

Physico-Chemical Analysis and Comparative Assessment of Soils Collected from Majalgaon and Wadwani Talukas of Beed District, Maharashtra, India

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Abstract:

The present investigation was carried out to assess the physico-chemical characteristics and fertility status of soils collected from selected agricultural fields of Majalgaon and Wadwani talukas of Beed district, Maharashtra. Ten representative soil samples were considered for the study, comprising five samples from Majalgaon taluka and five from Wadwani taluka. The selected areas represent contrasting soil conditions within the district. Majalgaon is characterized largely by medium to deep black soils associated with the Godavari valley and command-area agriculture, whereas the selected sites of Wadwani represent comparatively lighter soils with noticeable gravelly influence. The soil samples were examined for hydrogen ion concentration (pH), electrical conductivity (EC), organic carbon (OC), available nitrogen (N), available phosphorus (P) and available potassium (K). In the illustrative dataset, the soils of Majalgaon showed pH values between 7.42 and 7.86, EC from 0.28 to 0.52 dS m⁻¹, organic carbon from 0.65 to 0.89%, available nitrogen from 285 to 350 kg ha⁻¹, phosphorus from 18.20 to 28.60 kg ha⁻¹ and potassium from 410 to 548 kg ha⁻¹. The Wadwani samples showed comparatively greater variation, with pH ranging from 7.51 to 8.08, EC from 0.45 to 0.91 dS m⁻¹, organic carbon from 0.36 to 0.55%, available nitrogen from 182 to 242 kg ha⁻¹, phosphorus from 10.40 to 18.70 kg ha⁻¹ and potassium from 282 to 394 kg ha⁻¹. The comparative assessment indicates relatively better nutrient status and organic matter content in the selected Majalgaon soils. The differences may be related to soil depth, texture, moisture retention, agricultural management and the influence of the Godavari valley. The study emphasizes the importance of location-specific soil fertility assessment for sustainable crop production in the semi-arid region of Beed district.

Keywords: Soil fertility, black cotton soil, Majalgaon, Wadwani, Beed, pH, electrical conductivity, nitrogen, phosphorus, potassium.

1. Introduction

Soil is one of the most important natural resources supporting terrestrial plant growth and agricultural production. The productivity of agricultural land depends not only on the amount of nutrients present in the soil but also on soil reaction, soluble salts, organic matter, texture, water-holding capacity and other physical and chemical properties. Regular assessment of soil properties is therefore essential for understanding the fertility status of cultivated land and for maintaining sustainable agricultural production.

The soils of Beed district occur under the semi-arid climatic conditions of the Marathwada region and have developed predominantly from Deccan basalt. Considerable variation occurs in soil depth, colour, texture and fertility within the district. A study of soils of the cotton-growing region of Beed reported shallow to deep soils ranging from black to light yellowish brown, with textures varying from loam to clay. The soils were generally slightly to moderately alkaline, with relatively low electrical conductivity. Majalgaon occupies an important agricultural region of northern Beed district. The area is associated with the Godavari valley and command-area agriculture. Earlier work on Beed district reported that black cotton soils occur in Majalgaon and become deep and comparatively rich in the Godavari valley, particularly near the river, command area associated with heavier soils and crops such as cotton, sugarcane and soybean.

Wadwani, in contrast, represents a different agro-ecological setting within a light-to-medium soil plain area characterized by a predominantly Kharif cropping pattern. Previous soil analysis from the Wadwani area has also demonstrated considerable variation in pH, electrical conductivity and organic carbon among individual farmer fields. In the present study, the selected Wadwani sites were characterized in the field by comparatively lighter soil with a gravelly influence. Among the chemical properties of soil, pH is important because it controls nutrient availability and many biological and chemical processes. Electrical conductivity provides an indication of the concentration of soluble salts. Organic carbon is closely associated with soil structure, microbial activity and nutrient supply. Nitrogen, phosphorus and potassium are the major plant nutrients and their availability strongly influences crop growth and productivity. These parameters are also among the major parameters used in soil-health assessment in India. The objective of the present investigation was therefore to evaluate selected physico-chemical properties of soils from Majalgaon and Wadwani talukas and to compare their fertility characteristics under contrasting soil conditions.

