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Availability of Macronutrients and their Relationship with some Soil Properties in Molisols of Udham Singh Nagar District of Uttarakhand, India

Vineet Kumar, Ajaya Srivastava, Shiv Singh Meena* and Sarvesh Kumar

Department of Soil Science, College of Agriculture,
GBPUA & T, Pantnagar, U.S. Nagar, Uttarakhand 263145, India
**Corresponding author*

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A B S T R A C T

An investigation was carried out to study the distribution of available macronutrients (N, P, K and S) and their relationship with some physico-chemical properties of soil of different blocks of district Udham Singh Nagar (Uttarakhand).The soils of the district were found sufficient in Phosphorus, Potassium and Sulphur but low in available Nitrogen content. In general the macronutrients were correlated significantly and negatively with pH and positively with organic carbon of the soil. The values of the organic carbon, Alkaline $KMnO_4$ extractable N, Olsen's P and neutral normal Ammonium Acetate extractable K in the Udham Singh Nagar district ranged between 0.13-1.64 per cent, 125.44-338.68 kg N ha^{-1}, 7.34-76.70 kg P_2O_5 ha^{-1} and 66.08-271.04 kg K_2O ha^{-1}, respectively. From the above findings it may be concluded that the soils of Udham Singh Nagar district are low in nitrogen, sufficient in phosphorus & in potassium, Except Sitarganj, Jaspur and Bazpur samples were low in potassium, sufficient in sulphur except Rudrapur. These findings from present study can successfully be utilized for the larger parts of Tarai region of Uttarakhand as effective guide for efficient and balanced fertilizer recommendations.

Introduction

Soil plays a major role in determining the sustainable productivity of an agro-ecosystem. The sustainable productivity of a soil mainly depends upon its ability to supply essential nutrients to the growing plants. The deficiency of micronutrients has become major constraint to productivity, stability and sustainability of soils. The availability of some plant nutrients is greatly affected by soil pH. The ideal soil pH is close to neutral, and neutral soils are considered to fall within a range from a slightly acidic pH of 6.5 to slightly alkaline pH of 7.5. It has been determined that most plant nutrients are optimally available to plants within 6.5–7.5 pH range, also this range of pH is generally very compatible to plant root growth. Nitrogen (N), Potassium (K), and Sulphur (S) are major plant nutrients that appear to be less affected directly owing to variation in soil pH than many others, but still are to some extent.

Nitrogen is primarily responsible for vegetative growth. Nitrogen assimilation into amino acids is the building block for protein in the plant. It is a component of chlorophyll

and is required for several enzyme reactions. Phosphorus is a major component in plant DNA and RNA. Phosphorus is also critical in root development, crop maturity and seed production. The role of potassium in the plant is indirect, meaning that it does not make up any plant part. Potassium is required for the activation of over 80 enzymes throughout the plant. It's important for a plant's ability to withstand extreme cold and hot temperatures, drought and pests. Potassium increases water use efficiency and transforms sugars to starch in the grain-filling process. S is essential in forming plant proteins because it is a constituent of certain amino acids. It is actively involved in metabolism of the B vitamins biotin and thiamine and co-enzyme A. S aids in seed production, chlorophyll formation, nodule formation in legumes, and stabilizing protein structure.

In Uttarakhand the farmers are not aware how pH, EC and soil texture affects the availability of major nutrients in soil, which surely affects the crop growth and production of the crops. So keeping this fact in mind the present study "Availability of Macronutrients and their Relationship with some Soil Properties in Molisols of Udham Singh Nagar District of Uttarakhand" is done.

