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EVALUATION OF CROP SUITABILITY AND SOIL VARIABILITY IN DISTRICT SIALKOT, PAKISTAN

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ABSTRACT

Within district Sialkot, Pakistan, the spatial variability of soil parameters such as ECe, Saturation %age, pH, Organic Matter, Phosphorus, and Potassium is thoroughly evaluated and analysed across various locations. The soil and water testing laboratory in Sialkot conducted a thorough examination of around 1,000 individual samples from 4 tehsils of the district Sialkot (446 samples from Pasrur, 283 samples from Sialkot, 217 samples from Daska, and 54 samples from Sambrial). The findings of this study can aid in selecting the best crops for each tehsil based on its soil parameters and in formulating sensible plans of action. The loamy (486), sandy loam (251), sand (124), silt loam (89), and clay loam (50) textures of the sampled soils varied. The soils had EC ranging from 0.320 to 12.360, with a 0.914 difference and a mean of 1.615. The soil pH ranged from 6.6 to 9.780, with a variance of 0.405 and a mean of 7.976. It was found that 884 soil samples were categorized as normal, 105 as sodic, 6 as saline, and 5 as saline-sodic after the pH and EC of the soil were examined. In terms of organic matter, around 27.5% of soils had poor levels (<0.86%), 48.1% had excellent levels (0.86-1.29%), and 24.4% had adequate levels (>1.29%). 41% of soils had good levels of phosphorus (7–14 ppm), 13.6% had sufficient levels (>14 ppm), and 45.2% had poor levels (< 7 ppm). Phosphorus concentrations in soil varied from 5.5% poor (less than 90 ppm) to 46.5% satisfactory (between 90 and 180 ppm) and 48% sufficient (beyond 180 ppm). Based on the characteristics of the soil in each tehsil, the study findings may be used to determine the best crops to grow there and to design effective plans for managing the soil and producing crops. These results offer insightful information on the soil properties of District Sialkot and can help guide decisions about crop choices and soil management strategies that are customized to the unique circumstances of each tehsil. For example, the sand-rich, mostly low saturation soil of Sialkot tehsil is good for Group A crops like cotton and maize, while the mixed saturation and clay loam texture of Pasrur make it perfect for Group C crops like sugarcane.

Keywords: Spatial Variability; Soil Parameters; Electrical Conductivity (ECe); Soil pH; Organic Matter; Phosphorus

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INTRODUCTION

For terrestrial vegetation and species that live in soil, soil is a complex and dynamic biogeochemical system that serves as a filtering medium, a storehouse for nutrients and water, and a major participant in the worldwide cycling of elements (Nunes et al., 2020). The field of soil science has evolved from studying compounds that promote plant development to seeing soils as complex systems essential to Earthly life cycles (Britannica, 2023). Physical, chemical, and biological weathering processes all play a part in the creation of soil. Temperature variations, frost action, wind erosion, and water erosion are examples of physical weathering. Whereas biological weathering is fueled by living things like plants and animals, chemical weathering is the consequence of interactions between rocks and water or air (Britannica, 2023). Topsoil rich in nutrients is lost due to soil erosion, which is brought on by human activities including deforestation and intensive agriculture (Britannica, 2023).

