Soil Quality Valuation Through Physico-Chemical Analysis: A Case Study of Nashik Taluka

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***Abstract*—The present study is a physico-chemical analysis of agricultural soils from different villages of Nashik Taluka, District Nashik, and Maharashtra State. The fundamental indices of soil fertility and all soil nutrition were examined, including pH, Electrical Conductivity (EC), Total Organic Carbon (TOC), Available Nitrogen (N), Available Phosphorus (P), and Available Potassium (K) and soil moisture. To provide a detailed representation of field conditions, illustrative soil samples were gathered using established sampling techniques. The results indicated significant variability in soil properties across the tested villages. Soil pH and EC values indicated differences in soil reaction and salt content, while TOC levels showed the variations in organic matter content. Similarly, the availability of essential nutrients (N, P, and K) varied regionally, showing variation in soil fertility within the villages and Soil moisture** shows **amount of water is present in the soil at a given time. The results provide valuable information for farmers and agricultural advisors, supporting identification of nutrient deficiencies and guiding them to fertilizer management practices. This can increase crop productivity, improve nutrient utilization, and support economically sustainable agricultural practices in Nashik Taluka.**

***Index Terms*— Quality of soil, N, P, K, EC, PH, Total organic carbon, Soil moisture Nashik Taluka, Maharashtra**

I. INTRODUCTION

Agriculture is the strength of the economy of any country. Indian farmers are cultivating their farms in traditional ways, but nowadays, farmers are adapting new techniques and other experiments on their farms, due to which some advantages as well as disadvantages also occur [1]. Soil sampling is a critical and initial step in soil analysis, as only a very small fraction of the total soil quantity is ultimately analyzed in the laboratory. Therefore, obtaining a truly representative soil sample is essential to ensure the accuracy and reliability of soil test results. Soil test–based nutrient management has emerged as a key strategy for enhancing agricultural productivity and sustainability. The ideal and careful use of nutrients, guided by soil analytical data, not only improves crop productivity but also minimizes nutrient wastage and reduces adverse environmental impacts associated with unselective fertilizer use. In intensive agriculture systems, widespread deficiencies of primary, secondary, and micronutrients have been increasingly reported, highlighting the need for systematic soil testing and site-specific nutrient management practices [2]. Soil analysis is a various chemical process that determines the amount of present nutrients in the soil. Chemical soil analysis determines the content of basic plant nutrients: phosphorus (P_2O_5), potassium (K_2O), pH, humus content, total $CaCO_3$, available lime, organic matter, total sulphur (S), trace elements, and other physical characteristics. The physicochemical study of soil is important to agricultural chemists for predicting the increase in the crop yield [3, 4]. From the results of the amount of phosphorus, potassium, organic carbon, electrical conductivity, and pH, we can decide about the fertility of soil. Soil analysis is the combination of three discrete but interrelated processes: analysis, interpretation, and recommendation [5]. From the data of the results, we can decide which fertilizer is required for the growth of the plant [6, 7]. Everyone uses the soil, either directly or indirectly. It is a natural form on which agricultural crops grow, and it has a precious ecosystem [8, 9]. Soil is the middle in which

