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Assessment of soil chemical properties in Panzara command area of Dhule District

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Abstract
The investigation was carried out on 'Assessment of soil chemical properties in Panzara command area of Dhule district' during the year 2024-25 with the objectives to characterize the chemical properties of soils in the Panzara command area and to categorize the soils in Panzara command area based on soil chemical properties. A systematic survey was carried out and surface (0-22.5 cm depth) soil samples were collected from 100 different sites of 20 villages from Panzara command area i.e. Dhule and Sakri tehsil of Dhule district. The exact sample location was recorded using a GPS. Samples were analysed for soil chemical properties using standard procedures. The data thus obtained was interpreted with their relative properties and categorized as per ratings of soils. In Panzara command area, about 68% samples were slightly alkaline and 29% samples were moderately alkaline. Regarding electrical conductivity, 95% samples were normal and only 5% samples were under category of poor seed emergence. About 51% samples were low in organic carbon content in soil. Regarding $CaCO_3$ content, about 52% samples were high and 9% samples under very high category.

Keywords: Panzara command, soil chemical properties

Introduction
Assessment of soil quality index is one of the most important factors for agricultural production because of salinity and alkalinity in the irrigation command areas (Rajeshkumar *et al.*, 2016) [19]. Different morphological, physical, chemical and biological characteristics are found in soils. Their reactions to management techniques their innate capacity to provide ecosystem services their resistance to disturbance and their susceptibility to degradation are therefore different (FAO, 2017) [3]. Periodically assessing the fertility level of the soil is essential to monitoring its health.

Land and water are foundational to human existence, playing a crucial role in agriculture, ecology and overall sustainability (Khomiakov, 2020) [9]. The unplanned use of this resources lead to degradation. Land degradation is a complex ensembles of surface processes *viz.*, soil erosion, compaction, salinization, acidification and water logging, etc. Land degradation has affected about 1900 million hectares of land worldwide (Kumawat *et al.*, 2020) [11]. However, their availability and quality are increasingly under threat from various factors with climate change being one of the most significant (Khadatare *et al.*, 2024) [8]. These extreme changes in the environment give rise to the evaluation of resources i.e. soil and water to get up to the root cause.

The Panzara command area of Dhule district of Maharashtra is a significant agricultural region of district. The river Panzara is a sub basin of river Tapi, located in Northern Maharashtra, India. The river Panzara originates from Sahyadri Mountains at altitude of 1058 m above mean sea level. The total area of Panzara river basin is an about 2758 km^2. The area bounded by latitude 20º54' to 21º13' N and longitude 74º07' to 74º56' E in parts of Dhule districts of Maharashtra, India (Golekar *et al.*, 2017) [6]. Land use details have been observed that the major parts of the district are covered by agricultural land with net sown area of 4828.75 km^2 (67.70%). Forest covers area of 2088.90 km^2 (29.29%) and double cropped area covers 966.59 km^2 (13.55%) (Anonymous, 2021) [1].

Panzara river is expanded throughout the Dhule district Dams, watershed, canal water and lakes such a different kind of irrigation systems were followed by the farmers in this region. Panzara river in southern part of the district has ground water movement towards north direction with elevation from 550 m to 220 m above mean sea level (Anonymous, 2021) [1] which covers lands of Dhule and Sakri tehsil. Land degradation of this area which primarily caused due to salinization, nutrient depletion, soil erosion, droughts and waterlogging conditions, which directly affects the soil quality parameters pH, EC, organic carbon, calcium carbonate, available nutrients and micronutrients content. This study offers important insights into the sustainability of agricultural practices in the area by investigating the ways in which irrigation techniques and the river water quality affects these variables.

Materials and Methods

A systematic survey was carried out and surface (0-22.5 cm depth) soil samples were collected from 100 different sites of 20 villages of Dhule and Sakri tehsil of Dhule district and samples locations are showed in Fig. 1. Details regarding the site of sampling were noted as under: name of farmers, name of village, GPS location, latitude, longitude and vegetation. The soil samples from each village were collected from field using hand auger. The exact sample location was recorded using a GPS. After sampling, samples were air dried, ground and sieved through 2 mm sieve to obtain 500 gram size of each sample. For certain characteristics like organic carbon the sample was screened through 0.5 mm (100 meshes) (Jackson, 1973) [7]. Soil samples were analysed for pH and electrical conductivity in 1:2.5 soil suspension (Jackson, 1973) [7], organic carbon by wet oxidation (Nelson and Sommers, 1982) [13] and $CaCO_3$ by acid neutralization method (Piper, 1966) [16].

