International Journal of Science, Environment and Technology, Vol. 15, No 1, 2026, 22 – 30

ISSN 2278-3687 (O)
2277-663X (P)

ASSESSMENT OF SOIL FERTILITY STATUS IN SAIKHINDI VILLAGE OF SANGAMNER TEHSILOF AHILYANAGAR DISTRICT, MAHARASHTRA, INDIA

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Abstract: In the present study attempts have been made to assess the soil fertility status in Saikhindi village of Sangamner tehsil of Ahilyanagar district, Maharashtra during the month of June to December 2025. Fourteen representative surface soil samples from different survey numbers were analyzed for various soil fertility parameters like pH, EC, organic matter, available NPK and calcium carbonate content by standard procedures. The soil pH ranged from 7.7 to 8.8, indicating moderately to strongly alkaline conditions. Electrical conductivity values reflected low to moderate soluble salt levels, suggesting no significant salinity hazard for crop growth. Organic carbon content varied between 0.21 and 0.37%, which classifies the soils as low to medium in organic matter. Available nitrogen ranged from 107 to 134 kg N ha^{-1}, revealing low nitrogen fertility, a condition typical of low-organic-matter soils. Available phosphorus content (2.48–9.95 kg P ha^{-1}) was in the low to deficient range, pointing to a strong likelihood of P-limitation for most crops. In contrast, available potassium was high, ranging from 198 to 229 kg K ha^{-1}, indicating a well-supplied K status. Calcium carbonate content (1.80–14.80%) shows that the soils are calcareous, containing moderate to high levels of free $CaCO_3$, which may influence nutrient availability particularly P and micronutrients.
The soils were alkaline, low in organic carbon, nitrogen, and phosphorus but high in potassium, indicating the need for N and P fertilization along with organic matter addition, while potassium application can be minimized in these calcareous soils.
Keywords: Soil fertility, organic matter, available nutrients, calcium carbonate

INTRODUCTION

The most important and valuable natural resource that keeps life on Earth going is soil. An inch of top soil takes about a millennium to produce. Soil contamination and pollution are two of the biggest issues facing the modern world. Both natural and man-made factors have begun to cause soil deterioration, which has an impact on productivity. Human disturbance of the earth's ecosystem to generate food and fiber will raise the need for soils to supply vital nutrients as the human population grows. Higher plant productivity levels linked to growing human food demand have reduced the soil's natural capacity to provide adequate nutrients. Developing and implementing soil, crop, and nutrient management technologies that improve plant production and the quality of soil, water, and air is perhaps one of the biggest issues of

*Received Jan 2, 2026 * Published Feb 2, 2026 * www.ijset.net*

our time. We cannot continue to meet the needs of our expanding population for food and fiber if we do not increase the productive potential of our delicate soils. Modern agriculture is becoming increasingly reliant on a consistent supply of synthetic inputs (mostly fertilizers) derived from fossil fuels as a result of the advent of green revolution technologies. The soil has been negatively impacted by the overuse and unbalanced use of chemical fertilizers, which has reduced organic carbon, decreased soil microbial flora, increased acidity and alkalinity, and hardened the soil. The significant decline in soil fertility is a result of this circumstance.

Increasing crop productivity in the soil is mostly dependent on soil fertility. It includes both the effective management of nutrients and their supply. The soil's ability to give nutrients is indicated by its fertility state. Furthermore, man has control over soil fertility. On the other hand, depleting human activities and their interactions with natural surroundings lead to soil deterioration. These unfavorable interactions result in salinization, alkalization, waterlogging, etc., especially in semi-arid areas. Some of the efforts to improve poor soils under the current circumstances include the introduction of better plant kinds, the correction of salt-related issues, the management of disease and insect pests, and the reduction of erosion losses. The evaluation of soil fertility includes the measurement of available plant nutrients and estimation of capacity of soil to maintain a continuous supply of plant nutrients for a crop. The availability of nutrients depends on various factors such on types of soils, nature of irrigation facilities, pH and organic matter content. Voluminous research work related to such aspects has been done by many researchers. The Sangamner area is experiencing the problems of salinization, alkalinsation, waterlogging etc due to over irrigation, excess use of chemical fertilizers, intensive cultivation with modern production technology and establishment of sugarcane and allied industries. Therefore, an attempt has been made to evaluate the soil fertility status of the study area.

