Alinteri J. of Agr. Sci. (2021) 36(2): 104-111
e-ISSN: 2587-2249
info@alinteridergisi.com

http://dergipark.gov.tr/alinterizbd
http://www.alinteridergisi.com/
DOI:10.47059/alinteri/V36I2/AJAS21121

RESEARCH ARTICLE

Appraisal Soil Quality in the Agrarian Society of Pir Panjal Himalayas

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ARTICLE INFO

Article History:
Received: 04.05.2021
Accepted: 15.06.2021
Available Online: 14.07.2021

Keywords
Agriculture
Fertility
Organic
Physico-chemical
Soil Quality

ABSTRACT

Background: The present study pertains to appraise the soil fertility in the foot hills of Pir Panjal by measuring different physico-chemical parameters such as pH, electrical conductivity (EC), organic carbon (OC), nitrogen (N), phosphorus (P), and potassium (K) in the foothill of Himalayas. Study area with unique physiographic and socio-economic identities have attributed to the soil fertility.

Methods: Soil tests were carried at Soil Testing Laboratory (STL), Department of Horticulture. Soil samples at 1-30 cm depth were collected from 10 sample sites selected through composite sampling. Samples were collected randomly keeping in mind the maximum areal coverage. From each site, three sub samples were taken from selected locations to have holistic view of the soil fertility.

Conclusion: The study showed deficiency of N & K in all the soil samples, with little variations in other parameters. Sample sites adopting organic farming showed optimum soil fertility. In the study we concluded that practice of adapting organic fertilizers is suitable for maintaing soil fertility. Least perception in the use of different fertilizers (organic & inorganic) a potent cause in the soil deformities in the region.

Please cite this paper as follows:

Ganaie, M.I., Wani M.A., Dev, A. and Mayer, I.A. (2021). Appraisal Soil Quality in The Agrarian Society of Pir Panjal Himalayas. *Alinteri Journal of Agriculture Sciences, 36*(2): 104-111. doi: 10.47059/alinteri/V36I2/AJAS21121

Introduction

Appraising soil fertility by gauging different physico-chemical parameters is important to agriculturalists for maintain productivity and sustainable soil fertility (Jaishree *et. al.*, 2008 & Kanimozhi, 2011). Physico-chemical parameters affect the behavior of soil fertility and hence knowledge of soil analysis is important (Sumithra *et. al*, 2013). External factors such as land use and soil management practices, ecosystem and environmental interactions, socio-economic, indigenous knowledge and political significances play a significant role in the development of soil fertility (Sumithra *et. al*, 2013). Evaluating different physical, chemical, and biological properties of soil are used to measure soil quality functions (Nepal et al, 2018).

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The chemical components and properties of the soil affect many reactions and processes occurring in the soil environment (Gelaw *et. al*, 2015). Soil is a complex mixture of weather-beaten rock, mineral nutrients, decomposing organic matter, water, air and billions of living organisms, most of them microscopic decomposers (Miller et al, 2011). The soil is also a complex association being made up of some six constituents' namely inorganic matter, organic matter, soil organisms, soil moisture, soil solution and soil air (Chatwal *et. al*, 2005).

Soil testing is the only way to determine the status of soil fertility by examining different soil nutrients to develop specific fertilizer recommendations. Soil attributes that are sensitive to modifications can be used as indicators to enhance soil quality. All agricultural productions and growth depend upon physico-chemical parameters of the soil. The fertility of the soil depends on the concentration of nitrogen, phosphorus, potassium, organic material, inorganic materials and electrical conductivity. Potassium is used for flowering purpose, building protein, photosynthesis, fruit quality and reduction of diseases and phosphate is used for growth of roots in plants (Arshi et al, 2018; Nirja *et. al*, 2019). Fertility of soil is determined by the presence or absence of nutrients (macro and micro-nutrients) that are not homogeneously present in the soil which leads to surplus and deficit in terms of concentration of nutrients (Wajahat *et. al,* 2006). These nutrients are crucial for the normal growth of plants, and their deficiency can be altered by supplying the elements (Kolley, 1993).

