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Assessment of physico-chemical properties and mapping of soils in hot semi-arid eco-region of beed District, MH, India

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Abstract
A study was conducted to assess the nutrient status and mapping in soils of Beed district. To meet the requirement of ever population the judicious use of available natural resources with respect to its potential supply of nutrients and elements from soil as vital natural resource is very important. Tiny use of animal manures, crop residues, compost also use of soils that are inherently low in nutrient reserves and induced natural and anthropogenic factors which are limited to supply the adequate plant nutrient and turns nutrient imbalance. Thematic map are important and useful for better depth of understanding and developing the location specific crop production technology and strategies on spatial basis of Beed district soils. Hence, studies on Assessment of Soil Fertility Status and Mapping in Hot Semi-Arid Eco-Region of Beed District, Maharashtra (India) was undertaken to know the need for assessment of fertility status of Beed area. An investigation was carried out for 440 representative soil samples selected from 11 tehsils of Beed district of Maharashtra state in 2019 -2020 by using standard methodology for collection of soil sample. Soil samples were tested for physico chemical properties and the soil pH ranged from 6.95 to 8.78 with average values 7.66 i.e. slightly neutral to slightly alkaline, electrical conductivity ranged 0.09-0.99 dSm^{-1} with mean value of 0.35 dSm^{-1} and falls in suitable ranges of germination, organic carbon ranged from 1.0- 12.4 g kg^{-1} having average value of 5.25 g kg^{-1} and calcium carbonate ranged from 83.2-163.6 g kg^{-1} with average values 118.87 g kg^{-1} some calcareous to non-calcareous soils. From this investigation it is deduced that low medium to high in physicochemical properties was found in different sites of the Beed district. To maintain fertility of soil, farmers have to test their soils to obtain higher crop yield.

Keywords: pH, electrical conductivity, calcareousness, soil fertility, latitude, longitude thematic mapping

Introduction
In our country more than 58% of population depends on agriculture. Soil is the most vital natural resource of the nation and it is the exclusive source of infinite living organisms which supports the life of crop plants by acting as a medium for growth along with providing nutrients, air and water. Soil fertility plays a key role in increasing crop production in the soil. It comprises not only supply of nutrients but also their efficient management. Fertility status of soil decreasing day by day due to ever increasing human population, intensive cultivation, land degradation and desertification. Every inch of arable land has already been utilized to the maximum extent. The optimal management of these resources with minimum adverse effect on environment is essential.

Hence, assessment of available nutrient status of soils that are intensively cultivated needs to be carried out. Soil fertility and its evaluation is one area which needs immediate attention since it is now established that an arrest in the productivity of several crops is due to ever decreasing soil fertility on one hand and an imbalanced application of plant nutrients on the other (Srinivasarao, 2011) [9].

Soil fertility map for a particular area can prove highly beneficial in guiding the farmers, manufacturers and planners and researchers to know in ascertaining the requirement of various fertilizers in a season or year and making projections for increased requirement based on cropping pattern and intensity. A plan of development is succeed only when it's based on reliable knowledge on the extent of different kinds of soil in relation to active factors i.e. climate and vegetation etc. potential capacity of crop production and how smartly this finite natural resources is managed for the benefit of existing and future generation sustenance.

Experimental Area

In total 440 soil samples from 11 tehsils of Beed district of Maharashtra state was collected systematically based on available soil survey data base. Sample selection was random. From each tehsil 40 farmers were selected (Table 2). Representative soil samples up to depth of 20 cm were collected by adopting procedure outlined by Yadav and Khanna (1979) [12]. The collected soil samples were processed and analyzed by adopting the recommended procedure for soil pH, Electrical conductivity, organic carbon and calcium carbonate.

***Source*:** ACP, (2020-21)

Fig 1: Location map of Beed district

Geography and physiography of Beed district

Beed is one of the district of Marathwada areas of Maharashtra. It is situated flanked by Aurangabad and Jalna districts in the north, Parbhani in the east, Latur in the south east, Osmanabad in in south and Ahmadnagar district in the west and southwest. The district headquarters is located at Beed Town and for administrative purpose the district has been divided in 11 Tehsils *viz*., Beed, Georai, Patoda, Ashti, Shirur (Kasar), Ambajogai, Kaij, Majalgaon, Dharur, Parli (Vaijnath) and Wadwani as shown in Fig (1).