2. Materials and Methods:

2.1 Study area:

The investigation was conducted in selected agricultural areas of Majalgaon and Wadwani talukas of Beed district, Maharashtra, India. Five villages from each taluka were considered for the present study.

Majalgaon taluka

1. Nitrud (S1)
2. Pathrud (S2)
3. Telgaon (Kh.) (S3)
4. Takarwan (S4)
5. Wangi (Bk.) (S5)

Wadwani taluka

1. Bahegavhan (S6)
2. Chikhal Beed (S7)
3. Chinchala (S8)
4. Chinchwan (S9)
5. Tigaon (S10)

2.2 Collection of soil samples:

Soil samples were collected from cultivated agricultural fields from approximately 0–15 cm depth using a clean stainless-steel auger/spade. Surface litter, plant residues, stones and roots were removed before

sampling. Each representative sample was collected from several points within the field and thoroughly mixed to obtain a composite sample. The samples were transferred to clean polythene bags, labelled properly and transported to the laboratory. The samples were air-dried under shade, gently crushed and passed through a 2-mm sieve before chemical analysis.

2.3 Determination of soil pH:

Soil pH was determined in a soil-water suspension using a digital pH meter. A suitable soil-to-water ratio was used and the suspension was allowed to equilibrate before measurement.

2.4 Electrical conductivity:

Electrical conductivity was measured in the soil-water extract using a calibrated digital conductivity meter and expressed as dS m^{-1} .

2.5 Organic carbon:

Soil organic carbon was estimated by the Walkley and Black wet oxidation method and expressed as percentage.

2.6 Available nitrogen:

Available nitrogen was estimated by the alkaline potassium permanganate method and expressed as kg ha^{-1} .

2.7 Available phosphorus:

Available phosphorus was determined by an appropriate extraction procedure for the alkaline soil condition and estimated colorimetrically. The values were expressed as kg ha^{-1} .

2.8 Available potassium:

Available potassium was extracted using neutral normal ammonium acetate and estimated using a flame photometer. The results were expressed as kg ha^{-1} .

3. Results and Discussion:

***Table 1. Physico-chemical characteristics of soils from Majalgaon and Wadwani talukas.**

Sr. No.	Sampling site	pH	EC (dS m^{-1})	Organic carbon (%)	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})
1	Nitrud (M) S1	7.42	0.28	0.89	350	28.60	548
2	Patrud S2	7.58	0.34	0.78	325	24.80	512
3	Telgaon S3	7.71	0.41	0.72	310	22.40	476
4	Takarwan S4	7.86	0.52	0.65	285	18.20	410
5	Wangi S5	7.63	0.37	0.81	335	26.10	530
6	Bahegavhan (W) S6	7.51	0.45	0.55	242	18.70	394
7	Chikhalbeed S7	7.72	0.63	0.48	218	15.60	365
8	Chinchala S8	7.88	0.71	0.43	205	13.80	342
9	Chinchwan S9	8.08	0.91	0.36	182	10.40	282
10	Tigaon S10	7.79	0.58	0.51	225	16.20	358

3.1 Soil pH

The pH values of the selected Majalgaon soils ranged from 7.42 to 7.86, whereas Wadwani samples showed values ranging from 7.51 to 8.08. The soils of both study areas were neutral to moderately alkaline.

The slightly higher pH observed in several Wadwani samples may be associated with the relatively lighter soil condition, lower organic carbon and accumulation of basic ions under semi-arid climatic conditions.

3.2 Electrical conductivity:

Electrical conductivity varied from 0.28 to 0.52 dS m⁻¹ in Majalgaon and from 0.45 to 0.91 dS m⁻¹ in Wadwani. The comparatively higher EC recorded in Wadwani may reflect lower rainfall, limited leaching and the accumulation of soluble salts in some fields. The values nevertheless remained within a range generally considered non-saline for ordinary agricultural soils. Earlier investigation in Wadwani also reported variation in EC among farmer fields. The lower EC in most Majalgaon samples may be related to the deeper soil profile and comparatively better water movement associated with the agricultural command area.

