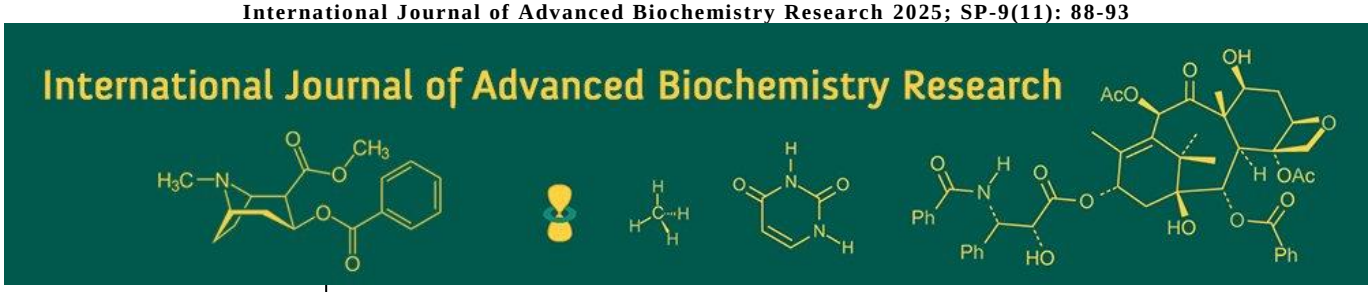

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Micronutrients fertility status of soil in Nira command area of Baramati tehsil

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Abstract
The present investigation entitled "Assessment of quality of soil in the Nira command area of Baramati tehsil" was undertaken to evaluate the chemical properties and nutrient status of soils in the Nira river command area. A total of 105 geo- referenced soil samples were collected across the region using a Global Positioning System (GPS) and analyzed using standard analytical methods. In the study of micronutrients analysis the available iron, manganese, zinc and copper ranged from 0.27-6.80, 1.71-22.46, 0.33-1.42, 0.75-7.7 respectively. Out of the 105 samples 62% samples were deficient and 38% were sufficient in iron. For manganese, 90% samples of samples are sufficient while 10% were deficient. Zinc deficiency observed in 16% samples of the with 84% being sufficient. In terms of copper content 100% samples were sufficient.

Keywords: Soil quality, Nira command area, Baramati tehsil, soil chemical properties, nutrient status, geo-referenced soil samples, GPS, micronutrientsutrient deficiency, soil fertility, standard analytical methods

1. Introduction
Maharashtra located in the western part of peninsular India covers a total area of 307,713 square kilometers ranking as the third-largest state in the country. It is bordered by several other states and the Arabian Sea. The state features a varied topography that includes the Deccan Plateau, the Western Ghats and the coastal Konkan region. Around 80% of Maharashtra's land approximately 17.43 million hectares is used for agriculture. However, only about 17% of this farmland, or nearly 2.94 million hectares, benefits from irrigation, making farming in the state largely dependent on rainfall. The cropping intensity is around 127%. The soil across much of Maharashtra is typically shallow and deficient in essential nutrients such as nitrogen, phosphorus, zinc and sulphur. Key crops cultivated in the state include sugarcane, cotton, sorghum, pearl millet, chickpea, soybean, sunflower and safflower (census and economic information center data).

Baramati tehsil located in the eastern part of Pune district, Maharashtra lies between latitudes 18°3′ and 18°12′ N and longitudes 74°13′ to 74°30′ E with an average elevation of approximately 538 meters above sea level. The region is geographically defined by the Nira river along its southern boundary, flowing from west to east and the Karha river a tributary that traverses from the northwest to southeast. Baramati is bordered by Indapur tehsil to the east, Satara district to the south, Purandar tehsil to the west and Daund tehsil to the north. Covering a total area of nearly 138,200 hectares about 104,107 hectares are suitable for cultivation. Of the cultivated land, approximately 39.9% (41,533 hectares) is irrigated, primarily due to the Neera-Karha irrigation scheme, while the remaining 60.1% (62,574 hectares) is dependent on rainfall (Khomane, 2021) [5]. The southern portion of Baramati, particularly the Nira command area was selected for study due to its predominantly agricultural land use.