Physiographic 3 units of district

1) Lowland Beed, 2) Highland Beed, 3) Sina basin.

Lowland Beed is the low lying northern part comprising a part of Godavari valley and is also known as Gangathari. It has a general elevation rangiong from 400 metre above mean sea level (m amsl) in the east to 500 m amsl in the west with number of residual hills reaching up to 600 m amsl.

Highland Beed occupies the southern part forming a part of Balaghat Plateau. This dissected series of hills extending from west to east divides the district into two parts.

Sina basin is low lying undulating area southwest and west of Highland Beed comprising almost whole of Ashti tehsil. It is interspersed with many low lying residual hills. The district is drained by Godavari, Manjra and Sina rivers and their tributaries. Godavari River flows from west to east along the northern boundary of the district. Manjra River starts from the mountains of Patoda tehsil and flows west to east forming the southern boundary of the district. Sina River flows along the south-western boundary of the district.

The soil types and there location on map of Beed district were presented in Table 1 and Fig 2 which well clarifies the soil of Beed district.

Table 1: Major soil types of Beed district

Soil type of district	Area ('000 ha)	Percent of total geographical area
Deep black soils	332.21	29.53
Medium deep black soils	130.66	11.62
Shallow black soil	661.96	58.85

***Source*:** ICAR -NBSS and LUP, Nagpur. (ACP, Beed District soil survey report 2020-21).

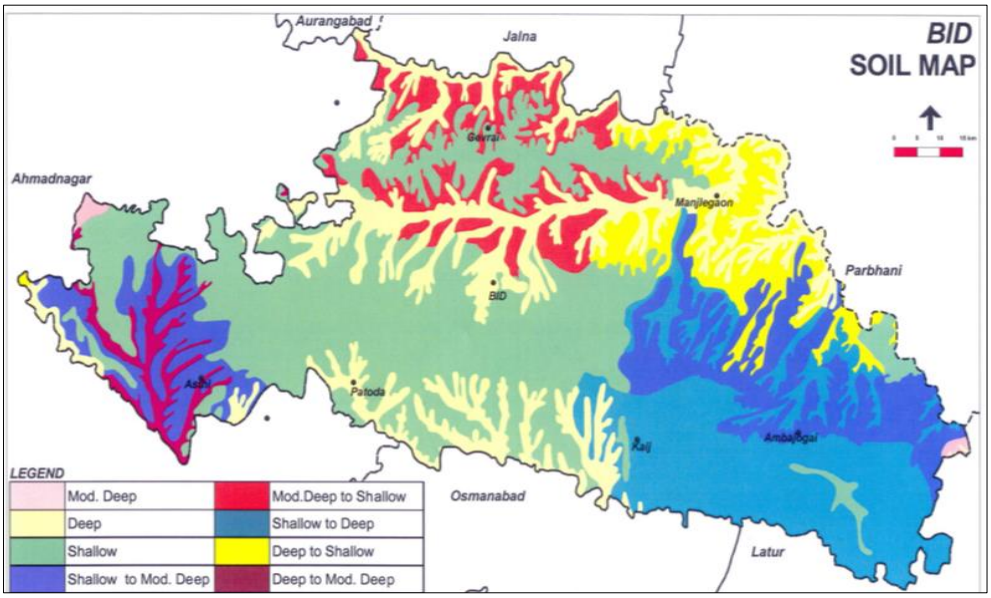

Fig 2: Soil map of Beed district. (Source: ICAR-NBSS &LUP, Nagpur, ACP, Beed District soil survey report 2020-21)