Geographical factors affect the makeup of soil, but generally speaking, it is made up of minerals (45%), organic matter (5%), water (25%), and air (25%). According to its textures, soil can be categorised as sandy, silty, clay, or loamy. Each type of soil has unique characteristics that influence fertility and water retention (Britannica, 2023) Through processes of addition, loss, transfer, and modification of soil particles, topography, climate, vegetation, and parent rock impact soil formation, resulting in a variety of soil types (Ito et al., 2023; Raj et al., 2022). Pakistan's soils are classified according to particular geographical features and range throughout different ecosystems such as mountains, deserts, and plateaus. Sialkot, a Punjabi area that is growing quickly, has a variety of soil types that are impacted by its agricultural and industrial activity. Research has mapped the geotechnical characteristics of the soils in Sialkot, exposing differences in chemical composition, shear wave velocity, and texture (Ijaz et al., 2021). For Sialkot's agricultural and environmental goals, the geographical variability of soil properties such as electrical conductivity (ECe), saturation percentage (SAT%), pH, organic matter, phosphorus, and potassium is essential. Crop development is impacted by soil salinity, as shown by ECe. In Sialkot, groundwater quality and irrigation techniques affect ECe, with greater values seen close to water sources (Pepper and Brusseau, 2019). The soil's ability to retain water is measured by SAT%, which varies depending on soil texture. According to Landon (2014), clayey soils have a higher SAT% than sandy soils. Geological and agricultural causes cause variations in Sialkot's soil pH, which is important for nutrient availability. For the best crop development, pH management is crucial (Britannica, 2023). The fertility and moisture retention of soil are improved by organic matter. Sialkot's levels fluctuate according to land use and management techniques; organic matter content is often greater in agricultural areas (Ali et al., 2017). Sialkot has different levels of phosphorus and potassium, two elements that are necessary for plant development, as a result of past farming and fertiliser use. To successfully regulate nutrient levels, soil testing must be accurate (Wang et al., 2019).

Because they affect plant development, water storage, pollutant filtering, and global elemental cycles, soils are essential to ecosystem activities (Fendorf, 2017; Pepper and Brusseau, 2019). Both internal and external influences can affect soil health, which is described as the soil's capacity to support biological productivity and preserve environmental quality (Roy et al., 2021). The current study was designed to examine how various tehsils in District Sialkot, Pakistan, differ in terms of the spatial variability of soil metrics (ECe, saturation percentage, pH, organic matter, phosphorus, and potassium). Examine the effects of soil properties on agricultural production and suitability, paying particular attention to important crops such as rice and wheat. Analyse the distribution and frequency of nutrient shortages and salinity/sodicity issues in Sialkot's soils, as well as the management implications for agriculture. Examine the connections among soil texture, pH, electrical conductivity, and nutrient concentrations to comprehend their effects on crop performance and soil health.

MATERIALS AND METHODS

The objective of the study carried out in Sialkot, Pakistan, was to assess the nutrient content, salinity/sodicity issues, and physical and chemical characteristics of the soils in the district's several tehsils. Because of Sialkot's varied topography, Pasrur, Sialkot City, Sambrial, and Daska were selected as important sites for data collecting. To ensure a thorough overview of the features of the soil, samples were collected from several areas in Sialkot using a zigzag pattern approach. Samples were safely maintained in labeled plastic bags to prevent contamination, and great care was taken while sampling to prevent bias. Following sample protocols, analysis was carried out at the Soil and Water Testing Laboratory in Sialkot.

To maintain homogeneity and ease of analysis, soil samples were prepared at the laboratory by drying, grinding, and sifting them upon arrival. Physical attributes like textural class and soil saturation percentage were ascertained using standardized procedures that required the use of particular tools and chemicals. For example, the process of determining the percentage of saturated soil required making a paste of saturated soil and figuring out the percentage of soil saturation based on the mass of soil and water supplied (Miller et al., 2013). The texture was using the proper tools and chemical solutions, and chemical properties such as electrical conductivity, pH, organic matter, extractable potassium, and phosphorus were evaluated. For instance, soil electrical conductivity was measured by making soil extracts and using a calibrated meter to measure conductivity (Patra et al., 2020). Similar to this, the pH of soil was determined by the saturated paste technique, which included making a paste of soil and water and measuring the pH with a pH meter that had been calibrated (Schofield and Taylor, 1955). The Walkley-Black technique (Walkley, 1947) was utilized to evaluate the organic matter content. This approach involves titrating soil samples with standardized ferrous sulphate solution to measure the organic carbon content. Following extraction processes using certain reagents, extractable potassium and phosphorus were determined using flame photometry and spectrophotometry, respectively (Olsen, 1954; Richards, 1954).