Quality of soil is defined as the capacity of soil to work within an environment and land-use boundaries to uphold biological efficiency, maintain environmental quality and to promote plant and animal health (Mukherjee et al, 2014). The main purpose of soil quality assessment is to achieve sustainable land use and management systems in order to increase the productivity in eco-friendly environmental.

For assessing soil quality, a complex integration of static and dynamic chemical, physical and biological factors must be defined to identify different management and environmental scenarios (Morugan-Coronado *et al*, 2013). The goal of soil fertility assessment is to holistically to address the factors influencing the crop nutrient utilization to maximize the plant performance. Therefore, the ultimate goal is to maintain the essential nutrients present in soil at a sufficient concentration to support metabolic functions of the plant.

There is a wide range of techniques used to assess soil fertility. Generally, soil fertility assessment can be carried by three broad categories: direct assessment of soil physical or chemical characteristics; quantification of essential elements in plant tissue; or evaluation of plant response to soil nutrient status (Cordell *et al*. 2009). A key component of any soil fertility assessment is the interpretation of results to generate fertilizer recommendations. Typically, one analyzes the nutrient content of soil or tissue samples or evaluates the expression of deficiency or sufficiency in plants and then interprets these findings to recommend rate of nutrients to apply to avoid or correct deficiencies (Dawson et al, 2011).