crops grow to nourish and clothe the world. Soil potency is vibrant to a productive soil. Certain external factors control plant growth: air, temperature, light, mechanical support, nutrients, and water. Plants had elements for their growth and completion of their life cycle. Carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, and other elements belong to it [10]. Plant growth, the firming of reproductive systems, the enzymes activation, and the digestion of carbohydrates all depend comprehensively on nitrogen (N), phosphorus (P) and potassium (K) [11]. The utilization of a soil test-based nutrient methodology, which allows for cost-effective administration of nutrients based properties of soil, has become a key strategy for good crop production and yield. Since the best use of nutrients, based on soil testing, can increase crop productivity and decreases nutrient waste and also minimizing the impact on the environment through optimal production, soil test-based nutrient management has become a crucial issue in efforts to increase agricultural productivity and production. In intensively farmed areas, deficiencies in primary, secondary, and micronutrients have been noted [12]. Everyone is impacted by soil, either directly or indirectly, and it is important to human existence. It is a natural organism with a delicate ecosystem that supports agricultural products [13, 14]. This approach is not planned to study the possible effects of sensitive nutrients, like phosphorus, on the ecosystem. The only purpose of this interpretation method is to determine whether the soil is now suitable for producing horticultural or agronomic crops. Although nutrient availability can play a significant role in determining the possibility of negative environmental consequences, it is only one aspect of the whole picture. The probable movement of nutrients off-site and their ability to have a negative environmental impact on surface and groundwater depend on a number of factors, including slope, ground cover, assimilation of nutrient sources, time of application, and others [15, 16].In addition to providing vital resources for the world's food production and fiber for clothes, soil is the primary medium for crop cultivation. A fruitful soil depends on soil fertility. Air, temperature, light, mechanical support, nutrients, and water are some of the extrinsic variables that regulate plant growth [17]. Early in the growing season, quick root formation is crucial in cold climates. For some crops, a modest amount of starting fertilizer may be advised even though the soil's available level may be considered optimal or even excessive in order to promote this. This mostly relates to recommendations for phosphate (P_2O_5), since encouraging early root growth requires a sufficient supply of accessible P. The amount of nutrients in starter fertilizer is usually lower than that of regular crop removal. Analysis, interpretation, and suggestion are the three separate but connected procedures that make up soil fertility testing [16]. Stefanic's definition [18] most closely resembles the basic biological aspect of soil fertility. The essential activity of the micro-population of plant roots of accumulated enzymes and chemical reactions, producers of biomass, humus, mineral salts, and active biologic substances, is what gives the soil its fertility. The potential degree of bioaccumulation and mineralization processes, which depend on the program and circumstances of the evolution of the ecological subsystem, as well as on human impacts, are linked to the fertility level. This term possesses an analytical quality. After a detailed understanding of the definition, the degree of soil fertility can be measured using soil sample studies [19].The formula determines the phosphate (P_2O_5) requirements for various crops. The goal of this current study is to determine the amount of soil nutrients in Nashik Taluka, Maharashtra. The information provided will help farmers calculate the amount of fertilizer that should be added to the soil in order to reduce production costs. This paper's goal was to examine the trends in the N, P, K, EC, OC, pH, and soil moisture condition of the soils in Maharashtra State, Nashik Taluka.

II. EXPERIMENTAL

The quality test survey of the soil was conducted in 2024. Fifteen villages from Nashik Taluka covering North, South, East and West were selected for this study. A representative soil sample collected from each village which represent soils of 5 to10 farmer's depending upon area of village. The soil samples were collected following standard quadric procedure and taken in polythene bags. In laboratory these samples were analysed for different chemical parameters following standard methods [20]. AR grade reagents and double distilled water were used for soil analysis. Results were compared with standard values [21] to find out low, medium or high nutrient's content essential for STR.

III. PHYSICO - CHEMICAL ANALYSIS

The major physical and chemical soil quality parameters, such as PH, Electrical Conductivity (EC), Organic Carbon (OC), and Nitrogen (N), were examined in the obtained samples [22, 23]. Chromic acid (Potassium Dichromate, H2SO4) oxidizes organic materials. Indian laboratories make extensive use of this technique. The conventional method of K and P analysis. A PH meter was used to measure PH; a conductivity meter was used to measure EC; a colorimeter was used to measure OC; a flame photometer was used to measure potassium; and a spectrophotometer was used to measure phosphorus. Every piece of equipment is made by Techtonic. Soil was examined at the Deolali Camp Chemistry Laboratory in Nashik.

IV. RESULT AND DISCUSSION

A total of 15 village soil samples of Nashik Taluka, District Nashik, Maharashtra, were collected in clean polythene bags and brought to the laboratory; it is the permissible standard according to the Chemistry Laboratory, Deolali Camp, and Nashik. Air-dry the soil samples in shade, crush the soil clods lightly, and grind with the help of a pestle and mortar. Pass the entire quantity through a 2 mm stainless steel sieve. If the gravel content is substantial, record it as a percent of the sample (w/w) and pass it through 0.2 to 0.5 mm sieves. Process the samples for analysis.

V.DETERMINATION OF SOIL

(1) Soil Temperature: Soil temperature is one of the most important soil properties that influences crop growth. Very little heat is produced by the chemical and biological activities in the soil; the sun is the main source of heat.

(2) PH: The soil response, or PH, is used to indicate how acidic or alkaline the soil is. Since it determines the soil's capacity, the pH is an essential property. The pH values ranged by less than 8.5, as Table 1 demonstrates. Acidic soil has a pH limit of less than 6.5, normal soil is between 6.5 and 7.8, alkaline soil is between 7.8 and 8.5, and alkali soil is greater than 8.5.

(3) EC: Electrical conductivity (EC) of aqueous soil extracts is used to assess total soluble salts. Normal EC in soil is less than 0.8 dsm-1, which is crucial for crops that are sensitive to salt and crucial for crops that can withstand it. 1.6–2.5 dsm-1, harmful to the majority of crops > 2.5 dsm-1. The EC value ranges from 0.4 to 1.8 (table no. 1).