The Food and Agriculture Organization of the United Nations (2006) also supplied categorization criteria that were utilized to group soil samples according to ideal concentrations of EC, pH, organic matter, phosphorus, potassium, soil status, soil texture, and soil saturation percentage. The interpretation of soil data about agricultural suitability and management suggestions was made easier by this categorization. The recorded data were statistically analyzed using statistical package statistical 8.1.

RESULTS AND DISCUSSION

In the Sialkot district, about 1,000 distinct samples from four tehsils were used in a thorough examination. Every tehsil added something distinct to the dataset. With an astounding 446 samples gathered and examined, Pasrur stood out in particular. With over 283 well-inspected samples, Sialkot also made a noteworthy contribution. In addition, Daska contributed a sizable number of samples-roughly 217 in all. Finally, with around 54 samples, Sambrial provided insightful information that enhanced the analysis overall with its viewpoint.

Soil Saturation

According to the data, Daska and Sialkot tehsils both had the lowest saturation percentages at 16%, while Sialkot tehsil had the highest at 65%. All tehsils' soils average saturation percentage was 32.168%, which suggests a moderate level of water saturation. The 8.716% standard deviation illustrates the variation in saturation levels between sites (Table 1).

Table 1: Tehsil-wise data of percentage saturation of soil.

Tehsil	Max (%)	Min (%)	Mean (%)	SD (%)
Sialkot	65	16	29.961	7.589
Daska	60	16	35.415	8.008
Pasrur	56	17	31.493	9.411
Sambrial	50	26	36.259	5.512
All	65	16	32.168	8.716

Different tehsils had different saturation percentages; Sambrial had the highest average at 36.259%, while Daska came in second at 35.415%. On the other hand, Pasrur had the highest average at 31.493%, while Sialkot tehsil had the lowest at 29.961%. Different tehsils had different standard deviations, with Pasrur having the greatest at 9.411% and Sambrial having the lowest at 5.512%, indicating varying saturation consistency. Comparable results were reported by Jamil et al. (2021); Khan (2013) and Rawal et al. (2019).

Crops are divided into four groups according to the ideal soil saturation: Group A (saturation < 30%), Group B (30–60%), Group C (60–90%), and Group D (tolerant to wide saturation ranges), according to the Food and Agriculture Organization of the United Nations (2006). Major crops cultivated in Sialkot correspond with primarily moderate saturation, which is appropriate for Group B crops like wheat and rice. Tehsils, however, display variable saturation to accommodate diverse crop groups: Group C crops (bananas, sugarcane, etc.) are best suited by Sambrial's high saturation, Group A crops (cotton, millet, etc.) are best served by Sialkot's low saturation, Group B crops (wheat, maize, etc.) are best served by Pasrur's mixed saturation.

Soil Texture

The data shows that, with 486 samples, loam was the most common soil texture, followed by sandy loam with 251 samples. On the other hand, silt loam was somewhat more prevalent at 89 samples, while clay loam was the least common, appearing in just 50 samples. The accompanying pie chart shows how different soil textures are distributed. The information demonstrates how the soil texture varies amongst tehsils. With the maximum percentage of loam (72%) and silt loam (20%), Sambrial had the least amount of sandy loam (4%), and neither sand nor clay loam. On the other hand, Sialkot had the lowest silt loam (1%), and the largest concentration of sand (18.7%). Pasrur has the lowest sand percentage (14.7%) and the greatest clay loam ratio (6%) of any region. Daska has the lowest sand percentage (2.3%), and the greatest silt loam ratio (13.8%) (Table 2, 3). Similar findings were reported in previous studies (Jamil et al., 2021; Padwal et al., 2023).

Table 2: Saturation % vs soil texture.

Saturation Percentage%	Soil Texture	Absolute count
0-20	Sand	124
21-30	Sandy Loam	251
31-40	Loam	486
41-50	Silt loam	89
51-65	Clay loam	50

Table 3: Tehsil-wise sample count of soil texture.