Study Area

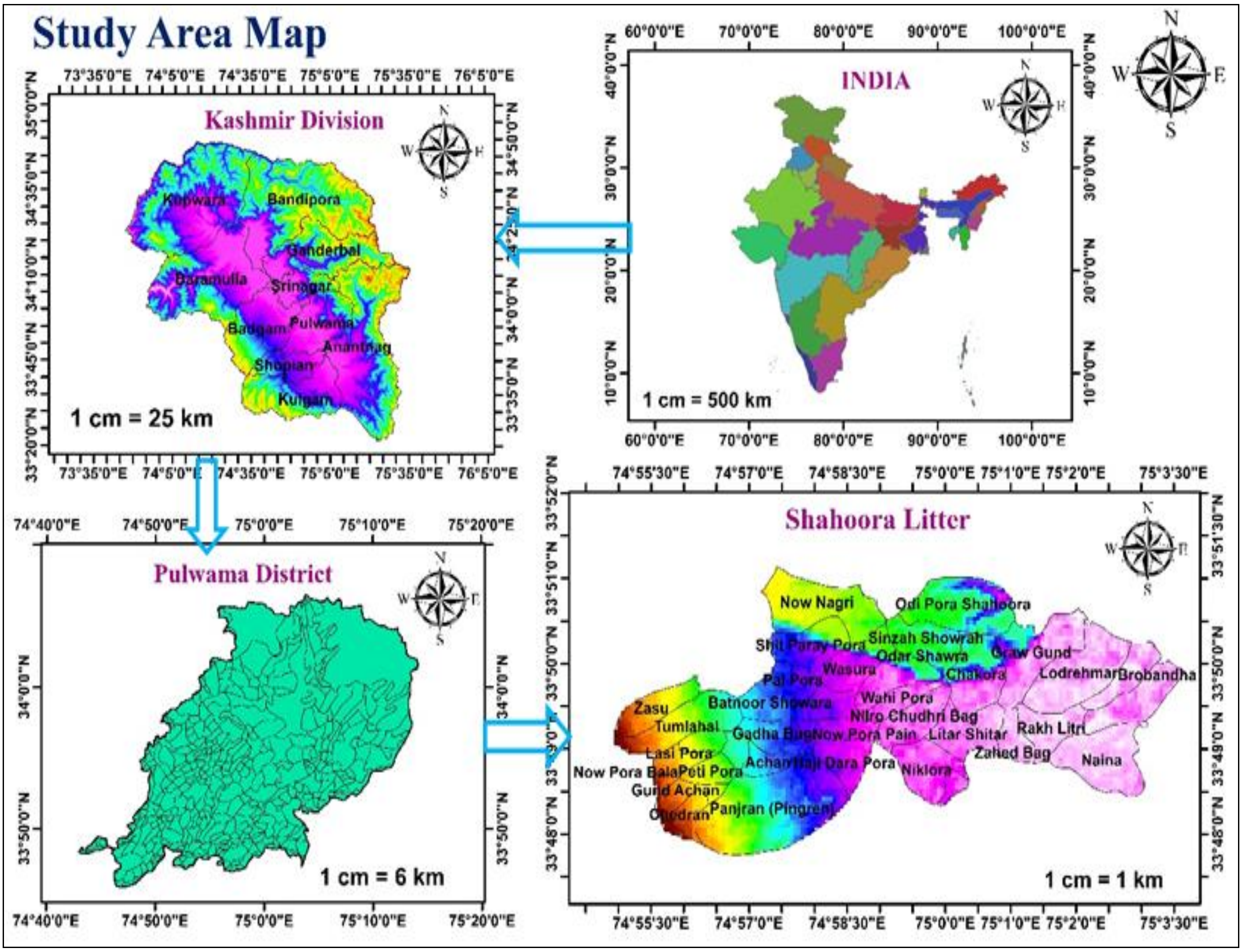


Figure I. Location map of the study area.
Source: Generated using shape file of India in Arc GIS 10.2

The study area is located about 14 km from the district headquarter Pulwama and 45km from the summer capital Srinagar (Jammu & Kashmir). It is a newly formed Tehsil of Pulwama district of Jammu and Kashmir, India and comprises of 40 villages with total population of 42000 & covers an area of 20 km^2 and most of the people (65%) are engaged with agriculture (District Census Hand Book, 2011). Study area with an average altitude of (1600 m) above the mean sea level. The climate is sub-humid temperate type with mean annual temperature 14^0 C and annual rainfall 506.1 mm (Indian Meteorological Department 2014). Study area with double crop cultivation (kharif as well as Rabi). In kharif season paddy is the main crop and in Rabi mustard is the main crop. Irrigation system is also moderately well drained (Rehman *et. al,* 2017). In the recent time people in the whole region have made a tremendous shift from agricultural land to horticulture sector due to high labour intensive, low productivity, and low-income generation in the agricultural sector.

Material and Methods

For the assessment soil quality, thirty soil samples at 1-30 cm depth were collected from 10 sample sites selected through composite sampling. Soil samples were collected randomly keeping in mind the maximum areal coverage. From each site three soil samples were taken from locations to have holistic view of the soil fertility in the region by taking mean value of sub-samples of the parameters. The soil samples were tested at Soil Testing Laboratory (STL), Department of Horticulture, Zainapora, Shopian Kashmir, and were compared with permissible range set by the standard soil classification as shown in the table I. Figure II shows the map of sample sites conducted for soil sample survey.

