper are very high in nutrient index values.

Thus, from the present investigation it can be concluded that, being a hilly region developed on basalt, land was sloppy. Soil depth was varied from shallow to medium. In an average, soils were free from soluble salt hazards with neutral to moderately alkaline in pH. Soils are medium in organic carbon. Nutritionally, soils in this high rainfall region showed lower content of available N and P and high to very high in available K however, medium to higher in available micronutrient status *viz*. Fe, Mn, Zn and Cu. Nutrient index values of available nitrogen and phosphorous were low. organic carbon, calcium carbonate, available zinc and available iorn were moderately high in nutrient index values. Available manganese was high in nutrient index values. Available potassium and available copper were very high in nutrient index values. The situation therefore demands the need of appropriate management practices in order to increase the soil fertility status by adopting many such practices as nutrient management, increased use of organic nutrient sources, sustainable land use and cropping systems and appropriate agronomic practices.

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