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Assessment of major and micronutrients in Tapi command area of Dhule District

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Abstract

The investigation was carried out on 'Assessment of major and micronutrients in Tapi command area of Dhule district' during the year 2024-25 with the objectives to characterize the soils in the Tapi command area for major and micronutrients content and to categorize the soils in Tapi command area based on major and micronutrients content. 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 Tapi command area i.e. Shirpur and Sindkheda 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 Tapi command area, regarding soil available N, 3% samples were very low and 88% samples were under low category. About 35% samples were low in soil available P. regarding soil available K, samples were under the category of moderately high to very high. About 47%, 25%, 76% and 10% samples were deficient in DTPA-Fe, DTPA-Mn, DTPA-Zn and DTPA-Cu content, respectively.

Keywords: Tapi command, major nutrients, micronutrients

Introduction

Soil degradation has become a global concern, and irrigated regions such as command areas are particularly vulnerable to degradation due to overuse, improper land management, and the accumulation of salts from excessive irrigation. (Gupta and Abrol, 1990) ^[9] found that excessive irrigation without adequate drainage often leads to the build-up of salts in the soil, a process known as salinization. This reduces soil permeability and affects root growth, ultimately limiting crop yields. Similarly, the loss of organic matter, primarily due to intensive farming practices, a significant issue in these region. Organic carbon is essential for maintaining soil structure, water-holding capacity, and microbial health (Lal, 2004) ^[14]. In many regions of India, organic matter depletion due to monocropping, over-fertilization and reduced crop rotations has resulted in soils that are more vulnerable to erosion and nutrient depletion (Shukla *et al.*, 2016) ^[24]. Studies have shown that regions experiencing soil degradation often face economic challenges, as the costs of restoring soil health are significant, and the long-term impacts on agricultural productivity can hinder rural development (Singh *et al.*, 2010) ^[25].

The Tapi river, one of the major rivers of Maharashtra, has been the lifeblood of agriculture in the North Maharashtra. The river originates in Multai in the Betul district of Madhya Pradesh at an elevation of about 752 m and before joining the Arabian sea, it traverses a total length of about 724 km of the total length, 228 km lies in Madhya Pradesh, 228 km in Maharashtra, 214 km in Gujarat and the remaining 54 km forms the common boundary between Madhya Pradesh and Maharashtra. The river flows generally east to west through Madhya Pradesh, Maharashtra and Gujarat States (Jain *et al.*, 2007) ^[10]. The command area is bounded by latitude 20°5' to 22°3' N and longitude 72°38' to 78°17' E in parts of Shirpur and Sindkheda tehsils of Dhule district of Maharashtra, India. River valley accounts 15% area of the district (Anonymous, 2018) ^[2].

This study aims to assess the current state of soil quality in the Tapi river command area, focusing on parameters such as soil organic carbon content, pH, EC, calcium carbonate,

Available nutrient and DTPA micronutrients. They play vital role in soil health and production of crops (Rattan *et al.*, 2009)^[22]. By examining how these factors are influenced by the river's water quality and irrigation practices, this research will provide valuable insights into the sustainability of agricultural practices in the region. Empowering local farmers with knowledge and strategies that will allow them to mitigate soil degradation and enhance the resilience of their farming systems, ultimately leading to improved economic outcomes for the community.

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 Shirpur and Sindkheda 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. Soil samples were analysed for available nitrogen by the alkaline permanganate method (Subbiah and Asija, 1956)^[27], available phosphorus (Olsen- P) by 0.5 M NaHCO₃ extraction (Olsen *et al.* 1954)^[17] and available potassium (NH₄OAc K) by 1N neutral NH₄OAc extraction on flamephotometer (Knudsen *et al.*, 1982)^[12]. DTPA extractable micronutrients (Mn, Fe, Cu, Zn) by DTPA extractant on Atomic absorption spectrophotometer (Lindsay and Norvell, 1978)^[15].