Table2: Details of soil sample collected from Beed district

Sr. No.	Name of Tehsil	No of Villages	No of soil sample	Location	
				Latitude	Longitude
1	Ambajogai	8	40	18° 42′ 55.9584″	76°23 28′. 626″
2	Ashti	8	40	18°48′37.6416″	75°1009′.6888″
3	Beed	8	40	18°59′ 24.3168″	75°45 11′.2752″
4	Dharur	8	40	18°48′ 57.2508″	76°0627′. 4572″
5	Georai	8	40	19°15′26.8344″	75°4537′. 4544″
6	Kaij	8	40	18°42′51.2496″	76°0351′. 7608″
7	Majalgoan	8	40	19°09′ 52.794″	76° 12 16′. 038″
8	Parali	8	40	18°50′43.1412″	76°3111′. 4456″
9	Patoda	8	40	18°′03 56.664″	76°1349′.9116″
10	Shirur kasar	8	40	19°03′45.1836″	75°2540′. 0152″
11	Wadawani	8	40	18°59′ 24.4392″	76°0228′. 9212″
Total	11		440		

*Data collected by own survey in research area

Material and Method

The present studies were undertaken in order to know various physicochemical properties, in the soil of Beed District of Maharashtra. The materials and method adopted are discussed here as following presented in Table 3.

Table 3: Methods of soil analysis

Sr. No.	Particulars	Method	*References
Physico-chemical properties			
1.	pH (1:2.5)	Digital pH meter	Jackson (1973)
2.	EC (dSm^{-1})	Conductivity meter	Jackson (1973)
4.	Organic carbon ($g\ kg^{-1}$)	Walkley and Black's Wet oxidation method	Piper (1966)
5.	$CaCO_3$ (%)	Rapid titration method	Jackson (1973)

*References provided in table format for each parameter.

Result

The evaluation of soil fertility status was carried out determining the soil properties *viz*, Soil pH, EC, organic carbon and calcium carbonate content. The results are presented in Table 4 were interpreted and discussed.

Table 4: Mean and range values of soil properties of different tahsils of Beed district

Sr, No.	Name of Tehsil	No. of samples	Soil properties			
			pH	EC dSm^{-1}	OC (g kg^{-1})	$CaCO_3$ (g kg^{-1})
1	Ambajogai	40	7.1-8.0 (7.58)*	0.1-0.51 (0.23)*	3.2-9.1 (4.47)*	90-142.3 (121.0)*
2	Ashti	40	7.14-7.96 (7.51)	0.25-0.99 (0.70)	1.0-6.5 (2.12)	93-163.5 (126.96)
3	Beed	40	8.28-8.51 (8.45)	0.13-0.86 (0.27)	3-8.9 (5.15)	101.3-142.3 (116.75)
4	Dharur	40	7-7.65 (7.14)	0.10-0.69 (0.23)	4-0-9.8 (6.73)	100-163.6 (123.28)
5	Georai	40	7.2-8.2 (7.59)	0.09-0.19 (0.157)	2.9-8.6 (5.46)	95.6-140 (113.81)
6	Kaij	40	8.11-8.78 (8.48)	0.25-0.52 (0.34)	2.0.-7.8 (4.44)	96.6-142.6 (116.39)
7	Majalgoan	40	6.95-7.87 (7.38)	0.17-0.54 (0.21)	3.2-8.9 (5.3)	102.2-142.6(122.09)
8	Parali	40	7-7.9 (7.57)	0.21-0.96 (0.41)	1.1-12.4 (6.0)	92.3-132.6 (111.94)
9	Patoda	40	7.5-7.7 (7.54)	0.20-0.32 (0.24)	3-8.2 (5.42)	95.6-142.6 (116.45)
10	Shirur kasar	40	7.2-7.8 (7.5)	0.1-0.31 (0.90)	4.2-9.9 (7.4)	83.2-142 (117)
11	Wadawani	40	7.38-7.84 (7.61)	0.14-0.53 (0.24)	3.6-8.9 (5.29)	102.3-143.2 (122.0)
Range			6.95-8.78	0.09-0.99	1.0-12.4	83.2-163.6
Mean			7.66	0.35	5.25	118.87

Figures in the parenthesis indicates mean values

Soil pH

The data presented in above Table 4 indicated that the soil pH of Beed district varied between 6.95 to 8.78 with an average value of 7.66. Data shows that the soils are tender to have alkaline soil reaction. The alkaline soil pH range in the present survey is because of alkaline basic parent material i.e Basaltic alluvium. Basaltic alluvium parent material rich in ferromagnesium mineral which on decomposition release basic cations which forms salts, further sub-tropical climate with high evaporation rate with low rainfall leach these salts in soil profile which tends to reach upper soil layer by capillary movement. Similar findings were also reported by Jibhakate *et al.* (2009) [5]. In the mid-plain of IGP the soils were near neutral to alkaline in reaction, and their pH varies from 6.7 to 8.9 as reported by Sidhu and Sharma (2010) [8].