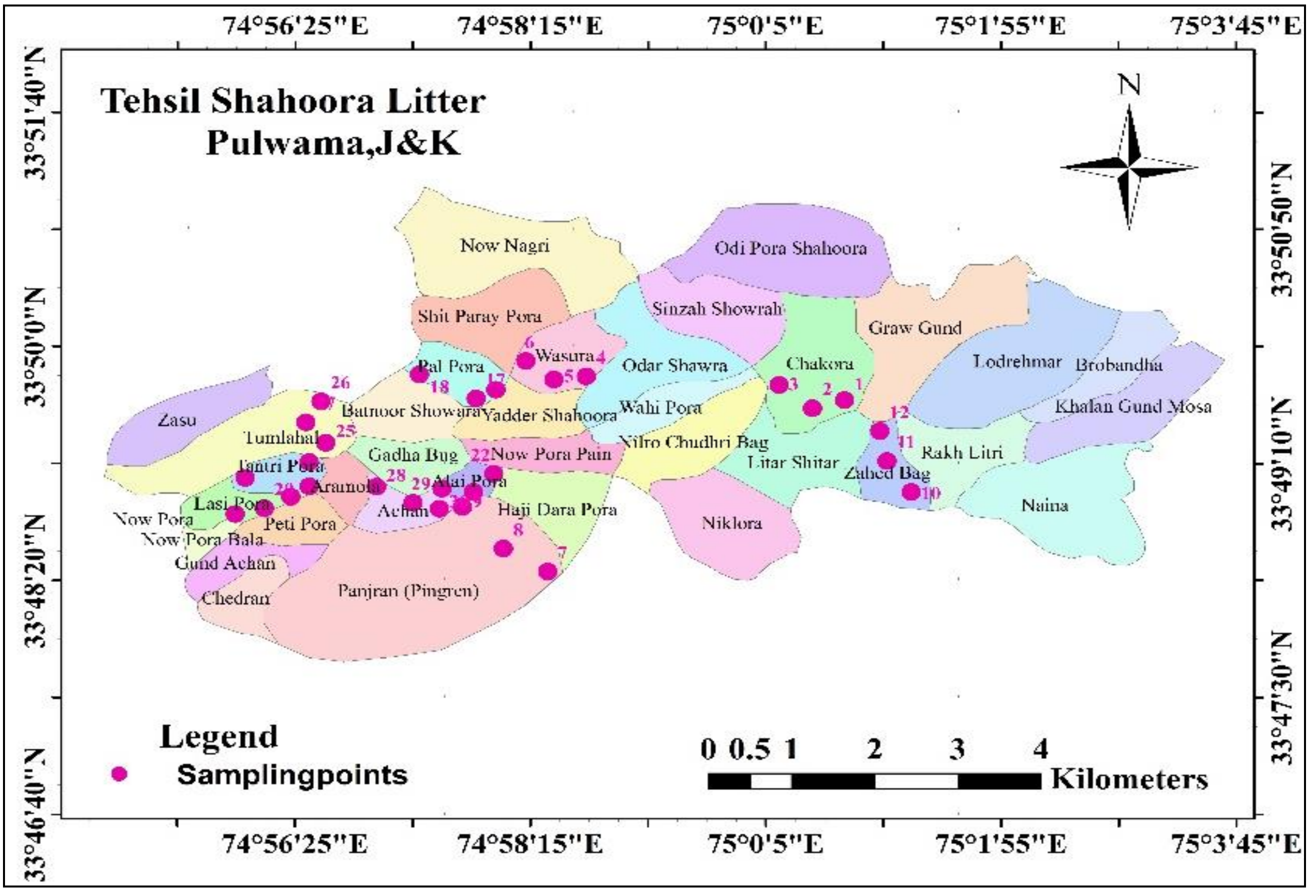


Figure II. Sample sites of soil sample survey

Equipment's and Methods used for Soil Testing

Following equipment's and methods were used while performing soil testing i.e. pH meter, conductivity meter, Titration Method/Walkey & Black Method used to measure (OC) (Page et al. 1982). Alkaline permanganate method to measure nitrogen availability (Subbiah and Asija, 1956). Spectrophotometer and Flame photometer to analyse the availability of phosphorous and potassium.

The soil parameter and their method of measurement/equipment used are shown in Annexure I.

Statistical Techniques

In this study we calculated mean, range and standard deviation to measure the soil quality in special package for social sciences (SPSS) software and compare it with the permissible limits of standard classification of soil set by Indian standard soil classification system (ISSCS).

Table I shows the standard soil classification and permissible ranges set by ISSCS.

Table I. Standard Classification of soil (ISSCS)

S. No.	Soil Test	Range	Classification
1.	pH	<4.5	Extremely acidic
		4.51-5.50	Very Strongly acidic
		5.51- 6.00	Moderately acidic
		6.01-6.50	Slightly acidic
		6.51-7.30	Neutral
		7.31-8.50	Moderately alkaline
		8.51-9.00	Strong alkaline
		>9.01	Very strong alkaline
2.	Electrical Conductivity(mmho/m) *(1dS/m=1mmho/cm)*	Up to 1	Average
		1.01-2.00	Harmful to germination
		2.01-3.00	Harmful to sensitive crop
3.	Organic Carbon	Up to 0.20	Very less
		0.21-0.40	Less
		0.41-0.50	Medium
		0.51-0.80	Average sufficient
		0.81-1.00	Sufficient
		>1.00	More than sufficient
4.	Nitrogen	Up to 50	Very less
		51-100	Less
		101-150	Good
		151-300	Better
		>300	Sufficient
5.	Phosphorous	Up to 15	Very Less
		16-30	Less
		31-50	Medium
		51-65	Average Sufficient
		66-80	Sufficient
		>80	More than Sufficient
6.	Potassium	0-120	Very less
		120-180	Less
		181-240	Medium
		241-300	Average
		301-360	Better
		>360	More than sufficient