Fig 1: Location Map of Tapi Command Area

Results and Discussion

Major nutrients

Soil available N

The available nitrogen content in soil samples from Tapi

command area ranged from 131 to 291 kg ha⁻¹ with an average of 205 kg ha⁻¹. Among the 100 soil samples tested, as per the six tier system given by Bangar and Zende (1978)^[4], 3% samples were very low, 88% samples were low and 9% samples were under moderate category. In Shirpur tehsils soil available nitrogen content ranged from 135 to 291 kg ha⁻¹ with mean 206 kg ha⁻¹ and in Sindkheda tehsils soil available nitrogen content ranged in between 131 to 285 kg ha⁻¹ with mean 203 kg ha⁻¹. The available nitrogen content was low in most of the soil samples in the command area because of low organic matter content in these soils. The variation in N content may be related to soil management, application of organic manures and fertilizers to previous crop. Nitrogen deficiency might be due to loss of nitrogen through volatilization and leaching. De Datta and Buresh (1989)^[5] also reported that, one likely reason for the low nitrogen availability in the semi-arid climate where high temperatures can accelerate nitrogen loss through processes such as volatilization, nitrification, denitrification, microbial fixation, leaching and runoff which collectively reduces the amount of nitrogen available to plants. Similar observations have been documented by Mandal *et al.* (2011)^[16] and Prasad *et al.* (2022)^[19].

Soil available P

The available phosphorus content in soil samples from Tapi command area of Dhule district ranged from 10.28 to 27.36 kg ha⁻¹ with average value 16.71 kg ha⁻¹. As per the six tier system given by Bangar and Zende (1978)^[4], among the 100 soil samples tested, 35% samples were in low category, 51% samples were moderate and 14% samples were moderately high category in the command area. The most of the samples were low to moderate in available phosphorus content in soils of studied area might be due to alkaline soil reaction and high content of CaCO₃ in the soil. At the higher pH calcium can precipitate with P as Ca-phosphate and reduce phosphorus availability (Badrinath *et al.*, 1986)^[3]. The available phosphorus content in soil samples from Shirpur tehsil ranged from 10.57 to 27.36 kg ha⁻¹ with mean 16.75 kg ha⁻¹ and in Sindkheda tehsil the available phosphorus content of soil samples ranged from 10.28 to 23.06 kg ha⁻¹ with mean 16.67 kg ha⁻¹. Similar result regarding available phosphorus were also reported by Gokule (2022)^[8] and Singh *et al.* (2022)^[26].

Soil available K

The available potassium content of Tapi command area ranged from 212 to 660 kg ha⁻¹ with average value 390 kg ha⁻¹. As per the six tier system given by Bangar and Zende (1978)^[4], among the 100 soil samples tested, 15% samples were in moderately high category, 14% samples were high and 71% samples were very high category. In the Shirpur tehsil region, available potassium content of soil samples was ranged from 235 to 660 kg ha⁻¹ with mean 413 kg ha⁻¹ and in Sindkheda tehsil the available potassium content of soil samples was ranged from 212 to 593 kg ha⁻¹ with mean of 367 kg ha⁻¹. The available potassium content in major portion of the study area in both the tehsils Shirpur and Dhule was in high category. Black soils were higher in available potassium status than red soils which may due to predominance of potassium rich micaceous, feldspars and illite minerals in parent material content as well as the extensive use of potassic fertilizers in certain areas. Comparable findings were made with respect to potassium content by Gawai (2019)^[7] and Rajeswari *et al.* (2019)^[20].

Micronutrients

DTPA -Fe

The DTPA-Fe content in the soil samples from Tapi command area ranged from 2.08 to 8.90 mg kg⁻¹ with mean 4.96 mg kg⁻¹. As per the six tier system given by Katkar and Patil (2010) [11], among the 100 soil samples tested, 3% samples were very low, 43% samples were low, 53% soil samples were moderate and 1% sample was high. As per the critical limit of 4.5 mg kg⁻¹, 53% samples were sufficient and 47% samples were deficient in DTPA-Fe content. The DTPA-Fe content in soil samples from Shirpur tehsil ranged from 2.24 to 8.90 mg kg⁻¹ with average 5.06 mg kg⁻¹ and in Sindkheda tehsil the DTPA-Fe content in soil samples ranged from 2.08 to 7.38 mg kg⁻¹ with average 4.87 mg kg⁻¹. The available iron content in the surface soil samples ranged from very low to moderate. This variation may be partly due to differences in organic carbon levels across the command area, as soils with higher organic matter tend to retain more iron. Practices like excessive liming or irrigation with alkaline water can reduce iron availability. Conversely, applying iron-containing fertilizers can increase it especially in areas with known deficiencies. These observations corroborated with the findings by Patil *et al.* (2016) [18] and Singh *et al.* (2022) [26].