StudyArea

Saikhindi is a village located in Sangamner tehsil, which is located in the Ahilyanagar district (formerly known as Ahmednagar district) of Maharashtra. Sangamner is a Taluka headquarter which is located at a distance of 150 km from Pune on Pune-Nashik National Highway No. 50 (Fig.1).

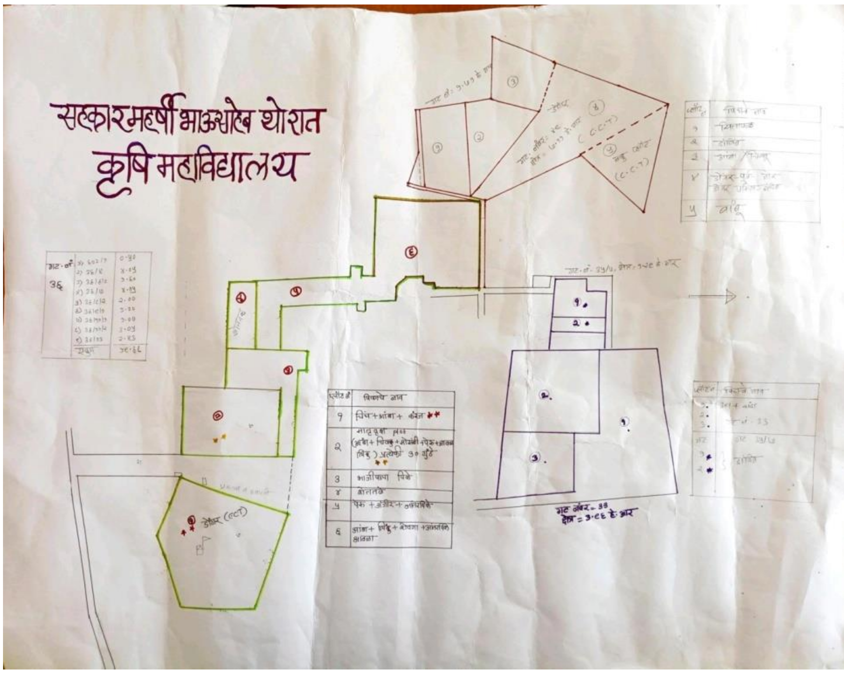

Fig.-1: Location map showing soil sampling stations in the Study area.

EXPERIMENTAL DETAILS

Selected 14 surface soil samples (0-20cm) were collected (Fig 1) in cloth bags as per the standard procedures. Quartering technique was used for preparation of soil samples. The samples were dried in air and passed through 2 mm sieve and stored in cloth bags. The soil pH and EC were determined from the saturation extract (l:5 soil water ratio) of soils. Organic carbon was estimated by Walkley and Black method. The available N (Alkaline permanganate method), available P (Olsen's method) and available K (Flame photometer method) were estimated by standard procedures. The calcium carbonate was determined by rapid titration method.

RESULTS AND DISCUSSION

For evaluation of the soil fertility status of the study area, pH, EC, organic carbon, available NPK and free calcium carbonate from the soils were determined and results obtained are presented in Table-1.

Soil pH

The supply of plant nutrients and thus the fertility of the soil are affected by pH. The solubility of most nutrients varies in response to pH. As acidity increases, the loss of these nutrients by leaching increases and their availability to plants decreases. The quantity of some nutrients may rise so greatly under acidic and alkaline conditions that they become toxic to plants. Therefore, it is very essential to control soil pH between 6.5 to 7.5 where most of the nutrients are available to plants for maintaining soil fertility.

In the present study, pH ranges from 7.7 to 8.8 reflecting alkaline nature of soils. It is interesting to observe a narrow range of variation in pH in the area. The alkaline reaction of the soils is primarily attributed to their calcium carbonate content, as the buffering action of free lime, slow dissolution of carbonates, and release of bicarbonate and calcium ions continually neutralize acidity and maintain elevated pH levels under low-leaching conditions. These results were in confirmatory with the results reported by several workers.

Electrical Conductivity

Soil electrical conductivity is an important indicator of soluble salt status, influencing nutrient availability and crop water uptake, and providing a basis for effective salinity and irrigation management in the studied soils. The EC values ranges from 0.11 to 0.68 dS/m in the study area. Electrical conductivity values indicate low to moderate soluble salt levels, likely due to good drainage, limited salt-rich parent material, and leaching that prevents accumulation of soluble ions.