Source: Indian standard soil classification system (ISSCS)

Results and Discussion

pH and Electric Conductivity (EC)

Soil pH is the scale of measuring acidity or alkalinity of a soil based on a value of 1-14. In the study we found that average pH value of soil samples at different locations varies from 6-5 to 7-5 with the mean value of 7.13 and standard deviation of 0.20 in the entire sample sites (Table II). Soils of few sites such as (Chakora, Tantrapora, Palpora, Lasipora), show moderately alkaline as compared to other areas which were having neutral pH value. Electrical conductivity (EC) of a soil extract used to estimate the level of soluble salts. It is done with the help of instrument called conductivity meter that is very reliable test for soil salinity. In the study, we found soil (EC) ranges 0.10 – 0.57 ds/m in all the sample sites with mean and standard deviation of 0.19 and 0.063 ds/m respectively. The electrical conductivity values (0.08– 0.28dsm^{-1}) in Panjran and Zehadbagh (Table II) show that the rate of volatilization is high and can be avoided by irrigation to the soil immediately after application of urea pills, waiting at least a month after limestone added to the surface of soils for the ammonium fertilization and maintenance of soil moisture (Boyd 1979).

Table II: Mean pH and EC of soil samples at different sample sites

S. No.	Sampling sites	pH			Mean	EC (dSm^{-1})			Mean
		S_1	S_2	S_3		S_1	S_2	S_3	
1	Chakora	7.5	7.5	7.5	***7.5***	0.26	0.3	0.16	***0.24***
2	Wasora	6.8	7.0	7.0	***6.9***	0.23	0.14	0.1	***0.16***
3	Panjran	7.5	6.8	6.7	***7.0***	0.51	0.18	0.14	***0.28***
4	Zehadbagh	7.5	6.5	7.5	***7.16***	0.1	0.57	0.41	***0.36***
5	Tantrapora	7.5	7.4	7.2	***7.36***	0.18	0.1	0.18	***0.15***
6	Palpora	7.5	7.5	7.0	***7.33***	0.27	0.26	0.22	***0.25***
7	Lasipora	7.5	7.5	7.0	***7.33***	0.2	0.18	0.16	***0.18***
8	Alaipora	6.5	7.0	7.5	***7.0***	0.25	0.25	0.22	***0.24***
9	Tumlahal	7.1	7.0	7.0	***7.03***	0.23	0.19	0.25	***0.22***
10	Achan	7.1	6.5	6.5	***6.7***	0.26	0.1	0.1	***0.15***
μ= 7.13	**SD = 0.203**	**Range = 6.5 - 7.5**				**μ = 0.19**	**SD = 0.063**	**Range = 0.10 - 0.57**	