Soil quality is an evolving concept aimed at assessing the health and effectiveness of soils, given their essential role in supporting both agricultural and natural ecosystems. It is a complex attribute that cannot be measured directly. Numerous definitions of the soil quality index exist in scientific literature but no universal set of soil characteristics has been agreed upon to quantify it. According to Doran and Parkin (1994) [2], soil quality refers to a soil's

ability to perform within an ecosystem to support biological activity, maintain environmental health and promote the well- being of plants and animals.

Acton and Gregorich (1995) [1] offered a more applied definition, describing soil quality as the soil's suitability to support crop production without causing degradation or harming the environment. Soil quality is determined by the interaction of measurable chemical, physical and biological properties, which can be managed or modified by human intervention, especially by farmers. Therefore, it is distinct from inherent soil properties such as those influenced by climate, topography, vegetation, parent material and time which are fixed and cannot be altered. From a productivity standpoint, each soil has a natural capacity to function, meaning some soils are innately more productive than others.

Micronutrients such as copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn) are vital for the healthy growth and development of crops. Both deficiency and excess of any of these elements can negatively impact plant growth. Copper helps mitigate harmful soil conditions by precipitating or deactivating certain soil toxins. Iron is essential for the synthesis of chlorophyll, while manganese plays a key role in photosynthesis and assists in the movement of other micronutrients within the soil. Zinc is important for the production of growth hormones, formation of starch and the maturation and development of seeds. (Marschner, H.,1995) [9].

2. Materials and methods

2.1 General information of study area

The Nira command area, located in Baramati tehsil of Pune district, Maharashtra, is an important agricultural zone irrigated by the Nira River. Geographically extending between 18°-18.5° N latitude and 74°-74.5° E longitude, the region features a mostly flat landscape with gentle slopes that aid surface drainage. The area has a semi-arid climate characterized by hot summers, moderate monsoons, and mild winters, with average annual rainfall of about 550-600 mm, mostly received during the southwest monsoon. The soils are primarily deep and medium black, ranging from clayey to loamy in texture with good moisture retention and fertility. However, the prolonged use of poor-quality irrigation water has resulted in increasing soil salinity and alkalinity, posing challenges to sustainable crop production.

2.2 Collection and analysis of soil sample

A total of 105 geo-referenced surface soil samples (0-22.5 cm depth) were collected from different locations across the Nira command area of Baramati tehsil to represent the various soil types. Sampling was carried out on a 1 km grid basis, and the latitude and longitude of each site were accurately recorded using a differential Global Positioning System (GPS). Soil samples were collected using a stainless steel auger to prevent iron contamination. The collected samples were analyzed for DTPA-extractable micronutrients, namely manganese (Mn), iron (Fe), copper (Cu), and zinc (Zn), using an Atomic Absorption Spectrophotometer as per the method outlined by Lindsay and Norvell (1978) [7].

2.3 Following is the list of villages selected for collecting soil samples

1. Songaon
2. Mekhali
3. Niravaghaj
4. Khandaj
5. Shiravali
6. Sangavi
7. Kambaleshwar
8. Pandharwadi
9. Late
10. Korhale Khurd
11. Sadobachi Wadi
12. Hol
13. Murum
14. Wanewadi
15. Nimbut

4. Result and discussion

4.1 Available iron

The overall data on available iron content is presented in Table 4.1 and illustrated in Figure 4.1. In the soils of the Nira command area of Baramati tehsil, available iron ranged from 0.27 to 6.80 mg kg^{-1} with an average of 3.00 mg kg^{-1}. Based on the critical limit of

4.5 mg kg^{-1} (Takkar *et al.*, 1989) [13], (62%) of the samples were found to be deficient in available iron while (38%) were considered sufficient. The minimum iron content recorded was 0.27 mg kg^{-1} at village sample Pandharwadi (V8Ss6) and the maximum was 6.80 mg kg^{-1} at Mekhali (V2Ss1).