(4) OC and Nitrogen (N):- Soil organic carbon serves as a crucial indicator of nitrogen presence in soil, and its measurement is frequently used to assess nitrogen availability. In the colorimeter method (Data et al., 1962), organic matter is converted through oxidation using chromic acid. The organic carbon levels in Nashik Taluka range from 0.23 to 0.85 (refer to table no. 1). The standard classifications for organic carbon are low (< 0.50), medium (0.50-0.75), and high (> 0.75).

(5) Phosphorus(P): The range of phosphorus was low, medium, and high (table no. 1). The aquatic ecology is dynamically impacted by inorganic phosphorus as orthophosphate. Plants use phosphorus, the most significant micronutrient, in the form of $H_2PO_4^-$ and HPO_4^- species.

(6) Potassium (K): In soil, the standard value of K as K_2O is low (< 140 kg K_2Oha^{-1}), medium (140-280 kg K_2O ha^{-1}), and high (> 280 kg K_2O ha^{-1}). The range of potassium was low, medium, and high (Table no. 1). Even though it is only found in trace amounts in soil samples, K is regarded as a significant micronutrient and is essential to the metabolism of fresh water. Although the earth's crust contains a comparatively large amount of K, most of it is inaccessible to plants.

(7) Soil Moisture: Soil moisture analysis is easily done by simple and standard gravimetric methodology. Moisture of soil is important for the growth of plant. In gravimetric method first take Weight of wet soil (W_1gm.) then Dry it completely in an oven at 105–110°C and then after cooling, weigh again (W_2 gm.). finally calculate the moisture content using following formula.

Moisture % = Wet weight (W_1) − Dry weight (W_2) / Dry weight (W_2) × 100

Experimental value of quality characteristic especially PH, EC, OC, N, P, K, of soil of Nashik Taluka are present in the table no. 1. Result are in tune with farming practices followed by farmers of this region. Most of the farmers are using chemical fertilizer, Urea and Nitrogen fertilizer only since last 10 to 15 years which contains concentrated amount of Nitrogen, OC & Phosphorus. On the basis of these results farmers are advised to use integrated nutrient management practice to maintain optimum concentration of all the essential nutrients for plants. Farmers are also advised to add bio-fertilizers containing organic carbon and nitrogen solubilising bacteria.

Table 1: Study of Presence of EC, PH, OC, N, P, K, in the soil of Nashik Taluka District: Nashik

Sr. No.	Name of Villages	EC	PH	OC	N	P	K	Soil Moisture(%)
I	Lahavit	0.4	6.9	0.4	0.03	34	810	54
II	Bhagur	0.5	6.8	0.6	0.05	98	168	48
III	Belatgavhan	0.9	6.5	0.4	0.04	32	410	42
IV	Shigvebahula	0.7	6.5	0.5	0.03	45	328	43
V	Shevgedarna	0.4	5.9	0.5	0.05	20	710	40
VI	Sansari	0.7	6.5	0.6	0.03	36	210	52
VII	Vihitgaon	0.8	7	0.3	0.05	68	840	58
VIII	Pimpalgaon khamb	0.6	7.2	0.5	0.02	30	720	57
IX	Vadner	0.3	6.7	0.6	0.02	20	330	54
X	Pathardi	0.2	6.6	0.5	0.04	38	290	38
XI	Deolali goan	0.3	6.4	0.8	0.03	56	815	40
XII	Samangoan	0.3	5.8	0.6	0.06	34	215	38
XIII	Madsangvi	0.4	5.4	0.7	0.04	20	255	40
IXV	Lohashingve	0.9	7.2	0.3	0.04	50	518	56
XV	Vanjarvadi	0.4	6.8	0.4	0.05	75	440	52

VI. CONCLUSION

The present study on soils from Nashik Taluka, Nashik District, revealed the status of key soil properties, including electrical conductivity (EC), pH, organic carbon (OC), and available nutrients such as nitrogen (N), phosphorus (P), and potassium (K). Soils deficient in essential nutrients indicate the need for nutrient-rich fertilizers to enhance soil fertility and optimize crop response. Soil analysis also facilitated the identification of soil-related constraints, including salinity, alkalinity, and acidity, enabling recommendations for appropriate treatment and improvementt measures. The study further assessed the suitability of the soils for crop cultivation and fruit plantation development, evaluated their potential for irrigation, and contributed to understanding the soil genesis of the region. Overall, the soils of the studied area were found to be suitable for agricultural productivity.

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