Source: Soil testing Lab., Department of Horticulture, 2019

Organic carbon and Phosphorus

Organic matter has a vital role in agricultural soil. The organic carbon of the soil samples was found low to medium in concentration within range of (0.22-1.05 %) with mean 0.57 percent, and standard deviation of 0.141 percent. The least value found in S_3 of village Tumluhal and highest value in S_1 of village Chakora. The two sampling villages of Palpora and Tumluhal shows less concentration of organic concentration and rest of the locations show an average to sufficient concentration as shown in table III. Therefore, the area having low OC in soil have been encouraged to use organic manure such as green manure and farmyard manure to the soil for the maintenance of optimum crop productivity. It supplies plant nutrient, improve the soil structure, improve water infiltration and retention, feeds soil micro flora and fauna, and the retention and cycling of applied fertilizer (Johnston, 2007). Phosphorus is an essential nutrient for plant growth. It is an important element that store energy in plant cells, which is crucial for photosynthesis. Phosphorous parameter is also called the *'master key to agriculture'* because low crop production is attributed mainly due to lack of phosphorus than the deficiency of other elements except nitrogen (Gobinder *et. al*, 2016). The recommended value of available phosphorus for the effective cultivation of rice and sugarcane is >30kg ha−1 (Rajendran & Shanmuganathan, 2019). The phosphorous of the samples investigated in the study ranges from 22.5 – 197 kg/ha with mean of 78.13 kg/ha, and standard deviation is 23.159 kg/ha (table V). There is wide range of values with respect to mean value. Only S_2 and S_3 of village Panjran, S_3 of Zehadbagh and S_1 of village Tantrapora have less Phosphorous in concentration and rest of the sites have sufficient and more than sufficient concentration as per the standard soil classification. Hence, results show available phosphorous is higher in concentration. Phosphorus amount may be improved by intensive fertilization of cash crops like tobacco, cotton and peanuts and application of green manures and bio solids in soils. For the management practices, decreasing run-off and soil erosion can be minimized by terraces, tillage practices; buffer strips grassed water ways reduce phosphorus run off.

Table III. Mean values Organic carbon and Phosphorus of soil samples at different sample sites

S.NO.	Sampling sites	OC (%)			Mean	P (Kg ha^{-1})			Mean
		S_1	S_2	S_3		S_1	S_2	S_3	
1	Chakora	1.05	0.34	0.43	***0.6***	197	66	57	***106.6***
2	Wasora	0.39	0.6	0.9	***0.63***	70.5	77	89	***78.8***
3	Panjran	0.68	0.7	0.72	***0.7***	94.4	32.4	31.3	***52.7***
4	Zehadbagh	0.6	0.45	0.71	***0.59***	168	75	22.5	***88.5***
5	Tantrapora	0.62	0.25	0.66	***0.51***	22.5	94	88.4	***68.3***
6	Palpora	0.42	0.4	0.38	***0.4***	116	131	135	***127.3***
7	Lasipora	0.65	0.68	0.68	***0.67***	49.2	48	40	***45.7***
8	Alaipora	0.72	0.76	0.7	***0.73***	67	67	75	***69.6***
9	Tumlahal	0.24	0.27	0.22	***0.24***	51.5	79	66	***65.5***
10	Achan	0.5	0.76	0.57	***0.61***	52.64	77.28	105	***78.3***
μ = 0.57% SD = 0.141 Range = 0.22 - 1.05						**μ = 78.13 SD =23.159 Range = 22.5 - 197**			

Source: Soil testing Lab., Department of Horticulture, 2019.