Electrical conductivity

Total soluble salt concentration is represented by E.C. The EC values in the present study varied between 0.09 to 0.99 dSm^{-1} with an average of 0.35 dSm^{-1}. These values are in accordance with study conducted by Dhamak *et al.* (2014) [2]. They also observed that soils EC values were varied between 0.1-to 0.65 dSm^{-1} as categorized on safe for crop production. In general soils of Beed district soils taxonomically fall in Entisol or Inceptisol order with good drainage and hence even soils are derived from basaltic alluvium the salt concentration could not reach to the level of crop injury.

Organic Carbon

Organic carbon is the back bone of crop production or soil quality. Its content in Beed district was observed between 1.00 to 12.40 g kg^{-1} with average value of 5.25 g kg^{-1}. The soils found to be very low to medium in organic carbon content. This might be because of shallow or eroded soil observed in this area. Further organic carbon content was low because of high temperature and low moisture content. These two climatic parameter hasten the oxidation of organic carbon present in organic matter in these soils. These results are in accordance with Dhamak *et al.* (2014) [3].

Calcium carbonate

The data on $CaCO_3$ are reported in Table 4 which shows that soils are calcareous to highly calcareous in nature. Patil *et al.* (2014) [6] reported that nearly 42 percent soils of Marathwada region are calcareous in nature. This might be due to precipitation and accumulation of calcium and magnesium carbonate in the soil due to high evaporation rates observed in this area.

Discussion

Mapping of Soil properties *viz.*, pH, EC, OC and $CaCO_3$

As seen in the Table 4 and fig 3 the soils are slightly alkaline to moderately alkaline. The soil genetic property found to be derived from the basaltic trap parent material observed in the Peninsula. Basalt rocks are basic igneous rocks showing less than 55 percent silica and rich in Ca, Mg, and Fe bearing minerals. Further, semi-arid nature of the area enhances the alkalinity in the surface soil, because of insufficient water available to leach down the salts from the soil profile. Similar results were also reported by with Jibhakate *et al.* (2009) [5].

Evidently, the data presented in Table (4) and depicted in fig 4 showed that all soils are in safe limits of soluble salt concentration as observed from the values of electric conductivity. Many other researchers also reported presence of safe content of total soluble salt concentration in this region of Marathwada. It is also observed that these soils receiving irrigation water from the newly constructed dam are becoming sodic due to non-judicious use of irrigation water during hot and dry summer. Organic carbon content is most important parameter that reflects the soil quality, because it provides food for microbes present in the soil, improves soil physical properties, control erosion and act as a source of plant nutrients.