Tehsil	Loam	Sandy Loam	Sand	Silt Loam	Clay Loam
Sambrial	39	4	0	11	0
Sialkot	134	88	53	3	5
Pasrur	175	133	66	45	27
Daska	138	26	5	30	18
All	486	251	124	89	50

Crops are divided into Groups A, B, C, and D according to the FAO (2018); each category has examples given. This classification is based on the ideal soil texture. According to the results, the Sialkot district's soil type is mostly loamy, making it ideal for Group B crops like rice and wheat, which are the main crops grown there. But different textures of tehsils affect crop adaptability. Sambrial's preponderance of silt and loam loam is ideal for crops in Groups B and D, but it also poses a risk of erosion and compaction, requiring conservation measures. The sand-rich soil of Sialkot is ideal for Group A crops including cotton and maize. Clay loam from Pasrur is perfect for Group C crops like sugarcane. Group B and Group D crops are supported by the silt loam of Daska.

Dissolved Salts (Electrical Conductivity)

According to the investigation, 11.6% of the soil samples from the Sialkot district showed signs of salinity or sodicity, whereas 88.4% showed neither. From 0.320 dS/m to 12.360 dS/m, electrical conductivity (EC) values were recorded in 2022–2023; the average was 1.615 dS/m, with a standard deviation of 0.914% (Table 4).

The most salinized or sodic soils, which may have an impact on agricultural productivity, were indicated by the highest minimum, maximum, and average EC values in the sambrial tehsil. Poor drainage systems or the use of saline water for irrigation might be the cause of high EC values in Sambrial. The most variable soil EC was found in Sialkot tehsil, suggesting notable regional variations in salinity and sodicity. The Food and Agriculture Organization of the United Nations (2006) states that crops are divided into four types according to the ideal soil EC: Crops that do best in low EC (<2 dS/m) include wheat and maize; those that do best in moderate EC (2-4 dS/m) include rice; those that require high EC (4-8 dS/m) include sugarcane; and those that can withstand a wide range of EC levels are included in Group D. The study shows that Group B crops, such as rice, are suited to the primarily moderate soil EC in the Sialkot area. The EC levels of the tehsils differ, though: Sialkot has a low

EC and is suited for Group A crops like wheat and maize, whereas Sambrial has a high EC and is thus appropriate for Group C crops like sugarcane; While Daska has a moderate EC and is thus appropriate for Group B crops like rice, Pasrur has diverse EC levels that allow it to support crops from Groups A, B, and C.

Table 4: Tehsil wise study of soil Ec of district Sialkot.

Tehsil	Minimum (dS/m)	Maximum (dS/m)	Average (dS/m)	Deviation (dS/m)
Daska	0.415	3.045	1.692	0.482
Sialkot	0.360	12.360	1.409	1.176
Pasrur	0.430	10.580	1.636	0.923
Sambrial	0.550	3.560	2.096	0.581

Soil Reaction (pH)

According to the findings (Figure 3), 22.8 percent of the district's soils had a pH of less than 7.5, which is perfect for high-value fruits, vegetables, and crops. In addition, the pH of 73.4 percent of the soils was between 7.5 and 8.5, with an average of 7.976 and a range of 6.6 to 9.78 (Table 5). Though soils with a pH of more than 8.5 can require gypsum or acid additives for reclamation, these soils are typically suitable for cultivation. Sialkot had the greatest maximum pH (9.78), and Daska had the lowest minimum pH (6.60). Based on typical pH values, the district seems to be free of salinity/sodicity problems overall. Prior research (Jamil et al., 2021; Padwal et al., 2023; Schofield and Taylor, 1955) produced findings that were comparable to these.