Potassium and Nitrogen

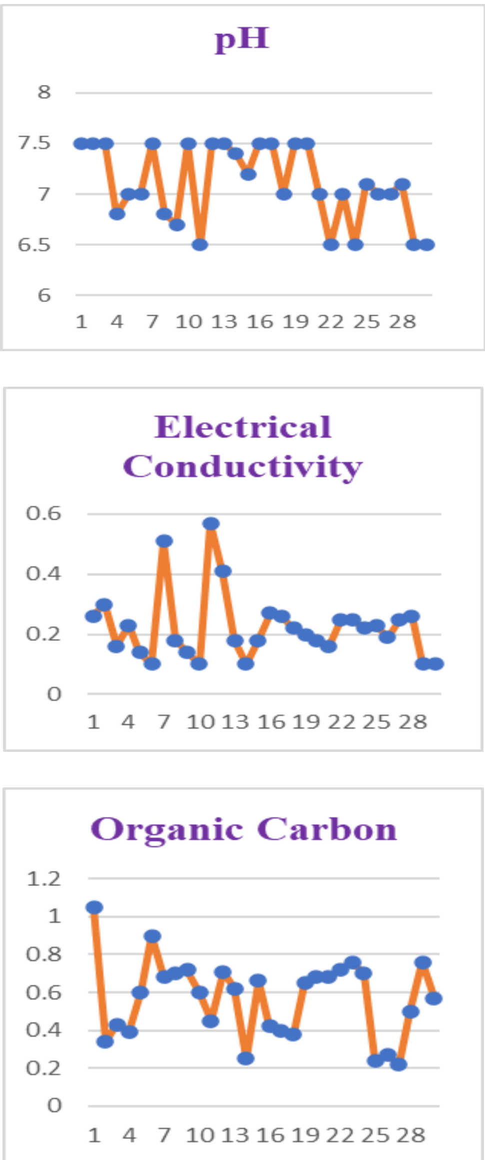
Potassium nutrient is essential for plant growth. It is involved in the activation of enzymes that are responsible for many physiological plant processes. It also plays a role in nutrient and sugar transport in the plant. It is essential for water regulation in the plant and increased winter hardiness of legumes. Plants require more potassium than any other nutrient, including nitrogen (Hodges, 1995). Deficiency of potassium leads to (i) stunted and poor root systems (ii) symptoms of interveinal chlorosis (iii) bronzing near the edges of lower leaves and moves inward until the entire leaf dies and are shed, when the deficiency continues (iv) reduction of carbohydrate production (v) premature defoliation (vi) delayed maturity (vii) reduced yield (viii) plant death. Potassium deficiency can be minimized by (i) implementing good soil erosion practices (ii) maintain good soil pH to increase soil cation exchange capacity (iii) building soil organic residues (iv) using split application to reduce leaching losses on soils with low cation exchange capacity (Bar-Tal, 1991). Samples investigated in the study depict potassium concentration range from 73.9 – 300 kg/ha with mean of 142.5 kg/ha and standard deviation of 75.42 kg/ha. The data is widely dispersing in nature. It is the only soil parameter which is very less to less in concentration except the sampling location of Zehadbagh which has adequate concentration (table VI). Thus, there is problem in available potassium in the study area. The recommended value for the effective cultivation of crops is shown in the table II. Nitrogen is essential in plant growth as it is the most vital element obtained by plants from the soil (Gorde, 2013). It is an essential nutrient for the cultivation of crops and plays an important role in sustaining high yields. Its deficiency results in a yellowing of the leaves, because of declining chlorophyll. The most important reason for the nitrogen loss in the soils of this investigation may be (i) denitrification (ii) ammonia volatilization (iii) leaching (iv) crop removal (v) surface run-off (vii) high soil pH. Nitrogen loss from crop removal may be avoided if the crop materials are directly exported from the farm in the form of grains forages (Hodges 1995). The statistics of this very parameter varied from 120 – 450 kg/ha with mean of 276.4 kg/ha and standard deviation of 69.9 kg/ha (table V II). Data is also wider in range. The available nitrogen is good to sufficient in concentration as per the standard soil classification shown in table II.

Table IV. Mean values Nitrogen and Potassium of soil samples at different sample sites

S. No.	Sampling sites	K (Kg ha^{-1})			Mean	N (Kg ha^{-1})			Mean
		S_1	S_2	S_3		S_1	S_2	S_3	
1	Chakora	300	95	85	***160***	184	172	217	***191***
2	Wasora	90	98	109	***99***	195	300	450	***315***
3	Panjran	300	90.7	77.2	***155.9***	340	350	360	***350***
4	Zehadbagh	259	344	125.4	***342.8***	300	325	355	***326.6***
5	Tantrapora	188	126	132	***148.6***	310	125	330	***255***
6	Palpora	91.84	92	88	***90.6***	210	215	200	***208.3***
7	Lasipora	73.9	79	85	***79.3***	338	330	300	***322.6***
8	Alaipora	94	98	88	***93.3***	360	355	335	***350***
9	Tumlahal	191.5	174	165	***176.8***	120	155	144	***139.6***
10	Achan	75.04	77.28	84	***78.7***	250	383	285	***306***
μ = 142.5 SD = 75.425 Range = 73.9 - 300					μ = 276.41 SD =69.969 Range = 120 -450				

Source: Soil testing Lab., Department of Horticulture, 2019

The variability of different physico-chemical parameters of soil samples of Tehsil Shahoora Litter is presented in figure III below.