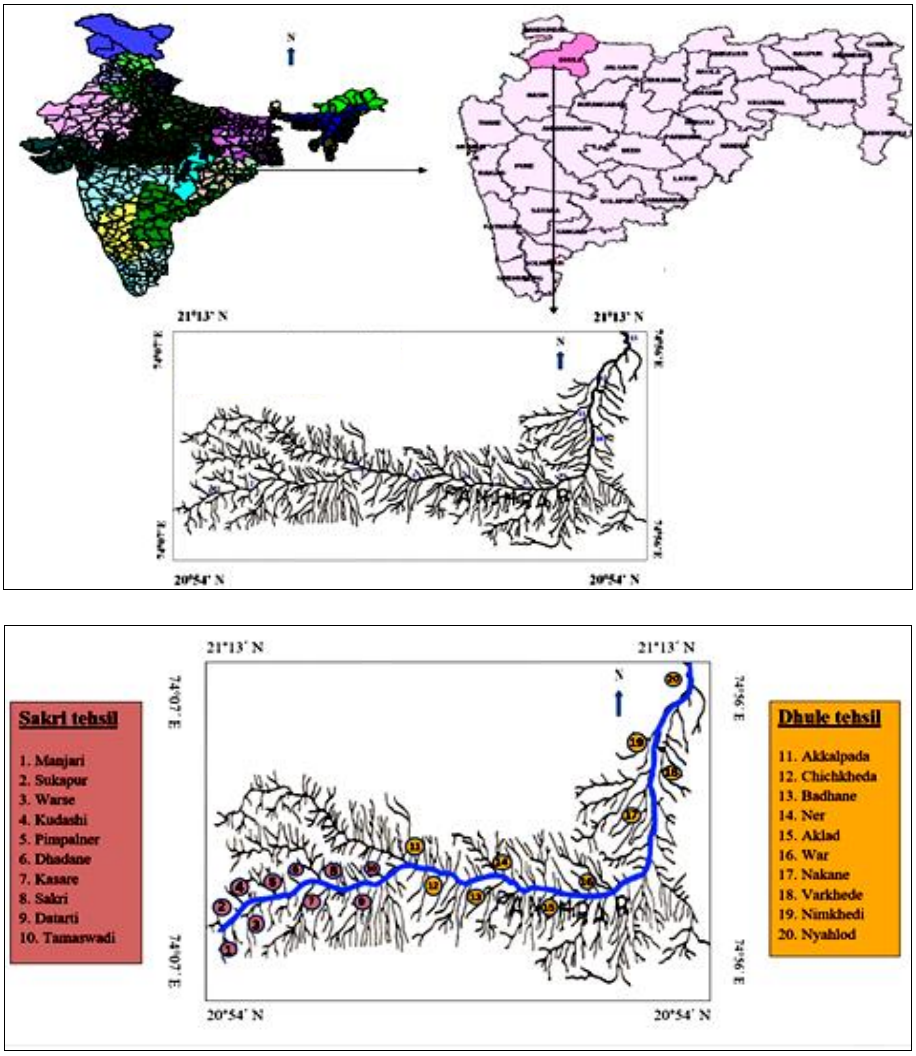

Fig 1: Location of Panzara command area of Dhule district

Results and Discussion

Chemical characteristics in soil

Soil pH

The soil pH values of soil samples from the command area ranged from 7.01 to 8.68 with an average of 7.75. Among the 100 soil samples tested, 3% samples were neutral, 68% samples were slightly alkaline and 29% samples were moderately alkaline in the Panzara command area as per the categorization given by Patil and Mali (1990) [15]. In Sakri tehsil, the pH of soil samples ranged from 7.01 to 8.12 with mean 7.47 and in Dhule tehsil the pH of soil samples was ranged from 7.13 to 8.68 with mean 8.04. In Panzara command area, the highest pH of soil sample (8.68) was observed at Nyahalod village of Dhule tehsil and the lowest pH of soil samples (7.01) was observed at Kudashi, Dhadane and Datarti villages of Sakri tehsil of Dhule district. The data revealed that the soils registered a slightly acidic to moderately alkaline reaction, probably the result of factors like rainfall, topography and parent material. In command area, the slight alkalinity may be due to the medium-deep black soils under irrigation, which have increased in

alkalinity as a result due to their origin from basaltic rock in the command area. The high pH in Dhule tehsil might be due to poor drainage, intensive irrigation and these conditions lead to greater carbonate and bicarbonate builds up, increasing soil pH further. Similar results were also found by Prasad *et al.*, (2022) [18] and Singh *et al.*, (2022) [21].

