



Nutrient Status of Soil and Farm Yard Manure (FYM) under Different Agro-Climatic Regions of Maharashtra

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To gain maximum crop production from a unit area, soil health is one of the major components. It is determined based on the nutritional availability and other parameters like pH, EC, organic carbon, etc. The reports on soil nutrients help farmers in fertilizer application to optimize the yields. The values of these parameters vary from region, soil type, agro-climatic zones, crop, etc. To maintain soil fertility application of organic source of fertilizer such as, FYM plays an important role. It is not only a good source of nutrients but also increases water-holding capacity, soil organic matter, soil physical properties, etc. The study was conducted with an objective to assess nutrient status of soil and FYM from various agro-climatic regions of Maharashtra.

Methodology: Maharashtra state is divided into nine different agro-climatic regions. The study was conducted to understand the region-wise variability in the nutritional composition of both soil and FYM in Maharashtra during the year 2020-21. Samples of soils and dried FYM were collected from farmer's fields from five agro-climatic regions of Maharashtra i.e., Western Maharashtra, Northern

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Maharashtra, Marathwada, Vidharbha, and Konkan. The samples were analyzed for various parameters at BAL-Chemical laboratory, BAIF Central Research Station, Urulikanchan.

Results: The analysis reports of soil samples revealed that soils of the Western Maharashtra region showed maximum values for N, Fe, Mn, Cu, and Zn whereas, soil samples from the Vidharbha region were having high values for P and K content as compared to other regions. The soil samples from the Konkan region showed low nutrients availability than other regions. The soil pH of different agro-climatic regions ranged from 6.3 to 9.0. Similarly, FYM samples of the Western Maharashtra region showed maximum values for N, P, K, Fe, Mn, and Zn content whereas, samples of the Marathwada region were comparatively low in all nutrients and organic carbon content. PCA biplot of macro and micro elements of soil and FYM nutrients revealed geographical/spatial structuring based on nutrient content.

Keywords: Nutrient status; soil; farm yard manure; agro-climatic region.

1. INTRODUCTION

Soil is an important in crop production as it is the main source of nutrients for the crop. Meeting the demand for food of the ever-increasing human population worldwide and achieving the target of certain stage use of maximum inputs through fertilizers, pesticides, fungicides, insecticides, nematocides, and herbicides were adopted [1]. Due to heavy use of chemicals, the life of beneficial soil microorganisms responsible for maintaining soil health is influenced. Soil analysis indicates the availability of soil nutrients which helps in determining the supplementation of nutrients efficiently and economic crop production.

Farmyard manure (FYM), is the organic source of nutrient supply and is applied to soil as usual practice. It has long been considered as a desirable soil amendment, and its effect on soil properties is numerous [2]. The quality of FYM varies from region to region and the source of livestock dung, as dung is the major component of FYM. Farmyard manures are the major source of nutrient supply also on small farm holdings [3]. The available reports indicated that the organic carbon content of the soil increased over its initial value with the period of incubation irrespective of soil types and the addition of FYM. The increase in organic carbon may be due to decomposition of organic matter and the fine root

stubbles which were left in the soil [4]. In this context, the study was conducted to assess the soil and FYM nutrient status of different agro-climatic regions of Maharashtra.

2. MATERIALS AND METHODS

2.1 Sample Collection

Explorations were made to the farmer's field and 78 samples of soil and 64 samples of FYM were collected from different districts located in five agro-climatic regions of Maharashtra (Table 1).

The climatic and edaphic characteristics of the study area has been showed in supplementary Table 1. The region-wise districts covered were Western Maharashtra: Pune, Satara, Sangali, and Kolhapur Northern Maharashtra: Dhule and Nandurbar, Vidarbha: Yawatmal and Wardha Marathwada: Osmanabad, Beed and Latur Konkan: Jawhar and Palghar (Fig. 1).

2.2 Procedure for Soil Samples

The soil sampling from the farmer's field was done as per the standard process which is diagrammatically presented in Fig. 2. The samples were taken upto 15-20 cm depth by adopting pit method of sample collection (Parewa et. al., 2016).