The low availability of iron in the soils is attributed to the high pH levels and the precipitation of iron induced by the presence of excess calcium carbonate, which limits its availability to plants. Patil *et al.* (2019) [10] reported comparable findings in the Madhalli sub- watershed located in the northern zone of Karnataka and Sarap *et al.* (2020) [12] in the soils of Baramati block of Pune district of Maharashtra.

4.2 Available manganese

The data on available manganese content is presented in Table 4.1 and illustrated in Figure 4.1. In the soils of the Nira command area of Baramati tehsil, available manganese ranged from 1.71 to 22.46 mg kg^{-1}, with an average of 11 mg kg^{-1}. Based on the critical limit of 2 mg kg^{-1} (Takkar *et al.*, 1989) [13], (90%) of the soil samples were classified as 'sufficient' while (10%) were 'deficient'. The minimum manganese content recorded was

1.71 mg kg^{-1} at village sample Pandharwadi (V8Ss6) and the maximum was 22.46 mg kg^{-1} at Mekhali (V2Ss1).

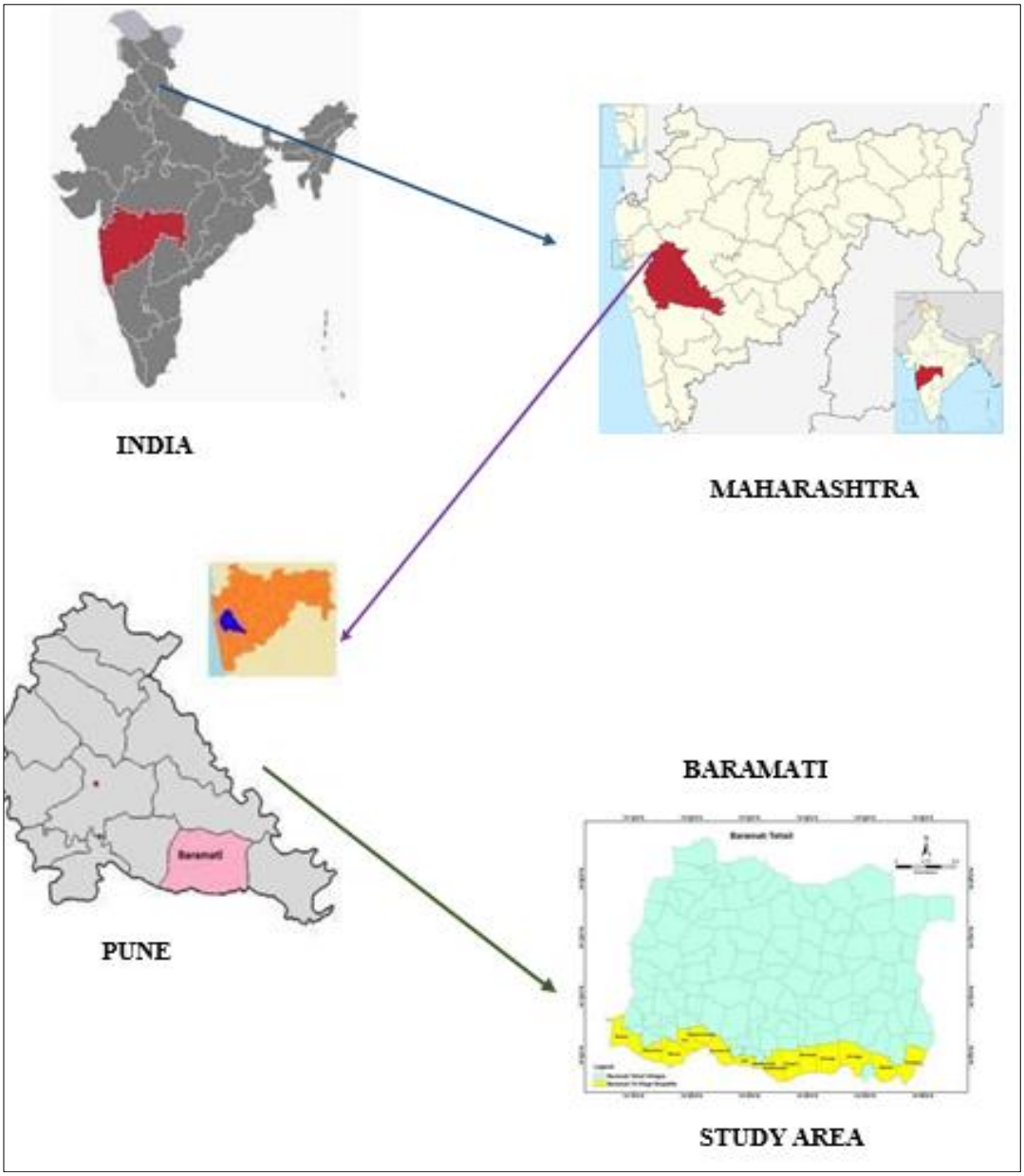
The adequate levels of available manganese may be attributed to the presence of high organic matter under favorable soil pH conditions. Moreover, the sufficient availability of NPK nutrients also supports the availability of manganese in the soil. Related observations were reported by Pattar *et al.* (2023) [11] of soils in Hunsur block of Mysuru district, Karnataka and Sarap *et al.* (2020) [12] in the soils of Junnar block of Pune district of Maharashtra.