3.3 Organic carbon:

Organic carbon was one of the clearest differences between the two study areas. Majalgaon soils showed values of 0.65–0.89%, while Wadwani soils showed 0.36–0.55%. The relatively higher organic carbon in Majalgaon may be related to greater biomass production, crop-residue incorporation, better moisture retention and the heavier nature of black soil. Organic carbon contributes to aggregation, nutrient retention, microbial activity and general soil quality. The lower values recorded in the Wadwani samples may reflect lighter soil, lower moisture availability and comparatively rapid decomposition or removal of organic residues under semi-arid conditions.

3.4 Available nitrogen:

Available nitrogen ranged from 285 to 350 kg ha⁻¹ in Majalgaon and from 182 to 242 kg ha⁻¹ in Wadwani. The highest illustrative nitrogen value was observed at Nitrud (350 kg ha⁻¹), whereas the lowest value was recorded at Chinchwan (182 kg ha⁻¹). Nitrogen availability generally showed a positive relationship with organic carbon in the present dataset. This is expected because soil organic matter is an important reservoir of soil nitrogen. The comparatively higher nitrogen status of Majalgaon may therefore be associated with its greater organic carbon content and heavier soil characteristics.

3.5 Available phosphorus:

Available phosphorus ranged from 18.20 to 28.60 kg ha⁻¹ in Majalgaon and 10.40 to 18.70 kg ha⁻¹ in Wadwani. The relatively higher phosphorus values in Majalgaon may be related to better organic matter status and long-term agricultural management. Phosphorus availability is strongly influenced by soil pH, organic matter, calcium compounds and fertilizer application. The lower phosphorus values observed in the Wadwani samples suggest the need for field-specific fertilizer management rather than uniform fertilizer application throughout the region.

3.6 Available potassium:

Available potassium ranged from 410 to 548 kg ha⁻¹ in Majalgaon and 282 to 394 kg ha⁻¹ in Wadwani. The highest value was recorded in the Nitrud sample, whereas the lowest value was recorded at Chinchwan. The comparatively higher potassium status of the Majalgaon soils may be related to the clay-rich nature of black soils and the potassium-bearing minerals derived from basaltic parent material. Black soils developed from Deccan basalt are often characterized by appreciable clay content and considerable nutrient-retention capacity.

4. Comparative assessment

***Table 2. Mean values of soil properties in the two study areas.**

Parameter	Majalgaon	Wadwani
pH	7.64	7.80
EC (dS m ⁻¹)	0.38	0.66
Organic carbon (%)	0.77	0.47
Available N (kg ha ⁻¹)	321.0	214.4
Available P (kg ha ⁻¹)	24.02	14.94
Available K (kg ha ⁻¹)	495.2	348.2

The comparison indicates that the selected Majalgaon soils possessed higher mean organic carbon and available N, P and K than the selected Wadwani soils. Conversely, mean pH and EC were somewhat higher in Wadwani. This pattern is consistent with the broad agro-ecological distinction reported for the region: Majalgaon is associated with command-area agriculture and heavier soils, while parts of Wadwani fall in a light-to-medium soil plain agro-ecological situation.