Table 1. Details of region wise sample collection

Agro-climatic region	Number of soil samples	Number of FYM samples
Western Maharashtra	25	22
Vidarbha	10	10
Northern Maharashtra	16	15
Konkan	16	6
Marathwada	11	11

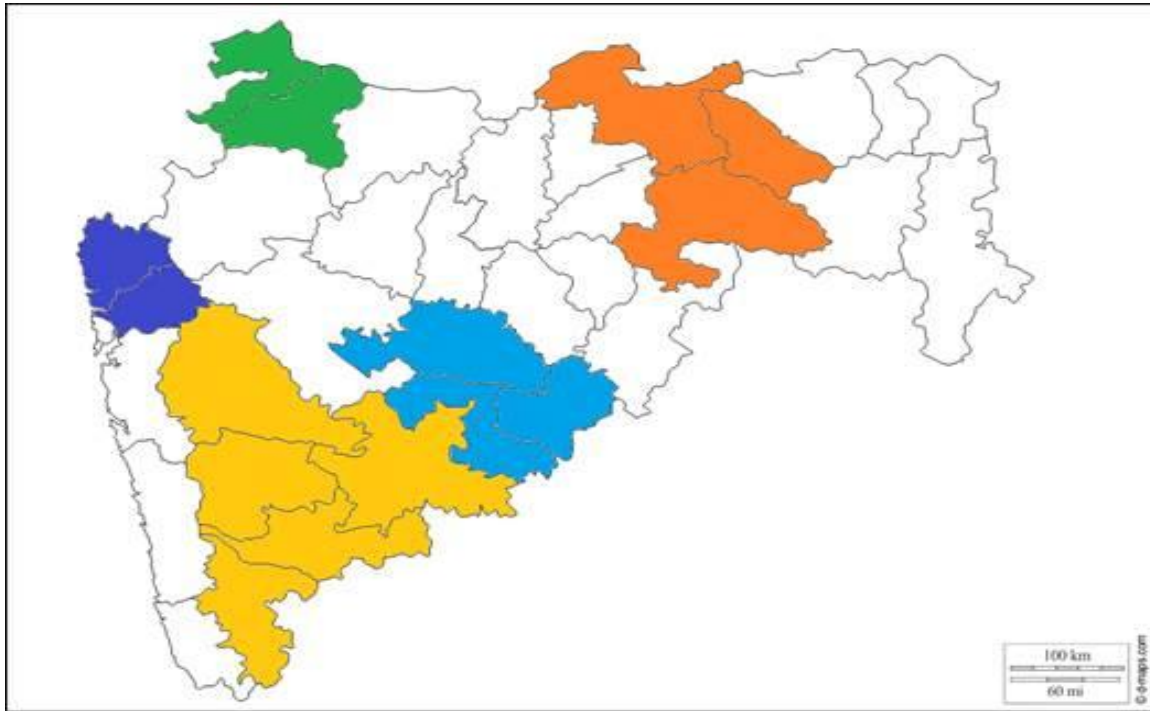


Fig. 1. District wise sample collection in Maharashtra state

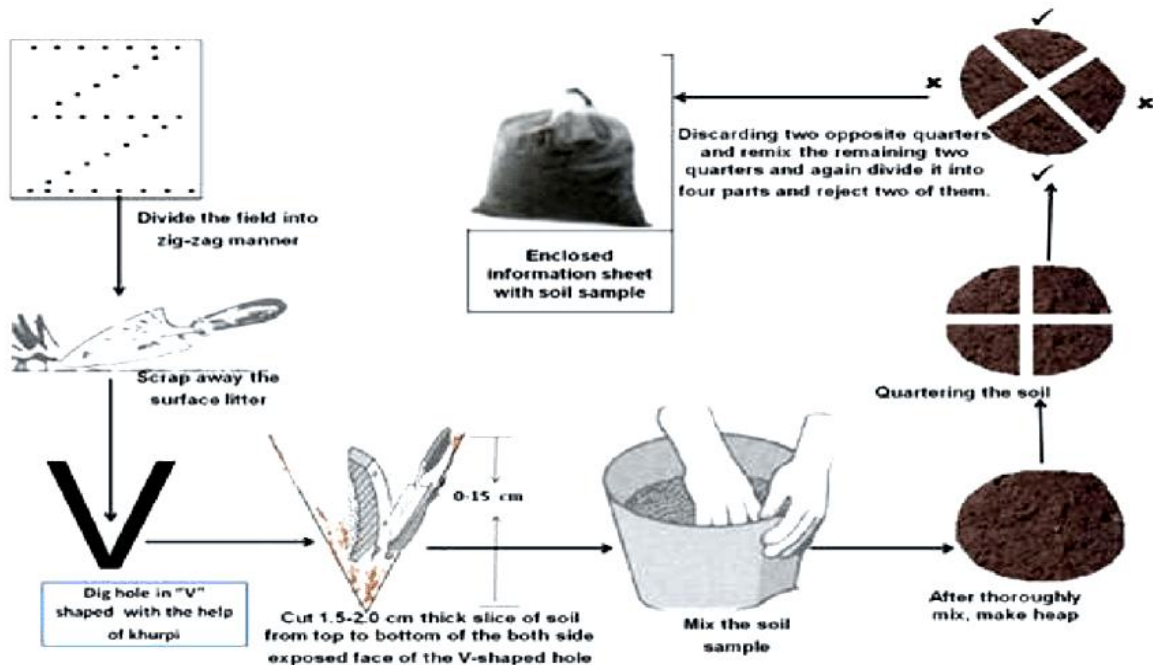


Fig. 2. Procedure for the sample collection from field

2.3 Analysis of Samples in the Laboratory

Collected bulk samples of soil and FYM were analysed for different parameters in the BAIF's NABL accredited chemical laboratory by

adopting standard procedures and methods given by the ministry of agriculture Govt. of India -2011 (e.g. estimation of nitrogen by Kjeldahl method, Phosphorus by Olsen's method, Potassium by Flame photometric method, etc.).

2.4 Data Analysis

The analytical data for soil and FYM samples were partitioned using past 4.11 software. Principal component Analysis (PCA) was drawn scatter plot based on given values.

3. RESULTS AND DISCUSSION

3.1 Soil Macronutrients

The values for N, P, and K in different regions were shown in Fig. 3. The differences in the values were observed region-wise and within the region also. The availability of soil nitrogen was higher in the Western Maharashtra region which was close to the Northern Maharashtra region samples. The average value for nitrogen content was 130.92 kg/ha and 130.82 kg/ha in western Maharashtra and Northern Maharashtra regions