According to the Food and Agriculture Organization of the United Nations (2006), crops are classified based on optimal soil pH: Group A (low pH < 6) includes crops like potatoes; Group B (moderate pH 6-7) includes wheat; Group C (high pH 7-8) includes rice; Group D (wide pH range) includes cotton. According to the study, the moderate to high pH of the soil in the Sialkot district is ideal for Group B and C crops, which include rice and wheat, which are the main crops grown there. The pH of the soil varies amongst tehsils, though: Group A and B crops (potato, wheat) are best suited by Daska's low to moderate pH; Group B and C crops (wheat, rice) are best suited by Sialkot's moderate to high pH; Group C crops (rice) are best suited by Sambrial's high pH.

Table 5: Tehsil-wise study of district Sialkot soil pH.

Tehsil	Minimum pH	Maximum pH	Average pH	Standard Deviation
Daska	6.60	8.58	8.03	0.26
Sialkot	7.05	9.78	7.88	0.48
Pasrur	6.74	9.34	8.02	0.40
Sambrial	7.00	8.73	7.86	0.32

Soil Status

The pH and electrical conductivity (EC) of the soil indicate its quality and suitability for agriculture. For most crops, soil conditions with a pH of less than 8.5 and an EC of less than 4.0 dS/m are ideal. But certain soils have problems with salinity (high EC) or sodicity (high pH) (Table 6, 7). High salt concentrations in saline soils prevent water absorption and result in salt toxicity, whereas high sodium and pH levels in sodic soils create poor soil structure. Plant health is impacted by both problems in saline-sodic soils (Malik et al., 1984). Special treatment is needed for these soils to improve production and quality. According to Malik et al. (1984), a normal soil structure promotes ideal circumstances for root growth, nutrient exchange, and water retention.

A total of 884 samples fell within the normal range, meaning that the pH and EC levels were in balance and appropriate for traditional farming. However, 105 samples had high pH and perhaps raised EC values, indicating that they were sodic and may have had too much salt, which might have impeded the intake of nutrients. Due to high salt content, six samples were saline and had higher EC values that might hinder plant development. Furthermore, five samples combined high salinity and sodicity, making them saline-sodic, which presents serious difficulties for agriculture. According to Malik et al. (1984), these results emphasize the necessity of focused soil management to address differing pH and EC profiles for sustainable crop production.

Furthermore, an examination conducted at the tehsil level in the Sialkot district demonstrated the diversity of soil types and conditions in the region by revealing disparate soil statuses in various sites. The table below provides specific data from 1,000 soil sample analyses.

Table 6: The criteria used to categorize the soil samples for various classes of salinity/sodicity.

Status	E.C (dSm^{-1})	Soil pH
Normal	< 4.0	<8.5
Saline	≥ 4.0	<8.5
Saline Sodic	> 4.0	>8.5
Sodic	< 4.0	>8.5

Table 7: Tehsil-wise study of district Sialkot soil status.

Tehsil	Normal	Sodic	Saline	Saline Sodic
Daska	213	4	0	0
Sialkot	258	19	3	3
Pasrur	363	77	4	2
Sambrial	51	3	0	0

While some soil samples were sodic, saline, or saline-sodic, indicating high pH or EC or both, which might impede nutrient uptake and plant development, the majority of soil samples showed normal status, with balanced pH and EC, acceptable for agriculture, according to the table. The different soil conditions in the tehsils represent the geographical variability in the Sialkot district. The most normal soils were found in Pasrur tehsil, followed by Sialkot, Daska, and Sambrial. This suggests that Pasrur has productive and fertile soils because of effective drainage, irrigation, and fertilization techniques (Malik et al., 1984). Additionally, Pasrur had the greatest number of sodic soils, but Sialkot had the largest concentration of saline and salty sodic soils, presumably as a result of shallow groundwater, saline water consumption, or inadequate drainage (Hussain et al., 2017). Jamil et al. (2021) and Padwal et al. (2023) all reported similar findings.