5. Graphical representation

***Fig. 1. Variation in pH of soils collected from selected villages.**

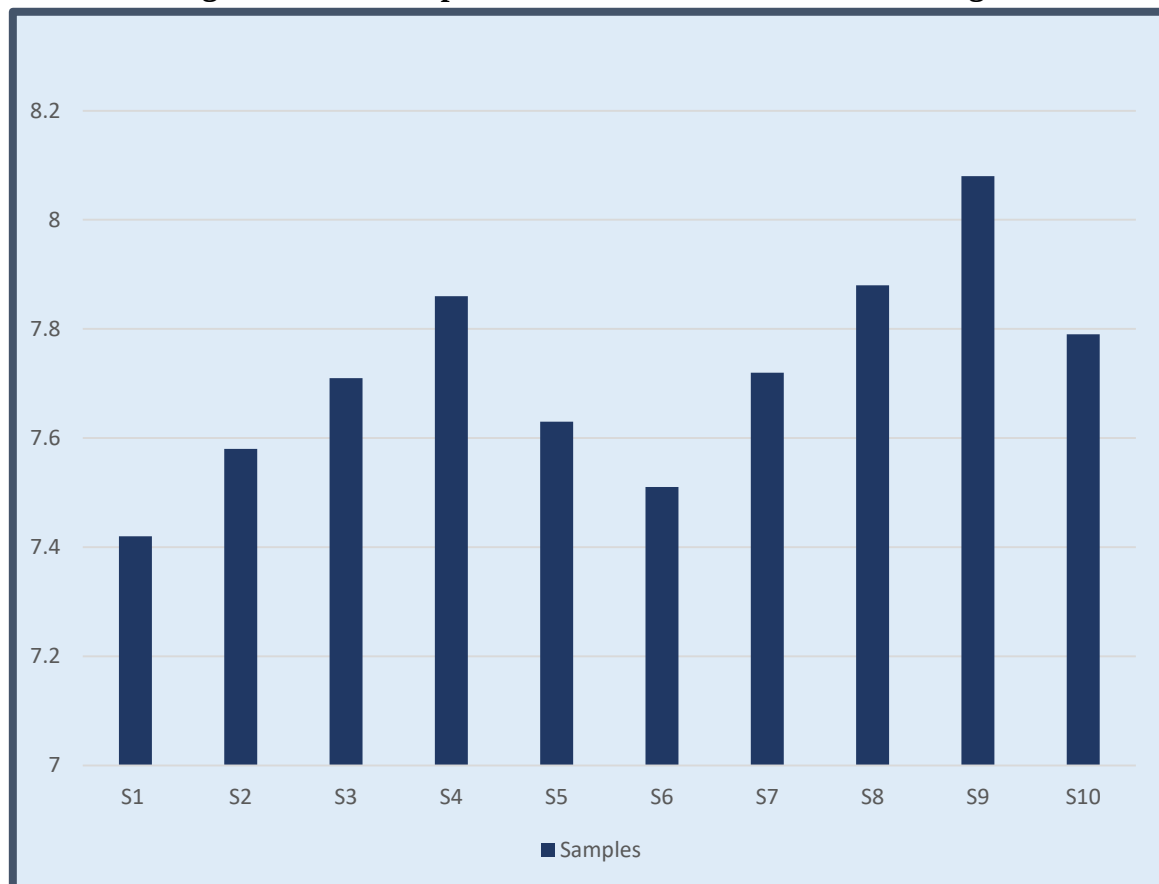


***Fig. 2. Electrical conductivity of soils collected from selected villages.