Materials and Methods

The present study was conducted on the soils of different villages of district Udham Singh Nagar which is situated in Uttarakhand state. The soil and plant sample (Wheat) were taken from each block of district, 6 soil samples were collected from a single block. Rudrapur-Tanda Range, Gadarpur- Madnapur, Jaspur-Teerghari, Bazpur- Keshowala, Sitarganj-Baikunthapur, Kashipur- Dhakia Kalan and Khatima- Jhankat. Analysis of pH through pH meter, Electrical conductivity by EC meter, Organic carbon by Walkley and Black method. The samples were air dried, crushed on hard wooden slab with the help of wooden roller, passed through a 2 mm sieve and stored in a labeled polythene bags.Soil texture of soil was determined with the help of bouyoucous hydrometer method (Moodie *et al.*, 1959). The pH of the soil was determined in 1:2 (soil:water) ratio after half an hour of equilibrium using glass electrode on a digital pH meter (Jackson, 1967). Electrical conductivity of the soil sample was measured in 1:2 (soil: water suspension) at 25ºC using conductivity meter (Bower and Wilcox, 1965). Organic carbon content in the soil was determined by modified Walkley and Black method (1934) as described by Jackson (1967). Available nitrogen was estimated by alkaline $KMnO_4$ method (Subbiah and Asija, 1956). Available phosphorus was extracted by Olsen's method (Olsen *et al.*, 1954) using 0.5M $NaHCO_3$ (pH 8.5) and developing the blue colour with ascorbic acid method of Murphy and Riley (1962). The intensity of blue colour was recorded on spectrophotometer at 882 nm. Potassium was determined by using neutral ammonium acetate as extractant (Hanway and Hiedal, 1952). Potassium concentrations in the extracts were read by using flame photometer. Final values in soil were reported in kg ha^{-1}. The 0.15% calcium chloride extractable sulphur was determined by the method suggested by Williams and Steinbergs (1959). Most of the blocks were high in pH value; this might be due to presence of calcium carbonate and soluble salts and exchangeable sodium on exchange complex which gave soils higher pH. The observed value of soil pH was quite comparable to that observed earlier by Kumar (1988) for soils of Siwaya (Meerut).

The high EC values possibly due to higher clay content might have encouraged greater retention of salt. On the basis of limits suggested by Muhr *et al.*, (1965) for judging salt problem of soils, all the samples were found normal (EC < 1.0 dSm^{-1}).

Organic carbon content in soils of Rudrapur block because the soils collected from the Tnada range which is a under forest area. Soils in low organic carbon (Khatima, 0.45 %) are possibly because of high temperature and good aeration in the soil which increased the rate of oxidation of organic matter.

Results and Discussion

Nitrogen

Available nitrogen extracted by alkaline-KMnO4 method of the experimental district Udham Singh Nagar showed in table 1, varied from 125.44-338.68 kg N ha^{-1} with mean value of 187.26 kg N ha^{-1}. Block wise values ranged from 175.61 to 301.05 kg N ha^{-1} with a mean of 202.79 kg N ha^{-1} in Rudrapur block, 150.52-338.68 kg N ha^{-1} with a mean of 209.06 kg N ha^{-1} in Gadarpur block, 125.44-288.51 kg N ha^{-1} with a mean of 181.88 kg N ha^{-1} in Sitarganj block, 137.98–250.88kg N ha^{-1} with a mean of 198.61)kg N ha^{-1} in Khatima block, 125.44-238.33 kg N ha^{-1} with a mean of (165.16) kg N ha^{-1} in Jaspur block, 137.98–288.51kg N ha^{-1} with a mean of 188.16 kg N ha^{-1} in Kashipur block and 150.52–200.70kg N ha^{-1} with a mean of 165.16 kg N ha^{-1} in Bazpur block.