4.3 Available zinc

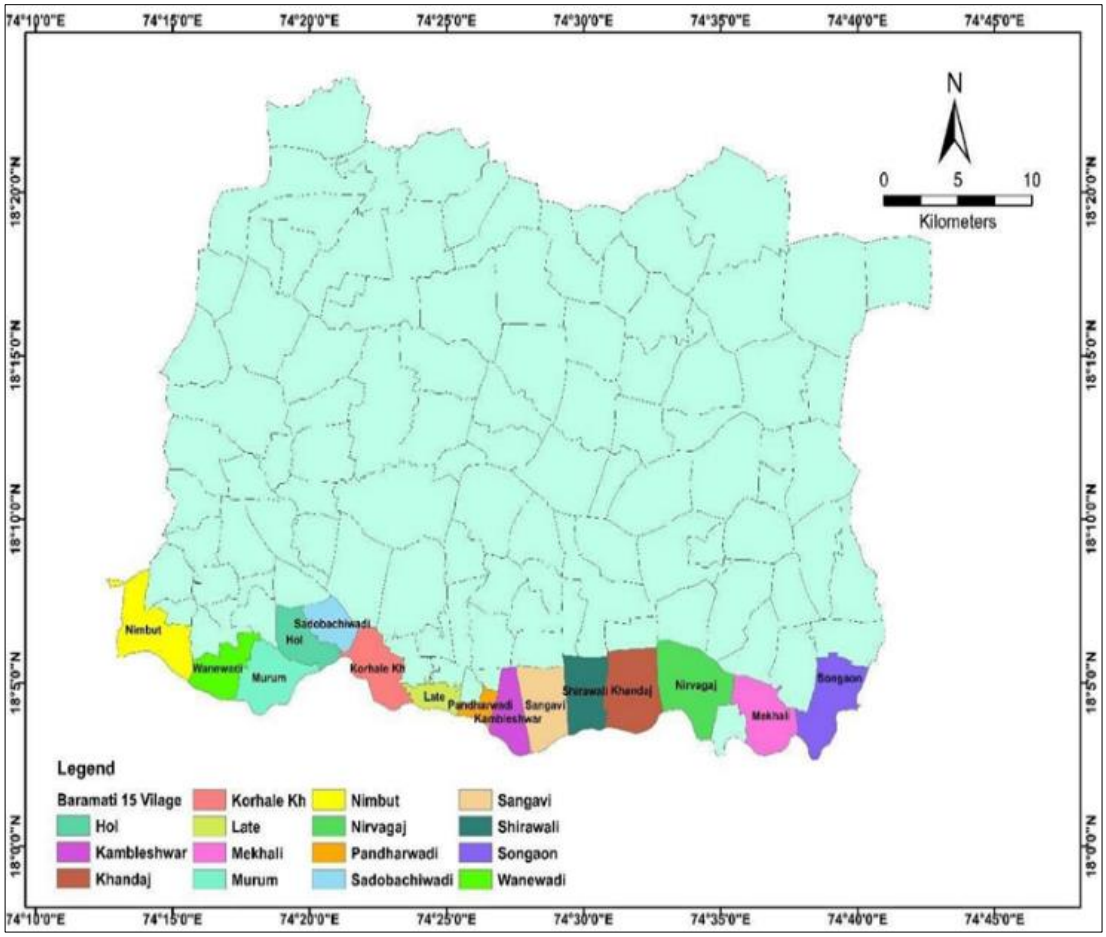
The data on available zinc content is presented in Table 4.1 and illustrated in Figure