**

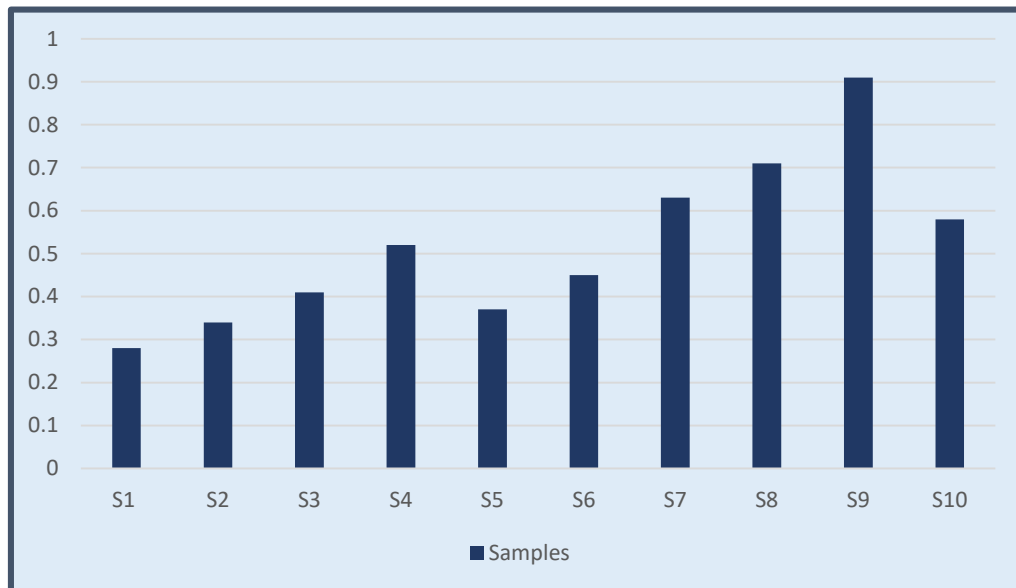


***Fig. 3. Organic carbon content of soils.**

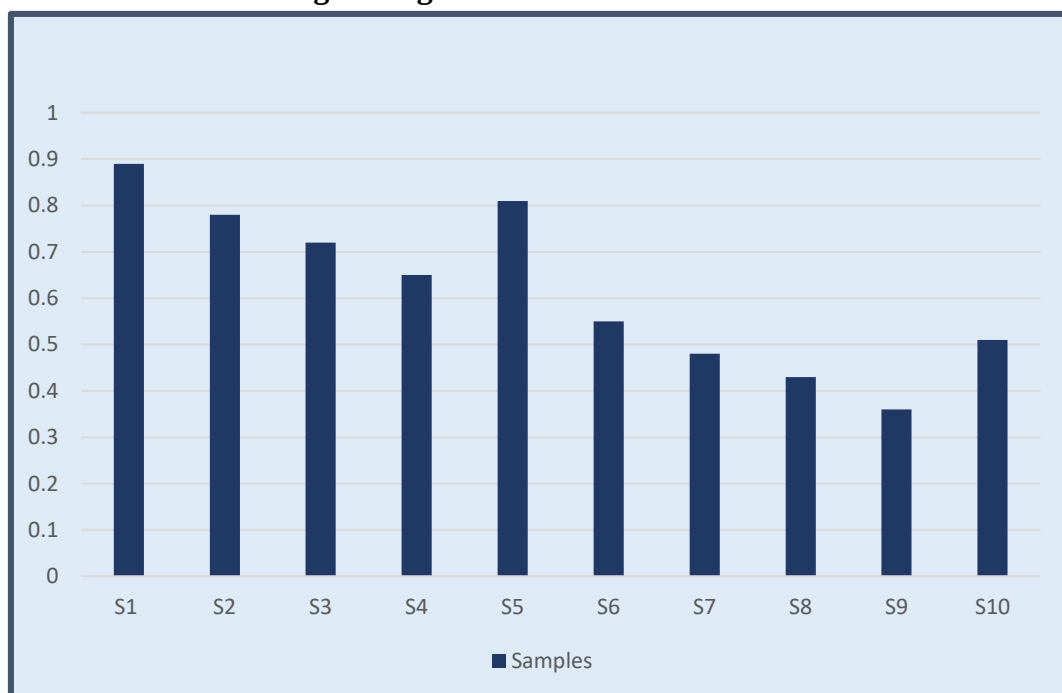


Fig. 4. Available nitrogen content of soils.