respectively. Ghodake et al., [5] also reported that the nitrogen content in the soil of western Maharashtra ranged between 95-328 kg/ha. Soils of the Vidharbha region were higher in Phosphorus and Potassium content as compared to other regions. The Phosphorus content varies from 21 to 42 kg/ha with an average of 27.6 kg/ha and the Potash content varies from 202 to 250 kg/ha with an average mean value of 239.6 kg/ha. The soil samples from Konkan and Marathwada regions showed lower nutrient availability than other regions which was 123.81, 27.75, 190.31 kg/ha in the Konkan and 125.50, 20.60, 182.50 kg/ha in Marathwada for nitrogen, phosphorus, and potassium respectively. Chaudhari et al., [6] also reported that the soil of the Beed district was lower in phosphorus. Hadole et al., [7] also showed similar results that, soils of the Palghar district of the Konkan region was found to vary nitrogen from 86.66 to 298.56 Kg ha⁻¹ with a mean value of 178.40 Kg ha⁻¹. PCA biplot drawn for soil macronutrients (Fig. 4)

showed two main groups and also region wise separation. The vectors for NPK demonstrated the influence of individual nutrients on its distribution across the selected regions. The regions containing districts of Ahmednagar, Palghar, Osmanabad and Latur showed relatively lower soil nutrient levels and others parameters. In the biplot, the main influence was found to be Potash. Based on the Phosphorus and Nitrogen content of the soil the regions found to bifurcate.