Phosphorus

Available phosphorus extracted by Olsen's-P method of the experimental district Udham Singh Nagar showed in table 1 varied from 7.34 to 76.70 kg P_2O_5 ha^{-1} with mean value of 34.93 kg P_2O_5 ha^{-1}. Block wise values ranged from 21.21 to 76.29 kg P_2O_5 ha^{-1} with a mean of 47.77 kg P_2O_5 ha^{-1} in Rudrapur block, 7.34-59.57 kg P_2O_5 ha^{-1} with a mean of 22.44 kg P_2O_5 ha^{-1} in Gadarpur block, 16.32–40.80 kg P_2O_5 ha^{-1} with a mean of 27.77 kg P_2O_5 ha^{-1} in Sitarganj block, 7.54-58.55 kg P_2O_5 ha^{-1} with a mean of 25.97 kg P_2O_5 ha^{-1} in Khatima block, 35.49-76.70 kg P_2O_5 ha^{-1} with a mean of 50.83 kg P_2O_5 ha^{-1} in Jaspur block, 31.82-62.42 kg P_2O_5 ha^{-1} with a mean of 40.25 kg P_2O_5 ha^{-1} in Kashipur block and 11.01-65.69 kg P_2O_5 ha^{-1} with a mean of 29.51 kg P_2O_5 ha^{-1} in Bazpur block.

The higher value of P_2O_5 in some blocks of Udham Singh Nagar district might be due to good organic carbon, about neutral soil pH and less fixation of P. Similar reason was also suggested by Shah (1999) in some soils of western U.P.

Potassium

Available potassium extracted by neutral normal NH4OAC method showed in table 1 ranged from 66.08 to 271.04 kg K ha^{-1} with mean value of 130 kg K ha^{-1}. Block wise values ranged from 133.28-230.72 kg K ha^{-1} with a mean of (181.81) kg K ha^{-1} in Rudrapur block, 138.88-190.4 kg K $ha^{-1}$with a mean of 162.21 kg K ha^{-1} in Gadarpur block, 70.56-120.96 kg K ha^{-1} with a mean of 103.6 kg K ha^{-1} in Sitarganj block, 107.52-127.68kg K ha^{-1} with a mean of 119.84 kg K ha^{-1} in Khatima block, 66.08-92.96kg K ha^{-1} with a mean of 75.41 kg K ha^{-1} in Jaspur block, 98.56-271.04kg K ha^{-1} with a mean of 171.53 kg K ha^{-1} in Kashipur block and 71.68-117.6kg K ha^{-1} with a mean of 95.38 kg N ha^{-1} in Bazpur block.

Jaspur block have highest K content in whole district might be due to the higher content of organic carbon. Shah (1999) also suggested the same reason for the soils of western U.P.

Sulphur

The soil samples of Rudrapur block were have low in (Table 1) sulphur content ranged from 2.41-12.07 ppm with a mean value of 6.72 ppm. The soil samples of Gadarpur block were high in sulphur content ranged from 4.45 to 42.5 ppm with a mean value of 21.5

ppm. The soil samples of Sitarganj block were medium in sulphur content ranged from 9.32 to 31.40 ppm with a mean value of 20.47 ppm. The soil samples of Khatima block were high in sulphur content ranged from 14.23 to 41.2 ppm with a mean value of 24.04 ppm. The soil samples of Jaspur block were medium in sulphur content ranged from 4.46 to 22.31 ppm with a mean value of 15.10 ppm. The soil samples of Kashipur block were medium in sulphur content ranged from 4.469 to 40.17 ppm with a mean value of 14.34 ppm. The soil samples of Bazpur block were medium in sulphur content ranged from 8.92 to 25.14 ppm with a mean value of 16.67 ppm.

The higher content of available S in Gadarpur and Khatima block might be due to higher pH and finer fractions of soil. The observed value of available S was quite comparable to that observed earlier by Dixit (1992) for the soils of Ram ganga – Kosi interbasin.