Organic Matter

The organic matter is a vital store of available nutrients. It helps to sustain soil fertility by improving soil structure, retention of mineral nutrients, increasing water holding capacity, water infiltration, drainage, aeration and root penetration. It also helps to increase the amount of soils flora and fauna. Thus the organic matter is an important contributes to soil fertility. It comes in a soil from remains of plants and animals. However, in addition to this, it also includes grasses, trees, bacteria, fungi, protozoa, earthworm and animal manure. It is obtained by estimating organic carbon from soil.

Table-1: Soil fertility parameters of the soils from Saikhindi village.

Sr.No	Survey No.	Sample. No.	pH	EC (dS/m)	OC (%)	Available nutrients (kg/ha)			Calcium carbonate (%)
						N	P	K	
1.	33/1	S_1	8.55	0.27	0.36	130	9.05	217	11.60
2.	33/2	S_2	8.52	0.23	0.22	100	7.91	209	7.60
3.	33/3	S_3	8.76	0.26	0.27	110	9.05	215	11.80
4.	35/7/1	S_4	8.30	0.31	0.37	134	8.14	228	11.20
5.	35/7/2	S_5	8.62	0.19	0.30	117	8.37	221	10.30
6.	36/1	S_6	7.98	0.11	0.21	107	3.62	201	3.70

7.	36/2	S_7	8.44	0.18	0.21	110	2.48	198	11.30
8.	36/3	S_8	8.51	0.28	0.36	130	9.50	233	14.80
9.	36/6	S_9	8.64	0.15	0.25	113	4.52	219	5.80
10.	49/1	S_{10}	8.54	0.43	0.24	110	8.82	216	9.50
11.	49/2	S_{11}	8.80	0.31	0.21	105	9.95	204	7.00
12.	49/3	S_{12}	8.58	0.19	0.30	122	5.43	219	9.30
13.	49/4	S_{13}	8.11	0.41	0.28	114	6.10	229	2.80
14.	49/5	S_{14}	7.73	0.68	0.27	115	7.46	217	1.80

The examination of the data presented in Table.1 showed that organic carbon content ranges from 0.21 to 0.37 % in the soils from the area. However, low status of organic carbon was noticed. This is possibly due to strong alkaline condition (pH >8.0) which might have dissolved the humic substances of soil and further they are lost from the soils.

The low organic carbon content (0.21–0.37%) is likely due to limited organic residue inputs, rapid decomposition under warm conditions, and calcareous soil properties that restrict organic matter buildup. That is to say that these soils require adequate nitrogen fertilization through organic manure, farmyard manure, green manure etc. Similar observations were reported.

Available Nitrogen

Deficiency of nitrogen is almost universal in Indian soils. Therefore, nitrogen application is a must for canopy development and high yields. However, nitrogen is an essential plant nutrient; it should be present in the soil in appropriate proportion for the growth of plants. The plants absorb nitrogen either as ammonium or as nitrate ion. The transformation of the nitrogen compounds in the soils involves the processes such as fixations of atmospheric nitrogen by free living and nodule forming bacteria, conversion of nitrogen containing compounds into humic acids, ammonification, nitrification, denitrification and then leaching loss of different nitrogen compounds by intra-soil and surface flows.

Considering such a unique importance of nitrogen for the growth of plants, attempt has been made to estimate available nitrogen from the soils in the study area. The results were presented in Table 1. The available nitrogen in the soil ranges from 105 to 130 kg/ha. It shows the soils from the area have low nitrogen status. This evidence is further confirmed by comparing the estimated values of nitrogen with Critical limits for delineation of soil fertility. These rating limits are irrespective of crops or soils. Critical limits for soil test values (available NPK) used in India is summarized in Table-2.

Table-2: Rating limits for soil test values used in India.

Nutrients	Low	Medium	High
Available Nitrogen (Kg/ha)	<280	280-560	>560
Available phosphorus (kg/ha)	<10	10-24.6	>24.6
Available Potassium (kg/ha)	<108	108-280	>280

Similar status of nitrogen in the soils was reported in the vicinity of the study area.