Electrical conductivity

The electrical conductivity (EC) of soil samples from the command area ranged from 0.14 to 1.32 dS m^{-1} with an average of 0.40 dS m^{-1}. As per the categorization given by Patil and Mali (1990) [15], among the 100 soil samples tested, 95% samples were normal and only 5% samples were under category of poor seed emergence in the Panzara command area. In Sakri tehsil, soil samples were ranged from 0.14 to 1.02 dS m^{-1} with mean of 0.31 dS m^{-1} and in Dhule tehsil, soil samples were ranged from 0.20 to 1.32 dS m^{-1} with mean 0.48 dS m^{-1}. The highest EC (1.32 dS m^{-1}) was noticed at Aklad village of Dhule tehsil and the lowest EC of soil samples (0.14 dS m^{-1}) was observed at Manjari and Warse villages of Sakri tehsil of Dhule district. Thus, in Panzara command area all the soil samples analyzed were non-saline and few were under category of poor seed emergence, deemed suitable for supporting healthy plant growth. Most of the samples exhibited normal salinity levels (EC less than 1). Therefore, based on salinity, the soils are considered appropriate for the productive cultivation of a wide range of plants. These findings are in line with results reported by Krishnaveni *et al.*, (2012) and Gokule (2022) [5, 10].

Organic carbon

The organic carbon content in soil samples from Panzara command area ranged from 0.23 to 0.86% with an average of 0.42%. As per the six tier system given by Bangar and Zende (1978) [2], out of 100 soil samples analysed, 51% samples were low, 35% samples were moderate, 13% samples were moderately high and 1% sample were high in category. In Sakri tehsil, soil samples were ranged from 0.25 to 0.86% with mean 0.48% and in Dhule tehsils samples were ranged from 0.23 to 0.66% with mean 0.37%. Maximum organic carbon content (0.86%) was observed in samples from Kudashi village of Sakri tehsil and the lowest organic carbon of samples (0.23%) was observed at Badhane village of Dhule tehsil of Dhule district. Sakri tehsil has high organic carbon content as compared to Dhule tehsil, which might be due to slightly better vegetation cover, less erosion and more cropping intensity in Sakri area. About 50% of the samples were low in organic carbon content in Panzara command area, which might be due to minimal use of farmyard manure and crop residues, as well as the quick decomposition caused by the high temperatures typical of semi-arid regions. Continuous cropping without replenishing the soil with FYM or organic residues has also led to nutrient loss and lower organic carbon in some areas. Similar results for soil organic carbon content were also reported by Mandal *et al.* (2011) [12] and Patil *et al.* (2019) [14].

Calcium carbonate

The calcium carbonate content in soil samples from Panzara command area ranged from 1.50 to 16.25% with an average of 6.36%. In Panzara command area, out of 100 soil samples analysed, 2% samples were moderate, 37% samples were moderately high, 52% samples were high and 9% samples were very high as per the categorization given by Patil and Mali (1990) [15]. In Sakri tehsil the calcium carbonate content in soil samples ranged from 1.50 to 8.75% with mean 4.72% and in Dhule tehsil the calcium carbonate content in soil samples ranged from 3.52 to 16.25% with mean 8.00%. The highest calcium carbonate content (16.25%) was observed at Nyahalod village of Dhule tehsil and the lowest calcium carbonate content (1.50%) was observed at Manjari village of Sakri tehsil in Dhule district. Soils from area are formed from basaltic and alluvium lithology under semi-arid climatic condition, characterized by low precipitation and high rate of evaporation favouring more accumulation and precipitation of $CaCO_3$. Sakri tehsil has moderate rainfall which causes partial leaching of carbonates and better drainage leading to less precipitation of $CaCO_3$, while in Dhule tehsil comparatively high $CaCO_3$ content might be due to poor drainage causing carbonate deposition in root zone. Soils derived from basaltic rocks in semi-arid areas, where low rainfall and high evaporation rates prevail, often show significant accumulation and crystallization of $CaCO_3$ (Singh and Kundu, 2010) [20]. Similar research findings were also reported by Potdar (2016) and Gawai (2019) [4, 17].