4.2. In the soils of the Nira command area of Baramati tehsil, available zinc levels ranged from 0.33 to 1.42 mg kg^{-1} with an average of 1.03 mg $kg^{-}1$. Based on the critical limit of
0.6 mg $kg^{-}1$ (Katyal, 1985) [4], (84%) of the samples were classified as 'sufficient' while (16%) were found to be deficient. The minimum zinc content was 0.33 mg $kg^{-}1$ at village sample Pandharwadi (V8Ss6), Wanewadi (V14Ss6) and the maximum was 1.42 mg $kg^{-}1$ at Khandaj (V4Ss6).
The presence of zinc-rich parent rocks like basalt or shale enhances the available zinc content in the soil. Furthermore, the consistent use of zinc fertilizers such as zinc sulphate as part of integrated nutrient management practices, helps maintain adequate levels of plant-available zinc, even under alkaline soil conditions. Analogous results were described by Vaddepally *et al.* (2017) [14] in the soils of village Baragaon Nandur, dist- Ahmednagar of Maharashtra also equivalent results were recorded by Mahashabde and Patel (2012) [8] in Shirpur tehsil.

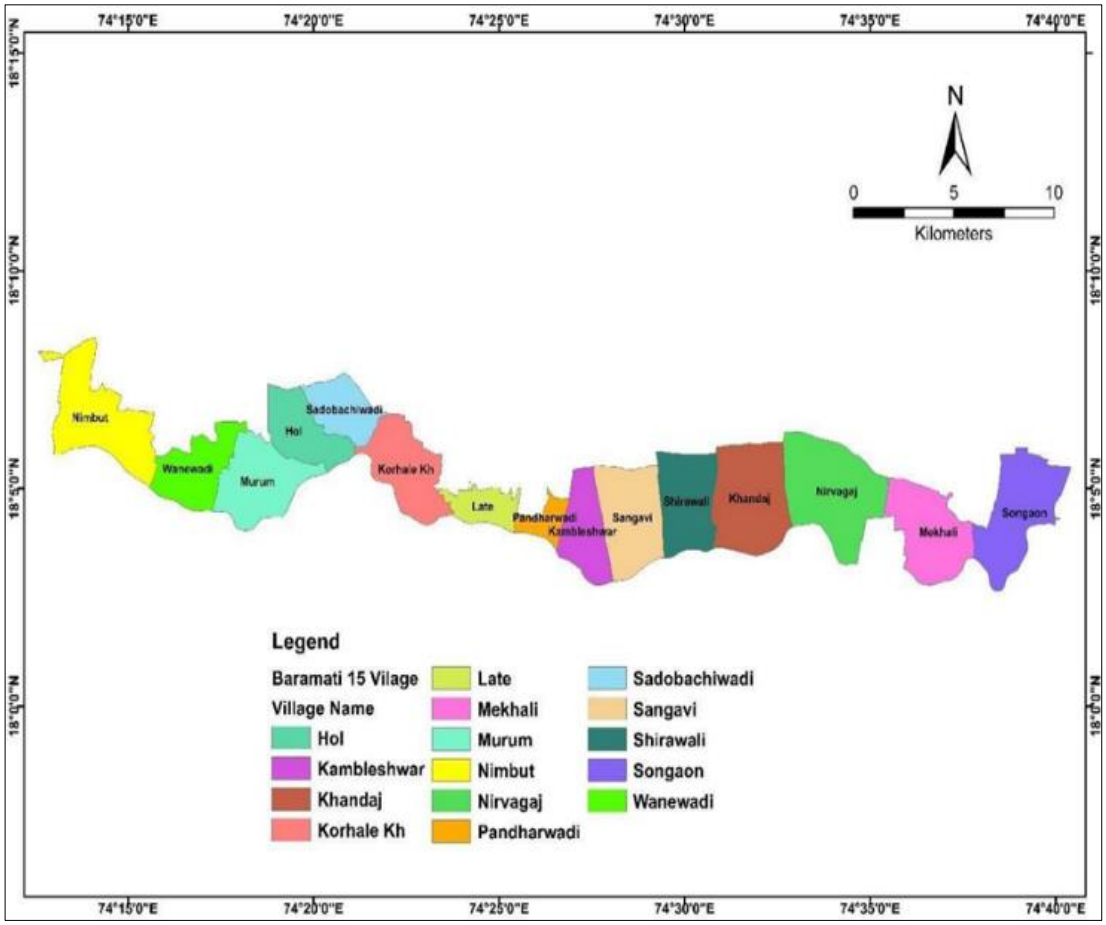
4.4 Available copper
The data on available copper content is presented in Table 4.1 and illustrated in Figure 4.2. In the soils of the Nira command area of Baramati tehsil, available copper levels ranged from 0.75 to 7.7 mg $kg^{-}1$ with an average of 3.5 mg $kg^{-}1$. According to the critical limit of 0.2 mg kg^{-1} (Katyal and Randhava, 1983) [4], all soil samples (100%) were classified as 'sufficient'. The minimum copper content was 0.75 mg $kg^{-}1$ at village sample Sadobachi Wadi (V11Ss4) while the maximum was 7.7 mg kg^{-1} at Mekhali (V2Ss1).
The findings indicate that the adequate copper availability in the soils may be influenced by the combined effects of various soil properties such as pH, electrical conductivity (EC) and organic carbon. While higher organic carbon content generally enhances copper availability, it tends to decrease with increasing pH and calcium carbonate levels in the soil. Similar results were found by Kumar *et al.* (2017) [6] in the soils of Chhattisgarh plain region of India and Sarap *et al.* (2020) [12] in the soils of different blocks of Pune district, (Maharashtra).



