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Nutrient status of different soil samples of Almora district of Uttarakhand and their correlation with soil properties

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Abstract
This experiment investigated soil properties (pH, EC and OC), macronutrient availability (N, P, K S and Ca) and the relationship between soil properties and macronutrient availability. Eight different locations in Bhikiyasain block, Almora district of Uttarakhand, were sampled for soil (0-15 cm depth). N, P, K, S and Ca levels in soil were examined using different methods. Available Nitrogen was analyzed by alkaline $KMnO_4$ method, available phosphorus by Bray method, available Potassium by Ammonium acetate method, extractable available Sulphur by $CaCl_2$ method and extractable available Ca by rapid titration method. The soil texture ranged from medium texture to fine texture. The soil pH showed positive and significant correlation with available Phosphorus. The OC and EC showed positive correlation with available K for the entire area of study. After analyzing all nutrient indices, the soils under study were found to be high in extractable N, S and Ca and medium in extractable K and low in P.

Keywords: Alkaline $KMnO_4$, $CaCl_2$ method. Ammonium acetate, and bray's method

1. Introduction
Soil, water, and air are three essential regular assets whereupon most life depends. The harmony between monetary reasonability and obliteration frequently depends on how we deal with our soil asset base. For instance, the soil gives supplements to plant development that are fundamental for creature and human substance. It gives the medium to the reusing and detoxification of natural materials and for the reusing of numerous supplements and worldwide gases (Bezdicek *et al.*, 1997) [1]. Soil gives biological system administrations basic to life, soil goes about as a water channel and a developing medium, gives environment to billions of living beings, adding to biodiversity and supplies the majority of the anti-toxins used to battle sicknesses. People use soil as a bin for strong waste, channel for wastewater, and establishment for our urban communities and towns. At last, soil is the premise of agroecosystems, which furnish us with feed, fiber, food and fuel (Mathew, 2012) [8]. Soil profitability is the limit of soil to create a specific plant or sequence of plants under a predefined the executive's framework. Practical soil efficiency is the reason for food security. Intensive agriculture practices decrease in soil profitability which can represent an immediate danger to food security (Duan *et al.*, 2011) [4]. Soil related problem, for example weakened soil health, influencing the harvest efficiency amazingly which can be dedicated by assessing the fertility status of the soil. Soil testing gives the data about the supplement's accessibility of the soil whereupon the manure suggestion for augmenting crop yields made. Soil properties comparable to assessment of fruitfulness status of soils of a zone is a significant setting of practical farming creation. Due to imbalanced and lacking fertilizer utilization which combined with low productivity of different information source, the response efficiency of substance manure supplements has declined massively under escalated farming. Thus, it is basic to know the nutrient status of soil to get most wanted yield from it. The soil of Uttarakhand is brown to grayish brown, acidic to moderate neutral in pH having low moisture retention capacity and highly erosion prone (Shukla *et al.* 2013) [10]. It is therefore important to periodically evaluate a region's nutrient status. The objective of this study is to examine soil samples taken from Bhikiyasain block, Almora district of Uttarakhand and determine the relationship between soil properties and extractable macronutrients.

2. Material Methods

The soil samples were air-dried in the shade after collection. A 2 mm sieve was used to remove particles from the air-dried samples before they were properly stored in labelled, clean bags. The general chemical characteristics of the treated soil samples were examined. The soil texture was measured by rapid feel method, which involves rubbing moist earth between the thumbs and fingers to evaluate the quality of soil texture. The Munsell color chart was used to assess the soil color. Comparison to a soil color chart is the most practical way to quantify soil colors. The pH of soil was measured by using soil-to-water suspensions in 1:2 ratio by thoroughly mixing and then the pH of the suspension was determined using a pH meter (Jackson *et al.*, 1967) [7]. The soil samples that were used to determine the pH were let for 24 hours to settle and the electrical conductivity meter was used to measure the soluble salts in a 1:2 soil-water solution at 25 °C in dSm^{-1}. Organic carbon was measured according to Walkley and Black Method (1934) [12]. In this process, chromic acid is created which in presence of sulfuric acid, oxidizes organic carbon. Back titration is performed using 0.5 N ferrous ammonium sulphate and the residual chromic acid. The quantity of chromic acid actually consumed in the oxidation is used to compute the amount of OC in the soil. The soil macronutrient (N, P, K, S and Ca) was then measured according to different conventional methods. Extractable nitrogen in soil was measured by Alkaline $KMnO_4$ method as proposed by Subbiah and Asija (1956) [11]. This procedure involves distillation of soil with alkaline $KMnO_4$ solution and the amount of liberated ammonia was absorbed in boric acid was determined by titration with standard acid. For determining the extractable phosphorus, the soil was extracted by 0.03N NH_4F + 0.025 N HCl as described by Bray's method (Bray and Kurtz, 1945; Frank 1998) [2, 5]. The Extractable potassium was measured by extracting the soil by 1N ammonium acetate (Hanway and Hiedal, 1952) [6]. Available Sulphur was evaluated by the method developed by Chesnin and Yien (1951) [3]. Which include the extraction of the soil by 0.15% $CaCl_2$ and the extractable S was determine by turbidimetry using $BaCl_2$ crystals. The extent of developed turbidity was measured on spectrophotometer at 420 nm wavelength. Calcium carbonate ($CaCO_3$) was determined by using rapid titration method as described by Piper (1966) [9].