3.2 Soil Micronutrients

The results of the micronutrient analysis of the study were shown in Fig. 5. It is revealed that region-to-region variability for micronutrients availability in soil was observed. Among the micronutrients soil of Western Maharashtra showed Fe deficiency. Indian soils are extensively deficient in micronutrients and 5.4% soils of in India recorded Cu deficiency [8]. All the collected soil samples from different regions of Maharashtra were analyzed for micronutrients such as Fe, Cu, Zn, and Mn. Among the agro-climatic regions soils in the Western Maharashtra region were higher in micronutrient content. The maximum average values for Fe, Cu, and Zn with 3.55, 2.5, and 2.1 ppm respectively were found in the Western Maharashtra region which was followed by the Konkan region with 1.5, 1.7, and 1.9 ppm respectively. Mahale et al., [9] also stated that the available Fe in the soil ranged from 2.40 to 13.86 mg kg⁻¹ with a mean value of 8.36 mg kg⁻¹, Mn ranged from 4.96 to 9.83 mg kg⁻¹ with a mean value of 6.99 mg kg⁻¹ and Zn ranged from 0.43 to 1.78 mg kg⁻¹ with a mean value of 1.23 mg kg⁻¹ in Konkan region of Maharashtra. Similar findings were also reported by Borkar et al., [10]. The results of the soil sample analysis of pH, EC, and OC have presented in Fig. 6.