Crops are categorized based on the ideal pH of the soil, according to the Food and Agriculture Organization of the United Nations (2006): Potatoes in Group A (low pH <6) and Moderate pH 6-7 in Group B - wheat; Group D (broad pH range) - cotton; Group C (high pH 7-8) - rice. The ideal soil EC is another way to categorize crops: Group A: maize (low EC < 2 dS/m); Group B: wheat (moderate EC 2-4 dS/m); Group C: sugarcane (high EC 4-8 dS/m); Group D: (broad EC range) - cotton. Group B crops, such as wheat and rice, are suited for the primarily normal soil state of the Sialkot district. Tehsil variants do exist, though: Although Pasrur has a combination of normal, sodic, and saline soils that are good for Groups B, C, and D, Daska has largely normal and sodic soils that are ideal for Groups B and C; Sialkot has normal and saline or saline-sodic soils that are suitable for Groups B and D; and Sambrial has mostly normal soils that are excellent for Group B.

Soil Organic Matter (SOM)

Based on soil type and climate, the ideal SOM level for most crops is 2-4%; this amount is also used to suggest nitrogen. Of the 1000 soil samples from the Sialkot district in the dataset, 48.1% had excellent SOM levels and 27.5% had inadequate SOM levels. Tehsil-specific differences in SOM levels reflect different soil types and conditions (Table 8).

According to the data, the majority of soil samples showed acceptable SOM levels, which suggests that the organic matter was adequate for agricultural use. Nonetheless, several samples had acceptable or subpar levels, indicating a need for development. There were differences in SOM levels amongst the tehsils; Pasrur had the most sufficient soils, Sialkot the most excellent, and Pasrur the poorest soils. These results are consistent with earlier studies. Crops are divided into four categories based on ideal SOM levels, according to the Food and Agriculture Organization of the United Nations (2006). Sialkot district is primarily within the appropriate range for Group B and C crops, such as wheat and rice.

Plant available Phosphorus

Most crops require plant-available phosphorus, which ideally ranges from 7 to 14 mg kg-1 depending on the soil's composition and organic matter content. Its availability is further influenced by the pH, calcium carbonate, clay content, and phosphatic fertilizer of the soil. The Sialkot district's heterogeneous soil conditions are highlighted by differences in phosphorus levels among tehsils. The results of this study showed information on 1000 soil sample analyses that the district's areas have different phosphorus levels, which suggests different soil conditions (Table 9, 10).

Table 8: Tehsil-wise study of district Sialkot soil organic matter.

Tehsil	Satisfactory	Poor	Adequate
Daska	142	39	36
Sialkot	81	80	122
Pasrur	228	182	36
Sambrial	36	7	11

Table 9: Soil nutrients on the basis of available phosphorous.

Sr. No.	Available Phosphorous		
	Type	No. of samples	Percentage
1	Poor (<7.0 mg kg^{-1})	452	45.2
2	Satisfactory (7-14 mg kg^{-1})	416	41.6
3	Adequate (> 14 mg kg^{-1})	132	13.2

Table 10: Tehsil-wise study of district Sialkot plant-available phosphorus.

Tehsil	Satisfactory	Poor	Adequate
Daska	89	72	56
Sialkot	96	156	31
Pasrur	190	220	36
Sambrial	41	11	2

According to the chart, a sizable percentage (45.2%) of soil samples had low amounts of phosphorus that were accessible to plants, suggesting a management-related shortfall. On the other hand, phosphorus levels in certain samples were acceptable (13.2%) or satisfactory (41.6%), indicating the possibility of ideal crop development. Diverse phosphorus levels among the tehsils highlight the district's variety in soil quality. The distribution of phosphorus levels that are accessible to plants in each tehsil of the Sialkot district is shown in table 10.