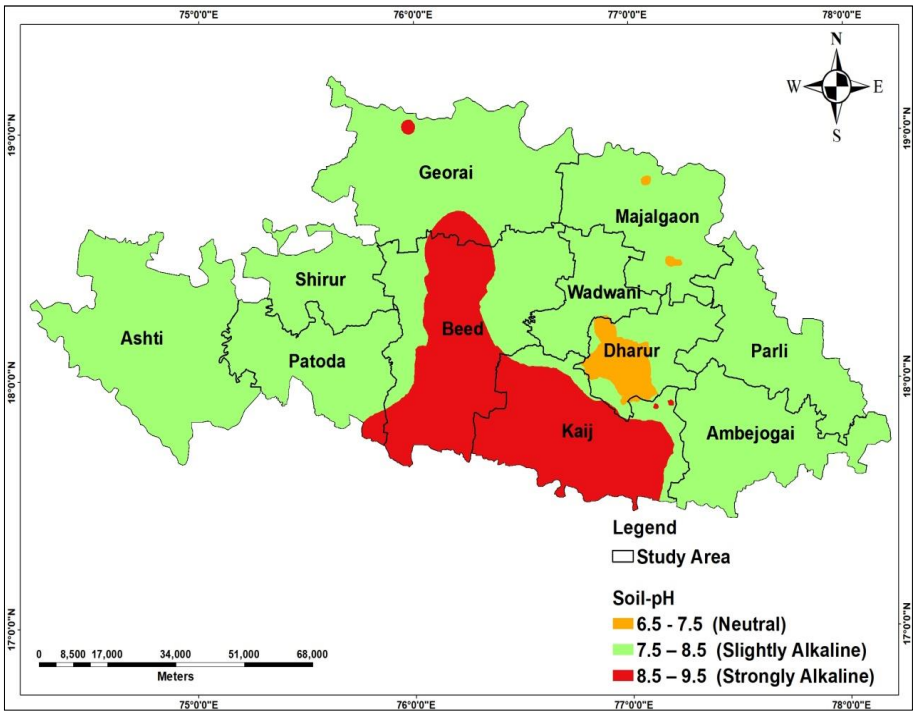

Fig 3: Soil pH status of Beed District

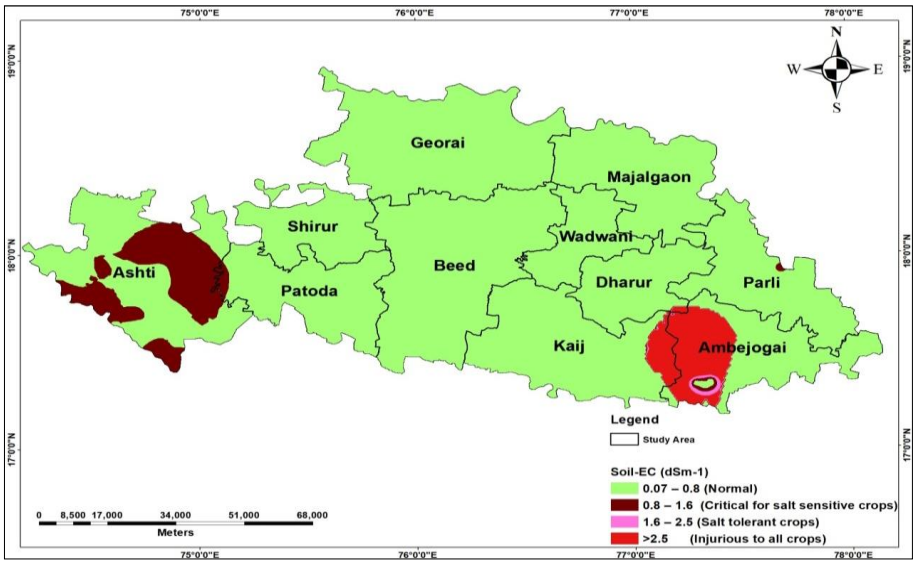

Fig 4: Soil EC status of Beed District

In the present study, data in Table (4) and fig. 5 revealed that out of 440 soil samples 112 samples were very low to low and 183 samples were moderate and rest of the samples belonged to moderately high to very high category of organic carbon status in soil. The majority of soils in Beed district were low to medium in organic carbon content (< 0.5%). The less addition of organic manure/organic coupled with high temperature reduces the organic carbon content in the soils of the study area. Organic carbon present in organic matter gets oxidized due to high temperature.

The data presented in Table 4 and depicted in fig.6 showed that out of 440 soil samples 414 samples were very highly calcareous in nature and 25 samples were slight calcareous in nature. The high calcium carbonate present in these soils in powder form converted to nodules with passage of time. The high calcium carbonate present in this soils in powder form as in nodules. Vineetha (1999) [11] reported that powder form of calcium carbonate is more injurious to plant, further high calcium carbonate content of the area possesses problem in availability of Fe, Zn, and P in greater way. The high calcium carbonate in soil affect the water holding capacity of soil which has great bearing on crop production under rainfed condition. Calcium carbonate affects the physical and chemical characteristics of soil and may prevent root penetration (Sys, 1985) [10]. Lime induced iron chlorosis is a very common phenomenon observed in the Beed district.