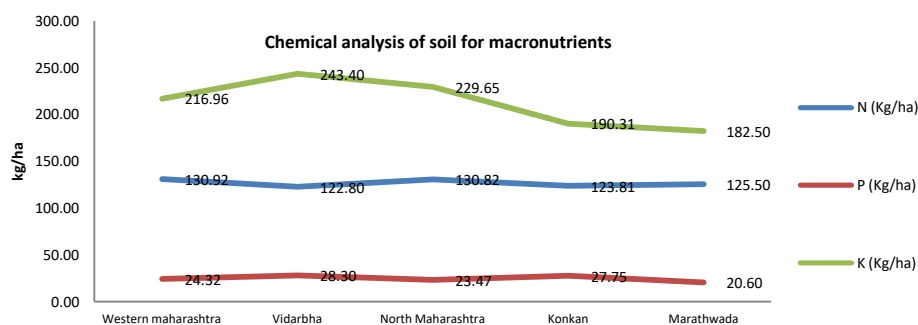


Fig. 3. Chemical analysis of different soil sample for soil for macronutrient

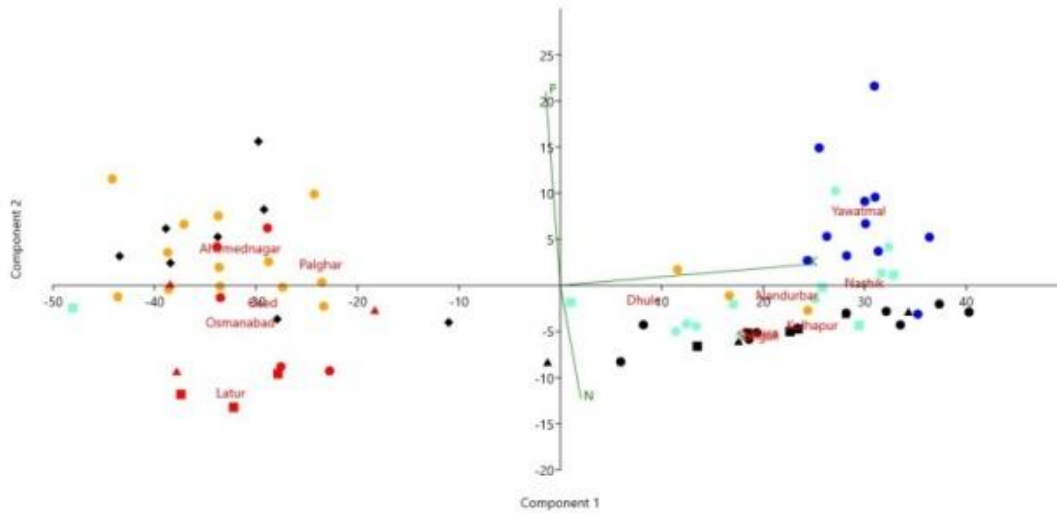


Fig. 4. PCA for soil macronutrients and region wise distribution

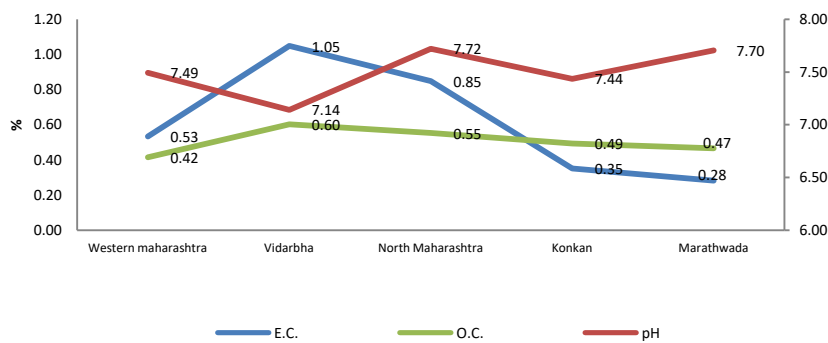


Fig. 5. Chemical analysis of Soil for micronutrients

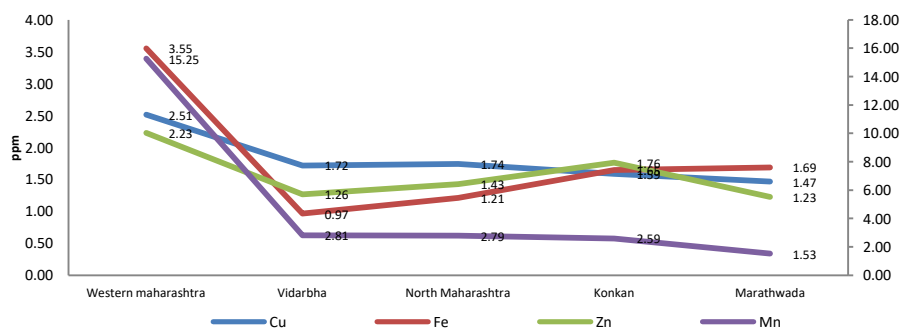


Fig. 6. Chemical analysis of Soil for other parameter

The soil pH of different agro-climatic regions ranged between 6.3 to 9.1. The low pH of 6.3 and the highest pH of 9.1 was observed in the Western Maharashtra region. Sathe et al., [11] reported that some parts of the Sangli district in western Maharashtra is having lower soil pH value of 6.58. Pawar and Sangale [12] also

stated that the soils were high in pH ranging between 7.16 to 9.56 in some parts Shirampur block of the Ahmednagar district. The organic carbon content ranged from 0.20 to 0.70% with a mean value of 0.50%. This variation may be due to different soil types, cropping patterns, and the use of organic manures in soil. The soils from

Vidharbha regions were rich in organic carbon content which was 0.57% to 0.66% with a mean value of 0.60% which was followed by North Maharashtra, Konkan, Marathwada, and western Maharashtra regions having an organic carbon content of 0.55%, 0.49%, 0.47%, and 0.40% respectively. The organic carbon of different soil series of Western Maharashtra ranged from 0.15 to 1.42 percent with an average value of 0.54 percent [5] (Fig. 7).

3.3 FYM Sample Analysis

All FYM samples collected from different agro-climatic regions of Maharashtra were analyzed for macro & micronutrients, and other parameters. The results were given in Table 2. Among the various agro-climatic regions, the FYM samples collected from Western Maharashtra were having high values for N, P, K, and Fe content. While the FYM samples collected from the Marathwada region were comparatively lower in macro and micronutrient content except for Zn which was found maximum. The organic carbon content ranged

from 18.93 to 20.61 percent in five agro-climatic regions. Lower organic carbon content was found in Konkan regions samples with a value of 18.93% followed by Marathwada, Northern Maharashtra, Vidharbha, and Western Maharashtra regions with values of 19.03, 19.68, 20.17 and 20.61 percent respectively. Nutrient variation in manures is affected by variations in ratio, composition, and utilization of animal work. Moreover collection, storage, and processing of animal waste and the addition of organic material [13-14].

PCA biplot (Fig. 8) showing differences concerning region-wise nutrient content of FYM. FYM samples from Kolhapur, Sangali, and Satara districts of Western Maharashtra contains higher Fe and OC whereas, Dhule and Nandurbar districts of Northern Maharashtra and Yawatmal from Vidharbha region contain a higher amount of Cu and EC. Samples of FYM from Nashik and Wardha districts were showing lower nutrient content. The rest of the district was rich in Zn content.