Table 1: Categorization of soil pH in Panzara command area

Category	Sakri tehsil	Dhule tehsil	Panzara command area
Sample No.	**1-50**	**51-100**	**(% samples)**
Extremely acidic (<4.5)	0	0	0
Strongly acidic (4.6-5.5)	0	0	0
Moderately acidic (5.6-6.5)	0	0	0
Slightly acidic (6.6-6.9)	0	0	0
Neutral (7.0)	3	0	3
Slightly alkaline (7.1-8.0)	45	24	68
Moderately alkaline (8.1-9.0)	2	26	29
Strongly alkaline (9.1-10.0)	0	0	0
Very strongly alkaline (10.1-11.0)	0	0	0

Table 2: Soil pH in Panzara command area

Particulars	Sakri tehsil	Dhule tehsil	Panzara command area
Sample no.	1-50	51-100	1-100
Minimum	7.01	7.13	7.01
Maximum	8.12	8.68	8.68
Mean	7.47	8.04	7.75
SD	0.31	0.35	0.43
CV (%)	4.18	4.37	5.54

Table 3: Categorization of soil electrical conductivity (dS m^{-1}) in Panzara command area

Category	Sakri tehsil	Dhule tehsil	Panzara command area
Sample no.	**1-50**	**50-100**	**(% samples)**
Normal (0-1)	50	45	95
Poor seed emergence (1.1-2)	0	5	5
Harmful to some crops (2.1-3)	0	0	0
Harmful to Most of the crops (>3)	0	0	0

Table 4: Soil electrical conductivity (dS m^{-1}) in Panzara command area

Particulars	Sakri tehsil	Dhule tehsil	Panzara command area
Sample no.	**1-50**	**51-100**	**1-100**
Minimum	0.14	0.20	0.14
Maximum	1.02	1.32	1.32
Mean	0.31	0.48	0.40
SD	0.22	0.31	0.28
CV (%)	71.29	63.54	69.90

Table 5: Categorization of soil organic carbon (%) in Panzara command area

Category	Sakri tehsil	Dhule tehsil	Panzara command area
Sample no.	**1-50**	**50-100**	**(% samples)**
Very low (< 0.20)	0	0	0
Low (0.21-0.40)	15	36	51
Moderate (0.41-0.60)	23	12	35
Moderately high (0.61-0.80)	11	2	13
High (0.81-1.0)	1	0	1
Very high (> 1.0)	0	0	0

Table 6: Organic carbon (%) content in Panzara command area

Particulars	Sakri tehsil	Dhule tehsil	Panzara command area
Sample no.	**1-50**	**51-100**	**1-100**
Minimum	0.25	0.23	0.23
Maximum	0.86	0.66	0.86
Mean	0.48	0.37	0.42
SD	0.13	0.07	0.12
CV (%)	28.54	21.21	29.20

Table 7: Categorization of $CaCO_3$ (%) content in Panzara command area

Category	Sakri tehsil	Dhule tehsil	Panzara command area
Sample no.	**1-50**	**50-100**	**(% samples)**
Very low (< 0.5)	0	0	0
Low (0.51-1.00)	0	0	0
Moderate (1.10-2.00)	2	0	2
Moderately high (2.10-5.00)	28	9	37
High (5.10-10.0)	20	32	52
Very high (> 10.0)	0	9	9

Table 8: Calcium carbonate (%) content in Panzara command area

Particulars	Sakri tehsil	Dhule tehsil	Panzara command area
Sample no.	**1-50**	**51-100**	**1-100**
Minimum	1.50	3.25	1.50
Maximum	8.75	16.25	16.25
Mean	4.72	8.00	6.36
SD	1.81	2.96	2.95
CV (%)	38.10	37.00	46.38

Conclusion

In Panzara command area, about 68% samples were slightly alkaline and 29% samples were moderately alkaline. Regarding electrical conductivity, 95% samples were normal and only 5% samples were under category of poor seed emergence. About 51% samples were low in organic carbon content in soil. Regarding $CaCO_3$ content, about 52% samples were high and 9% samples under very high category. Soils from Sakri tehsil were slightly healthier with balanced chemical properties as compared to Dhule tehsil in Panzara command area. From the experimental results it is concluded that, the soils from Panzara command area possess strong potential for sustainable agriculture, provided prejudicious use of organic sources including crop residue incorporation and green manuring for increasing organic carbon content in soil and encourage cultivation of tolerant crops under the condition of moderately alkaline pH and high calcium carbonate content.

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