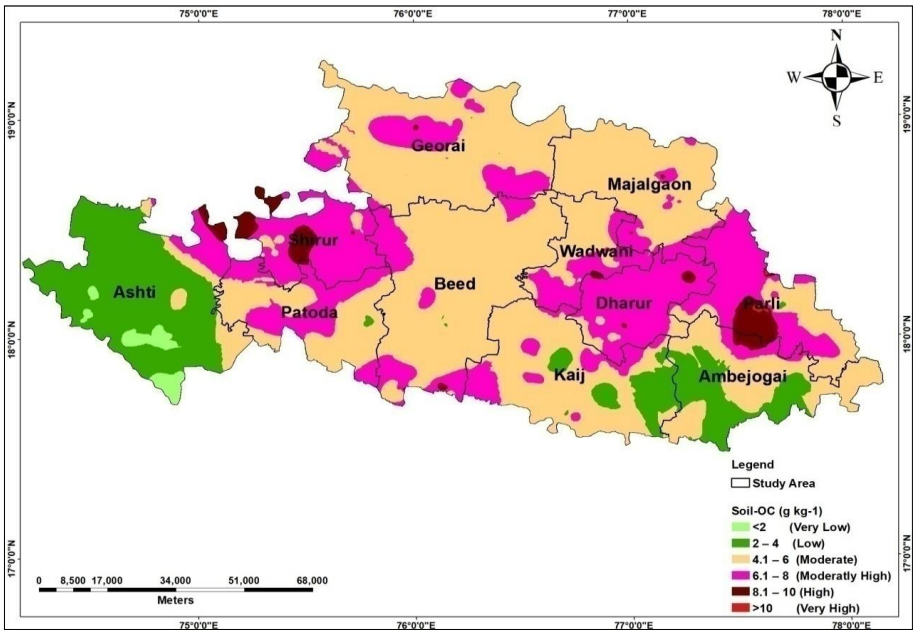

Fig 5: Soil Organic Carbon status of Beed District

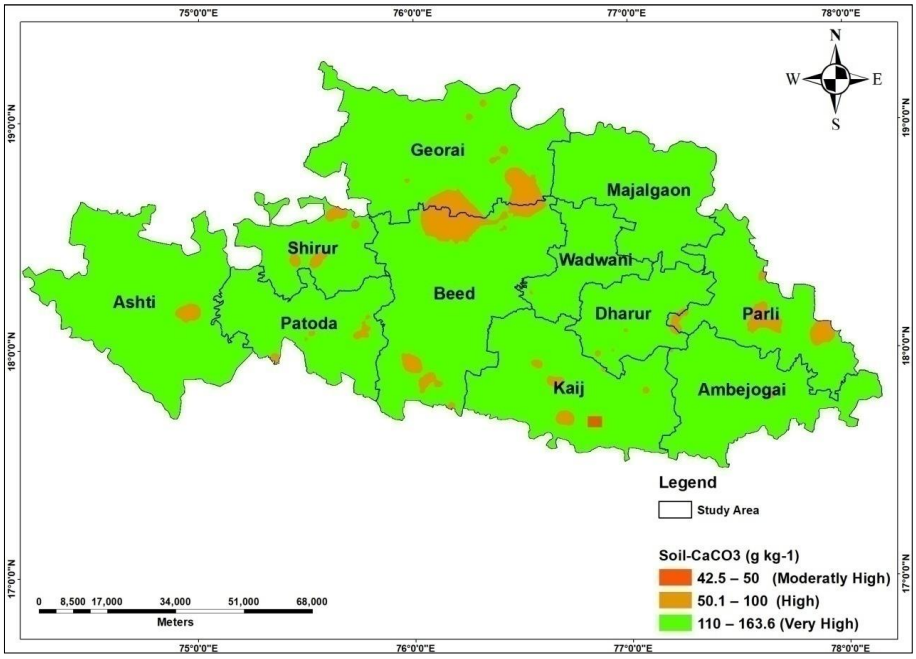

Fig 6: Soil Calcium Carbonate content status of Beed District.

Conclusion

The data summarises from above tables that the soils of Beed District were neutral to alkaline in reaction with safe limits for germination, low to moderate in organic carbon and calcareous to non-calcareous in nature. Thematic maps attracting farmers view to know the status of Soils in relation to physicochemical properties showing the marked area of sufficiency and deficiency.

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