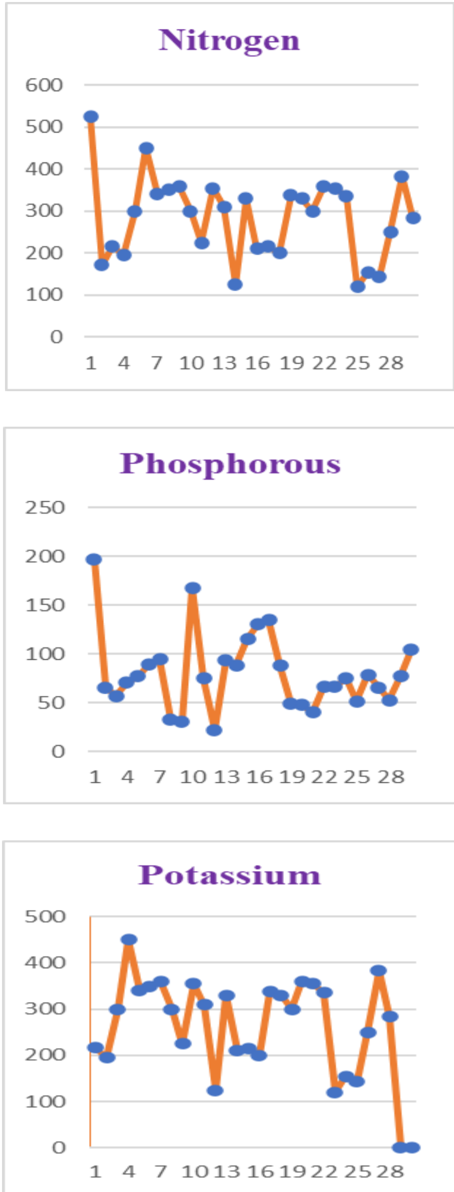


Figure III. Variability of different physico-chemical parameters

Conclusion

Appraising physico-chemical parameters of soil gives important information about the nature, presence of nutrients and most important it gives an idea regarding the fertility status of soil. In this study, soil samples from different villages of the study area were taken for the assessment of fertility status of the soil by using physico-chemical parameters like soil reaction (pH), electrical conductivity (EC) organic carbon (OC), nitrogen (N), phosphorous (P), and potassium (K). Results obtained from the study revealed that the parameters like pH, EC, N & P are good in quality and rest of parameters like OC & K varied significantly, mostly K which was found low in the soil samples. The study appraised that area practicing organic fertilizers were maintain high soil fertility in comparison to areas where inorganic fertilization is practiced lot. It was also found that people in the entire region lacks basis perception regarding the agricultural practices and largely depends on traditional or ancestral knowledge. Recommendation for areas having low organic carbon in soil have been encouraged to use organic manure such as green manure and farmyard manure to the soil for the maintenance of optimum crop productivity (Johnston, 2007). Grow cereal crops because there is significant amount of organic matter in their dead roots. Keep tillage to a minimum as it can expose the remains organic matter in the soil, use direct drill technique and it can't expose the stubble residues in the soil which are rich in organic carbon. To eradicate the potassium deficiency in a soil, burying banana peels below the soils surface, it is one of the effective method to raise the level. Wood ash is another content but it should be used more cautiously because it will raise the pH level. Compost made of food byproducts will also raise the level of potassium. After knowing the above facts regarding the soil, it will help farmers to solve the problems related to soil nutrients, amount of fertilizers to be used, etc. This knowledge will also help the people who are interested to work in the agricultural field.

Acknowledgement

The author expresses his gratitude to soil testing laboratory Zainapora Shopian, Deptt. of Horticulture for providing smooth atmosphere during soil testing.

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Annexure I. Soil Parameter with their Method of Measurement/ Equipment Used

S. No.	Parameter	Equipment/Method of Analysis
1.	pH	pH Meter
2.	EC	Conductivity Meter
3.	OC	Titration Method/Walkey & Black Method (Page et al. 1982)
4.	Available Nitrogen	Alkaline permanganate method (Subbiah and Asija, 1956)
5.	Available Phosphorous	Spectrophotometer
6.	Available Potassium	Flame Photometer