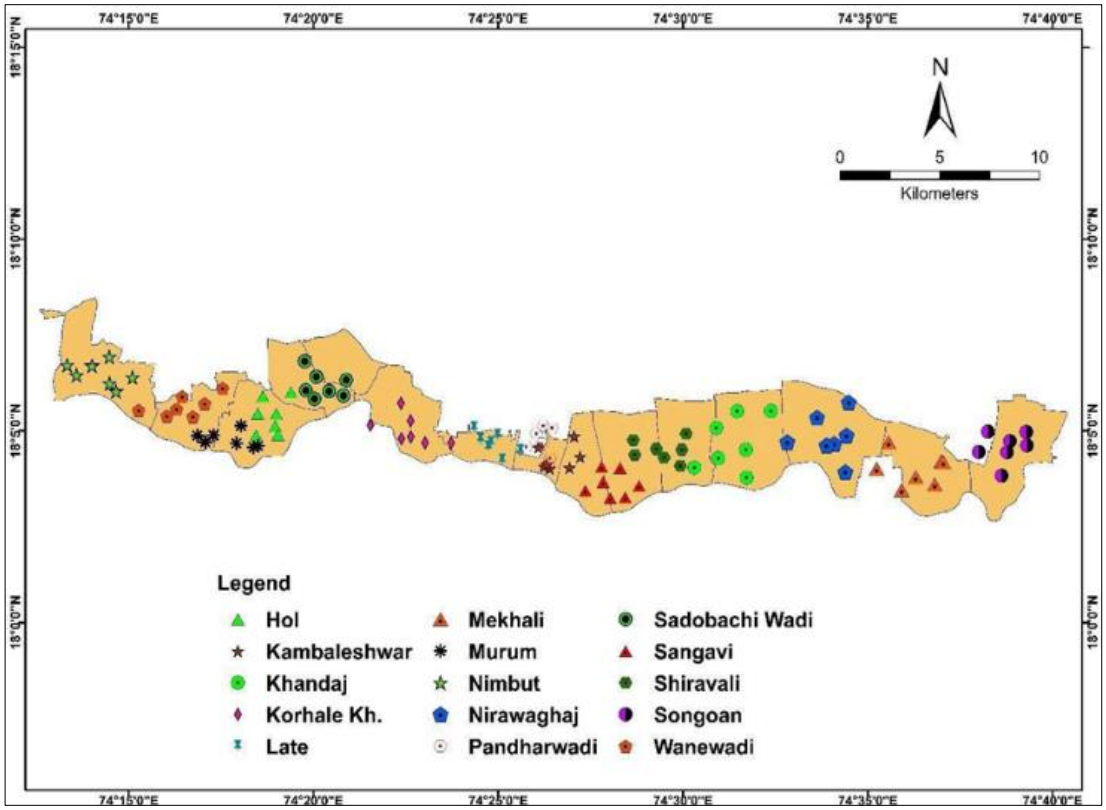
Map 3.1: Location map of study area



Map 3.2: Location map of Nira command area



Map 3.3: Location map of villages in Nira command area



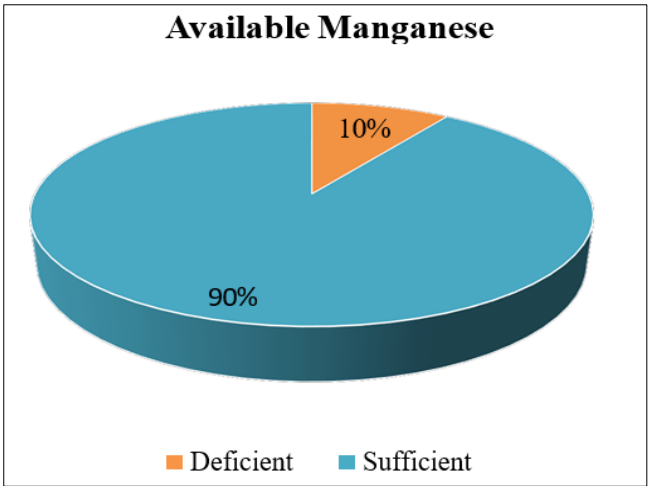
Map 3.4: Location map of sampling sites in Nira command area of Baramati tehsil