DTPA Mn

As per the six tier system given by Katkar and Patil (2010) [11], among the 100 soil samples tested, 25% samples were low, 59% samples were moderate and 16% samples were moderately high category for DTPA-Mn content (Table 4.17). As per the critical limit of 2.0 mg kg⁻¹, 75% samples were sufficient and 25% samples were deficient in DTPA-Mn content. In Shirpur tehsil the DTPA-Mn content in soil samples ranged from 1.12 to 5.00 mg kg⁻¹ with mean 2.73 mg kg⁻¹ and in Sindkheda tehsil the DTPA-Mn content of soil samples ranged from 1.52 to 5.11 mg kg⁻¹ with mean 2.94 mg kg⁻¹ (Table 4.18). The results are in conformity with the results reported by Sadanand (2016) [23] and Ranavare (2023) [21].

DTPA Zn

The DTPA-Zn content in the soil samples from Tapi command area ranged from 0.24 to 0.96 mg kg⁻¹ with an average of 0.55 mg kg⁻¹. As per the six tier system given by Katkar and Patil (2010) [11], among the 100 soil samples tested, 3% samples were very low, 73% samples were low and 24% samples were moderate. As per the critical limit of 0.6 mg kg⁻¹, 24% samples were sufficient and 76% samples were deficient in DTPA-Zn content. Low zinc levels were associated with alkaline soil conditions where zinc becomes less soluble and thus less available to plants. Additionally, high calcium carbonate content and excessive phosphorus fertilization can further reduce zinc availability due to nutrient interactions and fixation. The DTPA-Zn content in soil samples from Shirpur tehsil ranged from 0.28 to 0.96 mg kg⁻¹ with mean 0.57 mg kg⁻¹ and in Sindkheda tehsil the DTPA-Zn content in soil samples ranged from 0.24 to 0.92 mg kg⁻¹ with mean 0.54 mg kg⁻¹. Similar results regarding DTPA-Zn content were reported by Dongare (2010) [6] and Kumar and Singh (2024) [13].

DTPA Cu

The DTPA-Cu content in soil samples from Tapi command area in Dhule district ranged from 0.12 to 0.79 mg kg⁻¹ with an average of 0.51 mg kg⁻¹. As per the six tier system given by Katkar and Patil (2010) [11], among the 100 soil samples tested, 10% samples were low, 27% samples were moderate and 63%

samples were moderately high. As per the critical limit of 0.2 mg kg⁻¹, 90% samples were sufficient and only 10% samples were deficient in DTPA-Cu content. The DTPA-Cu content in soil samples from Shirpur tehsil ranged from 0.12 to 0.78 mg kg⁻¹ with the mean of 0.49 mg kg⁻¹ and in Sindkheda tehsil the DTPA-Cu content of soil samples of command area was ranged from 0.18 to 0.79 mg kg⁻¹ with the mean of 0.52 mg kg⁻¹. These observations corroborated with the findings of Mandal *et al.* (2011) [16] and Amara *et al.* (2015) [1].

Table 1: Categorization of soil available N (kg ha⁻¹) in Tapi command area

Category	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample no.	1-50	51-100	(% samples)
Very low (< 140)	2	1	3
Low (141-280)	42	46	88
Moderate (281-420)	6	3	9
Moderately high (421-560)	0	0	0
High (561-700)	0	0	0
Very high (> 700)	0	0	0

Table 2: Soil available N (kg ha⁻¹) in Tapi command area

Particulars	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample no.	1-50	51-100	1-100
Minimum	135	131	131
Maximum	291	285	291
Mean	206	203	205
SD	43.83	37.27	40.50
CV (%)	21.25	18.28	19.75

Table 3: Categorization of soil available P (kg ha⁻¹) in Tapi command area

Category	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample no.	1-50	51-100	(% samples)
Very low (< 7)	0	0	0
Low (7.1-14)	18	17	35
Moderate (14.1-21)	25	26	51
Moderately high (21.1-28)	7	7	14
High (28.1-35)	0	0	0
Very high (> 35)	0	0	0

Table 4: Soil available P (kg ha⁻¹) in Tapi command area

Particulars	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample no.	1-50	51-100	1-100
Minimum	10.57	10.28	10.28
Maximum	27.36	23.06	27.36
Mean	16.75	16.67	16.71
SD	4.42	3.62	4.02
CV (%)	26.41	21.75	24.07

Table 5: Categorization of soil available K (kg ha⁻¹) in Tapi command area

Category	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample no.	1-50	51-100	(% samples)
Very low (<100)	0	0	0
Low (101-150)	0	0	0
Moderate (151-200)	0	0	0
Moderately high (201-250)	6	9	15
High (251-300)	6	8	14
Very high (>300)	38	33	71