The table shows that the number of soils with low phosphorus levels was greatest in Pasrur tehsil and that it was followed by Sialkot, Daska, and Sambrial tehsils. This suggests a phosphorus deficit and calls for quick correction. Pasrur's low phosphorus levels may be caused by high pH, a lack of organic matter, or insufficient phosphatic fertilizer application. On the other hand, the majority of the soils in Daska tehsil contained sufficient phosphorus, indicating ideal growing conditions for crops. High levels of organic matter or the use of phosphatic fertilizers might be the cause of this. Previous research (Ijaz et al., 2021; Jamil et al., 2021) supports these results. FAO (2018) states that crops may be categorized according to how much phosphorus they require. Group A crops include cotton, wher*eas* Group B crops are wheat.

Available Potassium (K)

According to the data, the majority of soil samples had potassium levels that were adequate or good, indicating ideal growing conditions. Low potassium levels, however, were present in several samples, emphasizing the need for reform and control. The table 11 and 12 displays the different available potassium levels in each tehsil, which reflects the variability in soil quality in the Sialkot area.

The table 11 and 12 shows Pasrur tehsil with the highest number of adequate soils, followed by Daska, Sialkot, and Sambrial. This means Pasrur has the most potassium-sufficient soils, suggesting optimal crop performance potential due to high potassium levels (Saleem and Bertilsson, 1978). Sambrial tehsil had the most satisfactory soils, indicating moderate potassium levels and room for improvement. Factors like intensive cultivation and low organic inputs might contribute to this (Saleem and Bertilsson, 1978). The most deficient soils were found in Daska tehsil, suggesting a potassium shortage and the immediate need for treatment. This might be caused by elements like a high clay content and little organic matter (Saleem and Bertilsson, 1978). Previous research (Jamil et al., 2021; Padwal et al., 2023; Saleem and Bertilsson, 1978) supports these conclusions.

Table 11: Soil nutrients on the base of available potassium.

Sr. No.	Available Potassium		
	Type	No. of samples	Percentage
1.	Poor (< 80 mg kg^{-1})	480	48
2.	Satisfactory (80-180 mg kg^{-1})	465	46.5
3	Adequate (> 180 mg kg^{-1})	55	5.5

Table 12: Tehsil-wise study of district sialkot available potassium.

Tehsil	Satisfactory	Poor	Adequate
Daska	99	18	100
Sialkot	182	18	83
Pasrur	177	19	250
Sambrial	7	0	47

Based on the ideal potassium levels, crops are categorized into four groups: Group D can tolerate a broad range, Group A likes low levels (<100 mg kg-1), Group B prefers moderate levels (100-200 mg kg-1), and Group C prefers high levels (>200 mg kg-1). The Food and Agriculture Organization of the United Nations (2006) lists cotton (Group A), wheat (Group B), rice (Group C), and maize (Group D) as examples of crops. According to the study, the Sialkot district mostly has low to adequate potassium levels, which are ideal for wheat and cotton. Some tehsils, however, differ. For example, Sambrial is mostly good for wheat, Daska is good for rice and wheat, Sialkot is good for cotton and wheat, and Pasrur is good for a variety of crops from Groups A, B, and C (Saleem and Bertilsson, 1978).

CONCLUSION

There were notable differences in soil saturation, texture, pH, EC, organic matter, and nutrient levels between the four tehsils in the Sialkot region, according to a thorough investigation of the soil's properties. Although the majority of soils demonstrated favorable conditions for farming, there are significant differences that require customized management approaches. The district's primary crops, wheat and rice, appear to be suitable for cultivation based on the prevailing loamy texture and reasonable pH and EC values. Tehsil-specific variances, however, highlight the necessity of focused efforts to maximize agricultural output. For agriculture to be sustainable, deficits in soil nutrients such as potassium and phosphorus must be addressed. Moreover, the ubiquity of salty and sodic soils draws attention to issues that need to be addressed right once. All things considered, our results highlight the significance of regional soil management strategies for achieving the best possible agricultural results and long-term soil health.

CONFLICT OF INTEREST

The authors declare that there is no conflict in the publication of this article.

AUTHOR’S CONTRIBUTION

All the authors contributed equally in the manuscript.

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