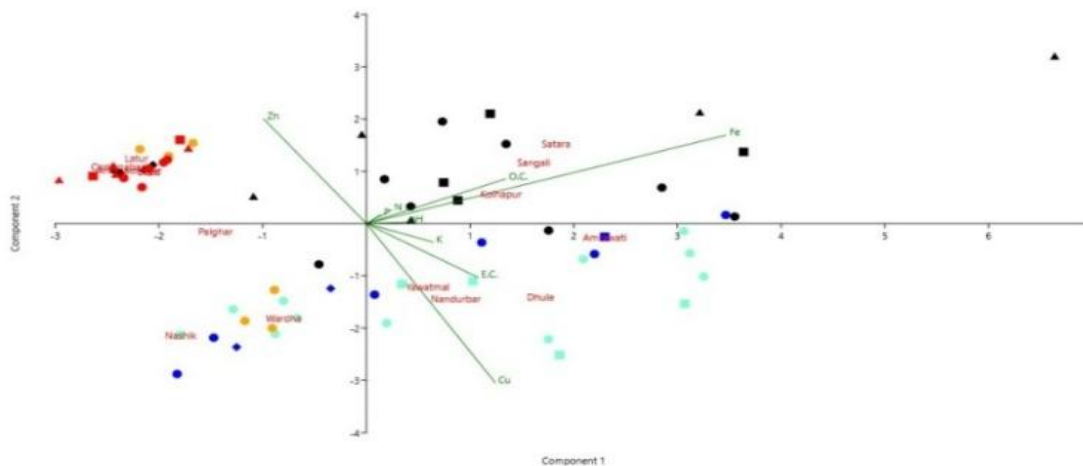


Fig. 7. PCA for soil micronutrients

Table 2. Chemical analysis of FYM for macro, micro, and other parameters

Agro-climatic regions	Nutrient content								
	N (%)	P (%)	K (%)	Cu (ppm)	Fe (ppm)	Zn (ppm)	E.C.	pH	O.C. (%)
Western Maharashtra	1.27	0.50	2.27	2.14	5.58	2.17	1.59	8.02	20.61
Vidharbha	1.11	0.33	2.19	3.69	4.58	1.09	2.08	7.44	20.17
North Maharashtra	0.98	0.34	2.24	4.24	5.15	1.11	1.96	7.96	19.68
Konkan	0.94	0.33	1.71	2.32	3.80	2.44	0.86	7.42	18.93
Marathwada	0.93	0.25	1.37	1.50	3.65	3.03	0.52	7.70	19.03

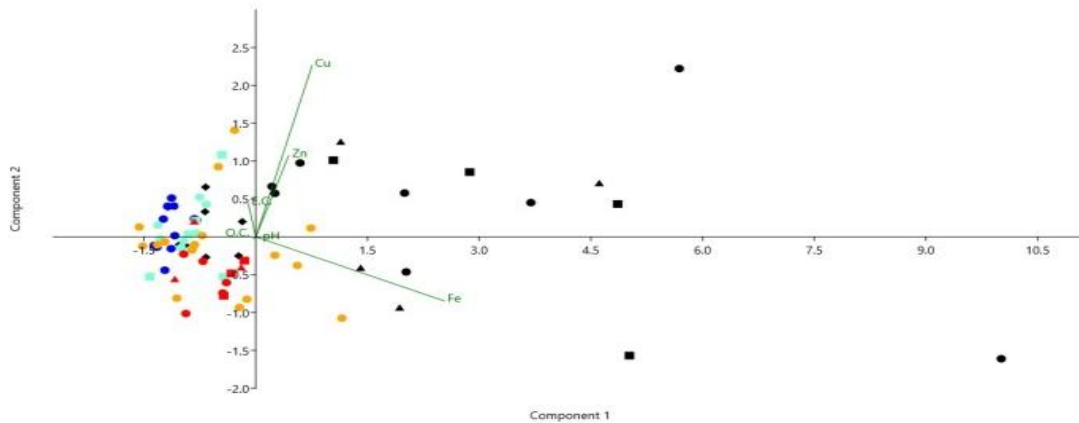


Fig. 8. PCA for Macro and Micro nutrient content of FYM

4. CONCLUSION

Soil and FYM samples were analyzed for nutrient content from various regions of Maharashtra. Western Maharashtra and Vidarbha regions contain higher macro and micronutrients compared to other regions. FYM samples from Western Maharashtra and Vidarbha regions were higher in NPK content whereas micronutrients were maximum in Western Maharashtra, Vidharbha regions, and northern Maharashtra regions.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Supplementary Table 1. Agro-ecological/agro-climatic zones of Maharashtra