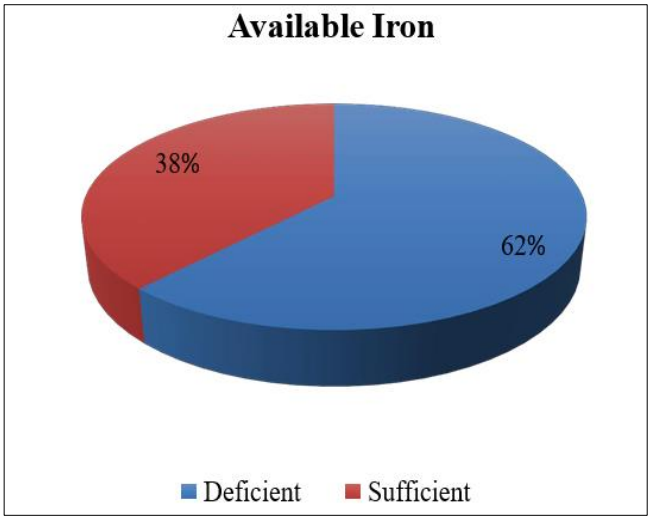
Table 4.1: Available micronutrient status in soils of Nira command area of Baramati tehsil

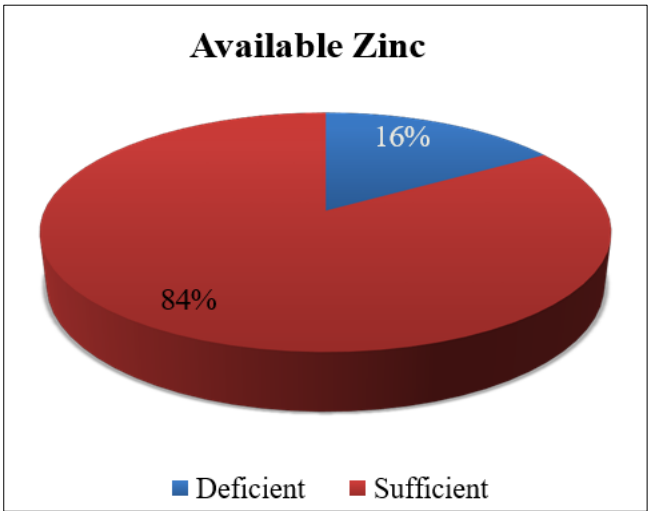
Particular	-1 Available Micronutrients (mg kg)			
	Fe	Mn	Zn	Cu
Mean	3	11	1.03	3.5
Standard deviation	2.34	6.16	0.32	2.22
Minimum	0.27	1.71	0.33	0.75
Maximum	6.8	22.46	1.42	7.7

CV%	**78**	**58**	**31.15**	**64**
Category D	Sufficient (38%)	Sufficient (90%)	Sufficient (84%)	Sufficient (100%)
	Eficient (62%)	Deficient (10%)	Deficient (16%)	

(Total no. soil samples analyzed - 105, figures in parenthesis are in per cent)







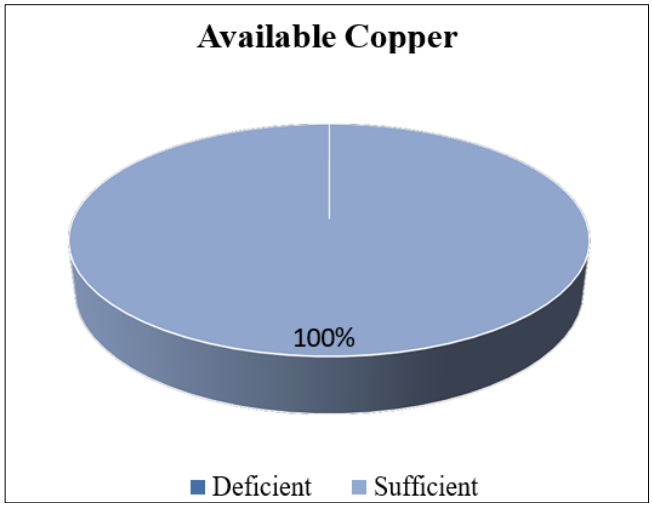


Fig 4.2: Soil available micronutrients (Zn,Cu) of Nira command area, Baramati tehsil.

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