3. Results and Discussion

3.1 General properties of soil of Bhikiyasain block of Almora district

General properties, pH, EC, Organic carbon, Organic matter Calcium carbonate content, texture and soil color of soils collected from Block Bhikiyasain of Almora district are shown in Table-1.

Table 1: General Physiochemical properties of soils collected from Block Bhikiyasain

Location	pH (Mean)	EC (dSm^{-1}) (Mean)	OC (%) (Mean)	Color	Texture
Dhanoli Talli	6.18 - 6.93 (6.55)	0.118 - 0.166 (0.143)	0.34 – 1.53 (1.06)	Reddish brown	Silty clay loam
Soli	5.86 - 6.68 (6.19)	0.075 - 0.156 (0.118)	1.40 – 1.44 (1.42)	Strong Brown	Sandy Loam
Ugaliya	5.83 – 6.35 (6.12)	0.137 - 0.176 (0.147)	1.25 - 1.56 (1.40)	Brown	Silty clay loam
Bhanti	6.28 - 6.62 (6.28)	0.084 - 0.186 (0.139)	0.52 – 1.59 (0.93)	Reddish Gray	Sandy
Pipaliya	5.02 – 6.12 (5.43)	0.760 - 0.952 (0.847)	0.74 – 1.63 (1.32)	Brown	Sandy loam
Tana Chatura	5.89 - 6.43 (6.18)	0.050 - 0.170 (0.090)	0.52- -0.68 (0.61)	Dark Brawn	Silty clay loam
Simora	6.34 – 6.81 (6.76)	0.235 - 0.263 (0.252)	0.98 – 1.36 (1.20)	Brown	Sandy clay
Nainisera	5.04 - 6.34 (5.66)	0.205 - 0.262 (0.232)	0.29 – 1.44 (1.37)	Reddish Gray	Sandy Clay
Bhikiyasain Block as whole	5.02 – 6.93 (6.15)	5.02 – 6.93 6.15	0.050 – 0.952 0.246	Brown	Silty clay loam

In Block Bhikiyasain 8 location: Dhanoli Talli, Soli, Ugaliya, Bhanti, Pipaliya, Tana chatura, Simora and Nainisera were selected.

The range of pH was found 5.02 – 6.93, with the mean value of 6.15. The highest and lowest pH was found at Simora (pH 6.76) and Pipaliya (pH 5.43), respectively. The range of electrical conductivity was found 0.050 – 0.952 dSm^{-1}, with the mean value of 0.246 dSm^{-1}. The highest and lowest EC was found at Pipaliya (0.847 dSm^{-1}) and Tana Chatura (0.090 dSm^{-1}), respectively. The range of organic carbon was found 0.050 – 0.952%, with the mean value of 0.246%. The highest and lowest OC was found at Soli (1.42%) and Tana Chatura (0.61%), respectively.

Table 2: Availability of macronutrients extracted in different location of block Bhikiyasain

Location	N- $KMnO_4$ $Kgha^{-1}$	P-Brays $Kgha^{-1}$	K-NH_4OAc $Kgha^{-1}$	S-$CaCl_2$ $Kgha^{-1}$	$CaCo_3$ (%)
Dhanoli Talli	585.80 -589.81 (579.35)	12.76 - 17.97 (15.74)	240.69 – 249.47 (245.67)	24.03 – 47.25 (31.88)	2.58 – 5.69 (4.26)
Soli	564.89 – 593.96 (582.81)	16.57 - 17.58 (17.01)	167.34 – 174.27 (171.31)	30.46 – 35.62 (33.88)	2.35 – 3.98 (3.26)
Ugaliya	565.19 – 572.82 (568.65)	13.42 - 18.27 (15.08)	271.82 – 280.78 (277.34)	24.37 – 40.38 (33.33)	4.70 – 5.24 (4.83)
Bhanti	568.65 – 589.22 (574.52)	13.45 - 19.64 (16.91)	165.98 – 176.54 (170.49)	47.08 – 49.36 (50.54)	2.68 – 4.25 (3.46)
Pipaliya	561.91 – 585.80 (575.35)	14.61 - 15.31 (14.87)	265.34 - 282.192 (269.30)	26.81 – 32.51 (29.31)	4.60 – 5.45 (4.88)
Tana chatura	557.91 – 573.89 (567.76)	14.16 - 17.32 (15.87)	226.32 – 241.36 (234.70)	29.54 – 38.70 (33.12)	3.58 – 4.16 (3.75)
Simora	547.61 – 581.41 (564.61)	18.21 - 20.83 (19.09)	136.47 – 165.16 (147.14)	32.56 – 41.82 (37.89)	3.95 – 4.43 (4.16)
Nainisera	552.60 – 577.65 (563.86)	14.54 - 16.13 (15.32)	215.15 – 240.26 (228.18)	36.81 – 43.92 (39.61)	3.58 – 4.60 (4.14)
Range Overall mean	547.61 - 593.96 573.25	12.76 - 20.83 16.23	136.47 - 282.19 216.86	24.03 – 49.36 36.20	0.58 – 2.80 1.92