Zone	Name of the zone	Climatic conditions	Average annual rainfall	Soil type
South Kokan Coastal Zone	Very high rainfall zone with laterite soils	Daily temperature above 20°C throughout the year. May hottest above 33 ⁰ C. Rainfall due to S-W monsoon from June to Sept.	3105 mm in 101 days	Laterite. PH 5.5-6.5 acidic, poor in phosphorous rich in nitrogen and potassium
North Kokan Coastal Zone	Very high rainfall zone with non- lateritic soils	Avg. daily temp 22 to 30°C. Mini. temp 17 to 27°C. Humidity 98% in rainy season & winter- 60%	2607 mm in 87 days. Maximum rain received in July i.e. 41 %	Coarse & shallow. PH 5.5 to 6.5, acidic rich in nitrogen, poor in phosphorus & potash.
Western Ghat Zone	Western Ghat Zone/Ghat zone	Maximum temp. ranges from 29-39° C. Minimum temp ranges from 13-20° C.	3000 to 6000 mm.	'Warkas' i.e. light laterite & reddish brown. Distinctly acidic, poor fertility low phosphorous & potash content.
Transition Zone -1	Sub Mountain Zone	Average maximum temperature is between 28-35°C and minimum 14-19°C	700-2500 mm. Rains received mostly from S-W monsoon.	Soils are reddish brown to black tending to lateritic. PH 6-7. Well supplied in nitrogen but low in phosphorous & potash
Transition Zone-2	Western Maharashtra Plain Zone	Water availability ranges from 120-150 days. Maximum temperature 40°C & minimum 5°C.	Well distributed rainfall 700 to 1200 mm.	Topography is plain. Soils greyish black .Moderately alkaline 7.4- 8.4, lowest layer is 'Murum' strata. Fair in NPK content. Well drained & good for irrigation.
Scarcity Zone	Western Maharashtra Scarcity Zone/ Scarcity Zone	Dry spell varies from 2-10 weeks. Water availability 60-140 days. Maximum temp. 41°C minimum-14- 15°C	Less than 750 mm in 45 days. Two peaks of rainfall. 1) June/ July 2) September. Bimodal pattern of rainfall.	Slope between 1-2%. Infiltration rate is 6-7 mm/hr. The soils are vertisol. Soils have Montmorillonite clay. Poor in nitrogen, low to medium in phosphate & well supplied in potash.
Assured Rainfall Zone	Central Maharashtra Plateau Zone /Assured Rainfall Zone	Maximum temperature 41°C Minimum temperature 21°C	700 to 900 mm 75 % rains received in all districts of the zone.	Soil colour ranges from black to red. Type-1) Vertisols 2) Entisols & 3) Inceptisol PH 7-7.5
Moderate Rainfall Zone	Central Vidharbha Zone /Zone of	Maximum temperature 33-38°C Minimum temperature 16-26°C	1130 mm	Black soils derived from basalt rock. Medium to heavy in

Zone	Name of the zone	Climatic conditions	Average annual rainfall	Soil type
	Moderate Rainfall	Average daily humidity 72 % in rainy season, 53 % in winter & 35% in summer.		texture alkaline in reaction. Low lying areas are rich and fertile.
Eastern Vidharbha Zone	Eastern Vidharbha Zone/ High Rainfall Zone	Mean Maximum temperature varies from 32 to 37°C. Minimum temperature 15 to 24°C. Daily humidity 73% for rainy season 62 winter & 35 summer	950 to 1250 mm on western side. 1700 mm on extreme east side No of rainy days 59.	Soils derive from parent rock granite, gneisses, and schist. Brown to Red in colour. PH 6 to 7

(Source: Agro-climatic zones in Maharashtra, <http://www.mahaagri.gov.in>)

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