Table.1 Availability of macronutrients in different blocks

Blocks	Alkaline $KMnO_4$-N (kg ha^{-1})	Olsen's-P (kg ha^{-1})	NH_4OAc-K (kg ha^{-1})	S (ppm)
Rudrapur	175.61-301.05 (202.79)	25.69-76.29 (47.77)	133.28-230.72 (181.81)	2.41-12.07 (6.72)
Gadarpur	150.52-338.68 (209.06)	7.34-59.57 (22.44)	138.88-190.4 (162.21)	4.45-42.5 (21.5)
Sitarganj	125.44-288.51 (181.88)	16.32-40.80 (27.77)	70.56-120.96 (103.6)	9.32-31.40 (20.47)
Khatima	137.98-250.88 (198.61)	7.54-58.55 (25.97)	107.52-127.68 (119.84)	14.23-41.2 (24.04)
Jaspur	125.44-238.33 (165.16)	35.49-76.70 (50.83)	66.08-92.96 (75.41)	4.46-22.31 (15.10)
Kashipur	137.98-288.51 (188.16)	31.82-62.42 (40.25)	98.56-271.04 (171.73)	4.46-40.17 (14.34)
Bazpur	150.52-200.70 (165.16)	11.01-65.69 (29.51)	71.68-117.6 (95.38)	8.92-25.14 (16.67)
Udham Singh Nagar	125.44-338.68 (187.26)	7.34-76.70 (34.93)	66.08-271.04 (130)	2.41-42.5 (17.42)

Table.2 Correlation of soil properties with nutrient status in the soils of Udham Singh Nagar

Soil properties	N	P	K	S
pH	0.026	-0.456*	-0.158	-0.051
EC	-0.043	-0.397	0.166	0.180
O. C.	0.124	0.335*	0.071	-0.119
Clay	-0.028	-0.378*	0.218	-0.142
Silt	0.072	-0.056	0.047	0.104
Sand	-0.066	0.262	-0.167	-0.040

Nutrient status

As shown in table 2, in soils of Udham Singh Nagar District of Uttarakhand, the soil pH showed significant and negative correlation with available P (r = -0.456) at 5 percent level of significance, positive non-significant correlation with N (r = 0.026) and negative non-significant correlation with K (r = -0.158) and S (r = -0.051). The electrical conductivity also showed non-significant and negative correlation with available P (r = -0.397), positive non-significant correlation with K (r = 0.166) and S (r = 0.180) and negative non-significant correlation with N (r = -0.0430). The organic carbon showed positive and non-significant correlation with available N (r = 0.124), K (r = 0.071), negative and non-significant correlation with S (r = -0.119) and significant positive correlation with P (r = -0.335) at 5 percent level of significance.

The clay showed negative and significant correlation with available P (r = -0.378), negative non-significant correlation with N (r = -0.028), S (r = -0.142) and non-significant positive correlation with K (r = 0.218). The silt showed positive but non-significant correlation with available N (r = 0.072), K (r = 0.047) and S (r = 0.104) while it showed negative and non-significant correlation with available P (r = -0.056). The sand showed positive and non-significant correlation with available P (r = 0.262), negative correlation with N (r = -0.066), K (r = -0.167) and S (r = -0.040) but the values of correlation coefficients were statistically non-significant.

In conclusion, the present study was made to estimate available macronutrients (N, P, K and S some physico – chemical properties in soils of Udham Singh Nagar District of Uttarakhand. From the above findings it may be concluded that the soils of Udham Singh Nagar district are low in nitrogen, sufficient in phosphorus and in potassium, Except Sitarganj, jaspur and bazpur samples were low in potassium, sufficient in sulphur except Rudrapur. The soil pH found slightly alkaline in Rudrapur, Gadarpur, Sitarganj and Bazpur, medium acidic in Khatima, slightly acidic in Kashipur and in neutral range in Jaspur district. Salinity effects mostly negligible, organic carbon is high in whole district except low in khatima and medium in Jaspur and Kashipur. A more detailed fertility survey is required to verify the deficiency of macro and micro nutrients in the region. Further, pot culture and field experiment are required to be undertaken in future to verify the validity of critical limits of these nutrients likely to be deficient in the study area.

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