3.2 Extractable macronutrient in soils of Bhikiyasain block of Almora district

The soil available N was measured by $KMno_4$ method. The range of available N was found 547.61 - 593.96 kg ha^{-1} with the mean value of 573.25 kg ha^{-1}. Highest N content was found in Nainisera with mean value of 563.86 kg ha^{-1} and lowest N content was found in Soli with mean value 582.81 kg ha^{-1}. The soil available P was measured by Brays method.

The range of P was found 12.76 - 20.83 kg ha^{-1} with the mean value of 16.23 kg ha^{-1}. Highest P content was found in Pipaliya with mean value of 14.87 kg ha^{-1} and lowest P content was found in Simora with mean value 19.09 kg ha^{-1}. The soil available K was measured by NH_4OAc method. The range of K was found 136.47 - 282.19 kg ha^{-1} with the mean value of 216.86 kg ha^{-1}. Lowest K content was found in Simora with mean value of 147.14 kg ha^{-1} and highest K content was found in Ugaliya with mean value 277.34 kg ha^{-1}. Extractable S was measured by $CaCl_2$ method. The range of extractable S was found 24.03 - 49.36 kg ha^{-1} with the mean value of 36.20 kg ha^{-1}. Highest S content was found in Bhanti with mean value of 50.54 kg ha^{-1} and lowest S content was found in Pipaliya with mean value 29.31 kg ha^{-1}.The soil available calcium carbonate was measured by rapid titration method. The range of CaCo3 was found 0.58 – 2.80% with the mean value of 1.92%. Highest CaCo3 content was found in Pipaliya with mean value of 4.88% and lowest N content was found in Soli with mean value 3.26%.

Table 3: Correlation of soil properties and N, P, K, and S of Location Bhikiyasain

	pH	EC	OC	OM	$CaCO_3$	N- $KMnO_4$	P- Bray	K- NH_4OAc	S- $CaCl_2$
pH	1								
EC	.421*	1							
OC	-.221	.195	1						
OM	-.221	.195	1	1					
$CaCO_3$	-.182	.375	.183	.183	1				
N	.079	-.066	.154	.154	-.086	1			
P	.451*	-.181	-.088	-.088	-.066	-.085	1		
K	-.381	.336	.094	.094	.448*	.057	-.585**	1	
S	.208	-.247	.076	.076	-.428*	-.205	.026	-.445	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Linear relationships present among the measured soil parameters and Bhikiyasain has been presented in Table No. 3. Soil pH positively and non-significantly correlated with available N (r = 0.079), available S (r = 0.208) at the 5% significance level and positively and significantly correlated with available P (r = 0.451). The pH was found negatively and non-significantly correlated with available K (r = -0.381) and calcium carbonate (r = -0.182).

Electrical conductivity was negatively and non-significantly correlated with available N (r = -0.066), P (r = -0.181) and available S (r = -0.247). The EC was found positively and non-significantly correlated with available K (r = 0.336) and calcium carbonate (r = 0.375).

The organic carbon showed positive and non-significant correlation with available N (r = 0.154), available K (r = 0.094), available S (r = 0.076) and $CaCo_3$ (r = 0.183). The OC was found non-significant and negative correlated with available P (r = -0.088).

4. Conclusion

From this study it may conclude that the soil of Bhikiyasain block of Almora district is silty clay loam, acidic in nature and rich in organic Carbon. The nutrient indices study conclude that the soil is high in available N, extractable S and $CaCO_3$ whereas medium in available K and low in available P. Correlation study suggest that the soil pH is positive and significant correlated with available P whereas the OC and EC showed positive correlation with available K. As variability was found in nutrient content, so site specific nutrient management may be recommended for improving the yields of crop.

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