Table 6: Soil available K (kg ha⁻¹) in Tapi command area

Particulars	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample no.	1-50	51-100	1-100
Minimum	235	212	212
Maximum	660	593	660
Mean	413	367	390
SD	126.88	103.19	117.39
CV (%)	30.65	28.06	30.03

Table 7: Categorization of DTPA-Fe (mg kg⁻¹) in Tapi command area

Category	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample no.	1-50	51-100	(% samples)
Very low (<2.5)	1	2	3
Low (2.5-4.5)	22	22	44
Moderate (4.5-9)	26	26	52
Moderately high (9-18)	1	0	1
High (18-27)	0	0	0
Very high (>27)	0	0	0
Sufficient (>4.5)	27	26	53
Deficient (<4.5)	23	24	47

Table 8: DTPA Fe (mg kg⁻¹) in Tapi command area

Particulars	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample no.	1-50	51-100	1-100
Minimum	2.24	2.08	2.08
Maximum	8.90	7.38	8.90
Mean	5.06	4.87	4.96
SD	1.61	1.26	1.44
CV (%)	31.81	25.87	29.03

Table 9: Categorization of DTPA-Mn (mg kg⁻¹) in Tapi command area

Category	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample no.	1-50	51-100	(% samples)
Very low (<1)	0	0	0
Low (1-2)	15	10	25
Moderate (2-4)	27	32	59
Moderately high (4-8)	8	8	16
High (8-16)	0	0	0
Very high (>16)	0	0	0
Sufficient (>2)	35	40	75
Deficient (<2)	15	10	25

Table 10: DTPA Mn (mg kg⁻¹) in Tapi command area

Particulars	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample no.	1-50	51-100	1-100
Minimum	1.12	1.52	1.12
Maximum	5.00	5.11	5.11
Mean	2.73	2.94	2.83
SD	1.19	0.99	1.10
CV (%)	43.58	33.55	38.73

Table 11: Categorization of DTPA-Zn (mg kg⁻¹) in Tapi command area

Category	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample no.	1-50	51-100	(% samples)
Very low (< 0.3)	1	2	3
Low (0.3-0.6)	38	35	73
Moderate (0.6-1.2)	11	13	24
Moderately high (1.2-1.8)	0	0	0
High (1.8-2.4)	0	0	0
Very high (>2.4)	0	0	0
Sufficient (>0.6)	11	13	24
Deficient (<0.6)	39	37	76

Table 12: DTPA Zn (mg kg⁻¹) in Tapi command area

Particulars	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample no.	1-50	51-100	1-100
Minimum	0.28	0.24	0.24
Maximum	0.96	0.92	0.96
Mean	0.57	0.54	0.55
SD	0.15	0.16	0.15
CV (%)	26.31	29.62	27.27

Table 13: Categorization of DTPA-Cu (mg kg⁻¹) in Tapi command area

Category	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample no.	1-50	51-100	(% samples)
Very low (< 0.1)	0	0	0
Low (0.1-0.2)	7	3	10
Moderate (0.2-0.4)	13	14	27
Moderately high (0.4-0.8)	30	33	63
High (0.8-1.2)	0	0	0
Very high (> 1.2)	0	0	0
Sufficient (> 0.2)	43	47	90
Deficient (< 0.2)	7	3	10

Table 14: DTPA Cu (mg kg⁻¹) in Tapi command area

Particulars	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample no.	1-50	51-100	1-100
Minimum	0.12	0.18	0.12
Maximum	0.78	0.79	0.79
Mean	0.49	0.52	0.51
SD	0.19	0.17	0.18
CV (%)	38.77	32.69	35.29

Conclusion

In Tapi command area, regarding soil available N, 3% samples were very low and 88% samples were under low category. About 35% samples were low in soil available P. regarding soil available K, samples were under the category of moderately high to very high. About 47%, 25%, 76% and 10% samples were deficient in DTPA-Fe, DTPA-Mn, DTPA-Zn and DTPA-Cu content, respectively. Soils from Shirpur tehsil were slightly healthier with higher nutrient availability as compared to Sindkheda tehsil in Tapi command area. From the experimental results it is concluded that, the soils from Tapi command area possess strong potential for sustainable agriculture, provided implementation of targeted soil fertility interventions including use of nitrogenous fertilizers, use of acid forming fertilizers, micronutrient supplementation particularly zinc and iron containing micronutrient fertilizers.

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