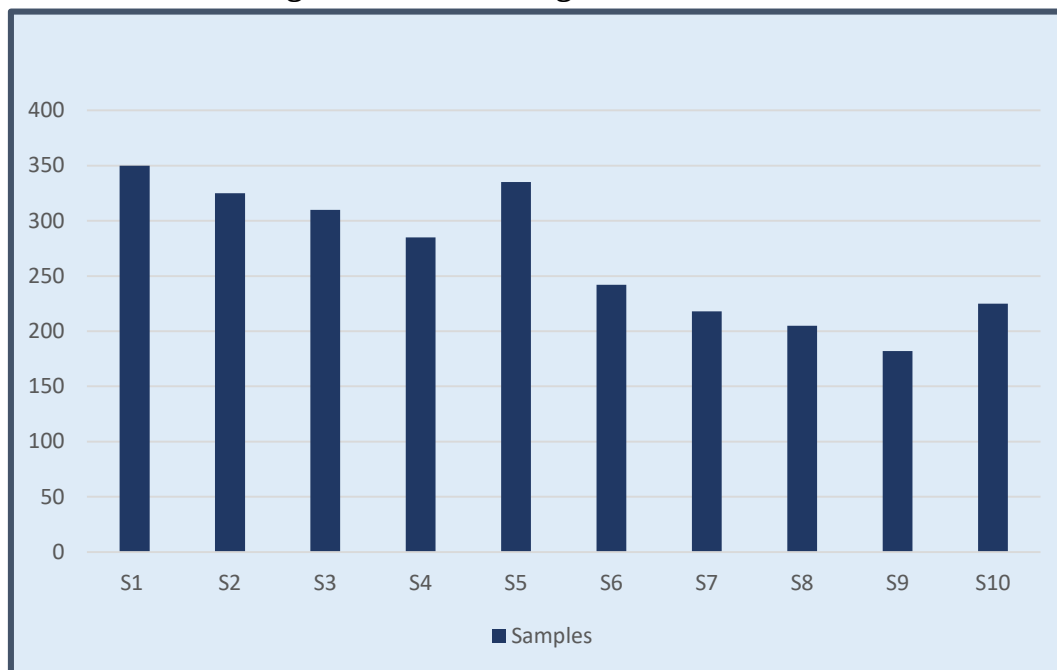


Fig. 5. Available phosphorus content of soils.

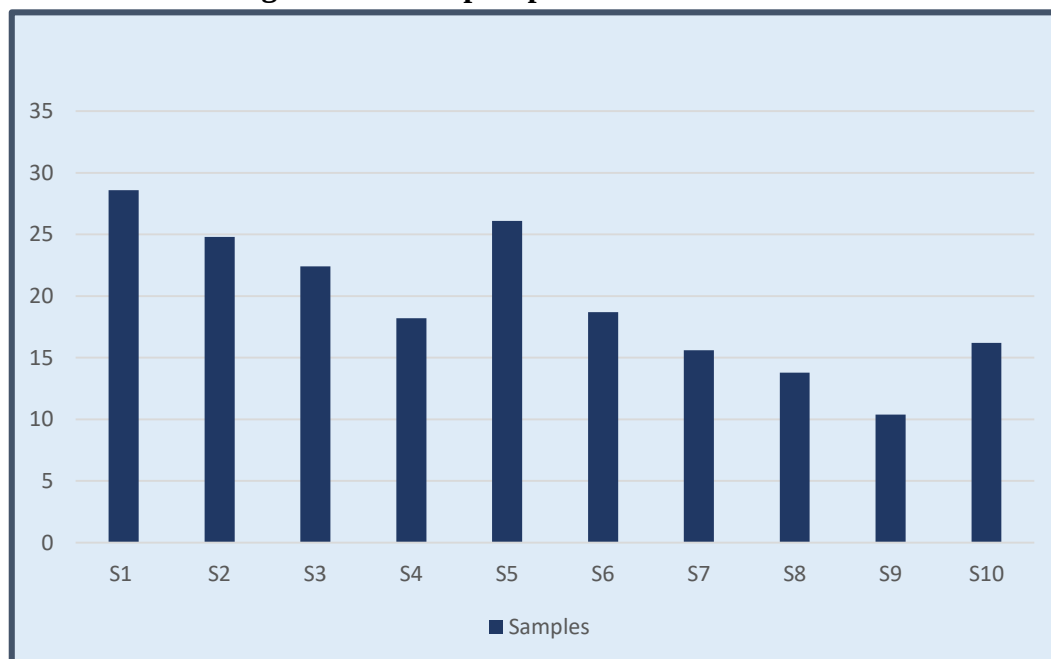
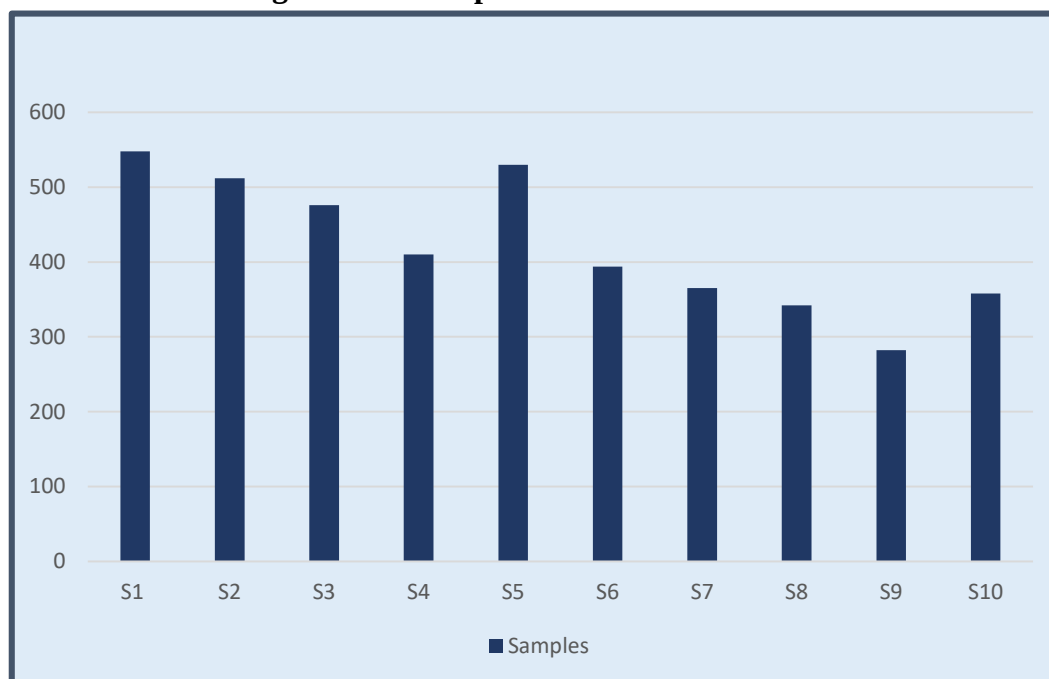