Available Phosphorus

Phosphorus is often referred to as the ‘master key to agriculture’ because crop yields are more frequently limited by phosphorus deficiency than by any nutrient except nitrogen. It plays a vital role in plant growth, cell division, root development, flowering, and fruit formation, and it promotes early maturity. Phosphorus is also essential for energy storage and transfer (ATP) and forms an integral part of important organic compounds such as nucleic acids, phospholipids, and certain oils and amino acids.

Phosphate ions enter the soil solution through the mineralization of organic phosphorus compounds or from applied fertilizers. Plants absorb phosphorus mainly as the dihydrogen phosphate ion ($H_2PO_4^-$) from the soil solution. In soils, phosphate is readily chemisorbed through reactions with Al and Fe oxides in acidic conditions, or with Ca compounds in alkaline conditions, which strongly influences its availability to plants.

In the present study, available P ranges from 2.48 to 9.95 kg/ha (Table 1). The low status of available P was found nearly in all the soils in the area. This is possibly attributable to strongly alkaline condition of the soil (pH > 8.0) besides high content of $CaCO_3$. However, in calcareous soils water soluble P is rendered insoluble within few hours as P ions precipitate on $CaCO_3$ particles. Comparing the P values with the critical limits of P (Table 3) also supports this inference. Nearly all the soil samples have been shown low category of P in the area.

Available Potassium

Potassium is a master nutrient for the production of superior quality crop. Potassium exists in K^+ form and its function appears to be catalytic in nature. The potassium is important for plant because it participates in the activation of large number of enzymes which are involved in physiological process of plants. It controls the water economy and provides the resistance against a number of pests, diseases and environmental stresses. The available K in the soil ranges from 198 to 229 kg/ha (Table 1). All soils samples have higher content of available K. This is possibly due to the release of K from clays under high pH conditions and use of potassium fertilizers like KCL and the area that the rate of release of this element K_2SO_4 and its uptake is not ordinarily influenced in salt affected soils. However, the K contents in soil when compared with the critical limits (Table3), it were noticed that the available K in soil is in high category.

Soil testing provides information regarding nutrient availability in soils which forms the basis for the fertilizer recommendations for maximizing crop yields. On the basis of soil testing results, the recommended fertilizer doses for the crops are modified for making fertilizer recommendations to the farmers. If the level of nutrient is low, the recommended fertilizer dose for the crops is increased by 25%. If it is medium then the general dose is recommended as it is. While the level of nutrients is high, recommended dose is reduced by 25%.

Free calcium carbonate

The presence of free calcium carbonate reflects calcareous soil conditions, contributing to alkaline pH and affecting nutrient availability, particularly phosphorus and micronutrients.

The calcium carbonate content (1.80–14.80%) clearly reflects the calcareous nature of the soils, indicating substantial amounts of free $CaCO_3$. Such levels of carbonate not only maintain an alkaline soil reaction but also play a major role in governing overall soil chemistry. High $CaCO_3$ affects nutrient dynamics by increasing phosphorus fixation, reducing the availability of micronutrients (Fe, Zn, Mn, Cu), altering microbial activity, and influencing soil physical properties through flocculation and aggregation. Thus, the calcareous condition has both direct and indirect effects on soil fertility and plant nutrient uptake.

CONCLUSION

The soils studied exhibited an alkaline reaction (pH 7.7–8.8) largely due to the presence of free calcium carbonate, which acted as a strong buffering agent and influenced nutrient dynamics. Electrical conductivity values (0.11–0.68 dS/m) indicated low to moderate soluble salt levels, suggesting non-saline conditions suitable for crop growth. Organic carbon content (0.21–0.37%) remained low, reflecting limited organic matter inputs and rapid decomposition under prevailing conditions. The available nitrogen and phosphorus in the soils are in low category. However, higher content of K was observed in the soils. The high values of K in the soils are attributed to release of K from clays under high pH conditions. Available phosphorus was affected by chemisorption processes involving Ca, Al, and Fe, reducing its plant availability. The calcium carbonate content (1.80–14.80%) confirmed the calcareous nature of the soils, contributing to alkaline pH and restricting the availability of phosphorus and micronutrients. Overall, while the soils are not constrained by salinity, their low organic carbon and high $CaCO_3$ levels highlight the need for integrated nutrient and organic matter management to enhance soil fertility and crop productivity.

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