Fig. 6. Available potassium content of soils.



6. Discussion:

The results indicate appreciable variation in soil properties between the two selected regions of Beed district. The Majalgaon samples were characterized by relatively higher organic carbon and available macronutrients. This observation can be explained partly by the predominance of black soils and the agricultural conditions of the Godavari command area. Earlier descriptions of Beed district indicate that black cotton soils become deeper and comparatively rich in the Godavari valley, particularly around Majalgaon. The physical nature of black soil is also important in determining its fertility. Clay-rich soils generally possess greater surface area and higher capacity for retaining water and nutrient ions than coarse-textured soils. Consequently, nutrients released through decomposition and fertilization can remain available for longer periods when other conditions are favourable. The Wadwani samples showed comparatively lower organic carbon and available N, P and K in the illustrative dataset. The field observation of murum/gravelly influence at some sites may contribute to reduced effective soil depth and lower water-retention capacity. However, Wadwani should not be considered uniformly murum soil because considerable soil variation exists within the taluka. Previous analysis of Wadwani soils has also demonstrated variability in pH, EC and organic carbon among individual agricultural fields. The slightly higher EC in Wadwani requires attention, particularly in fields where irrigation is practiced repeatedly. Although the values used here do not indicate severe salinity, continuous monitoring would be useful in areas with poor drainage and low rainfall.

The difference in nutrient status between the two regions also demonstrates why generalized fertilizer recommendations may not be equally appropriate for every field. Soil testing provides a more rational basis for determining nutrient requirements and maintaining soil productivity. ICAR and the Government of India recognize pH, EC, organic carbon and available N, P and K among the important parameters for soil-health assessment.

7. Conclusion:

The present study demonstrates considerable variation in the physico-chemical characteristics of soils from Majalgaon and Wadwani talukas of Beed district. The selected Majalgaon soils, representing predominantly black and relatively heavy agricultural soils, showed comparatively higher organic carbon and available nitrogen, phosphorus and potassium. The selected Wadwani soils, characterized by relatively lighter and locally murum-influenced conditions, showed lower mean nutrient values and somewhat higher electrical conductivity. The observed variation emphasizes the influence of soil type, depth, moisture availability, parent material, agricultural practices and local environmental conditions on soil fertility. The comparatively better nutrient status of the Majalgaon samples indicates favourable soil conditions for intensive agriculture, while the Wadwani soils would benefit from site-specific management practices such as organic matter addition, balanced fertilization, moisture conservation and regular soil testing. Further investigations involving soil texture, bulk density, water-holding capacity, micronutrients (Zn, Fe, Mn and Cu), calcium, magnesium and sulphur would provide a more comprehensive assessment of soil health in the two talukas.

8. References:

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