Research Article

Soil Fertility Assessment of Maize Growing Soils of Handwara, District Kupwara of Northern Kashmir

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Abstract

Soil Fertility status of maize growing soils and their correlation studies were carried out for Handwara region; district Kupwara of Northern Kashmir. Twenty composite surface soil samples at representative sites of Tehsil Handwara were collected and investigated for physico-chemical properties and the available nutrient status. The soils were slightly acidic to slightly alkaline in reaction (6.10-7.48). In general, the soils were low in soluble salts (0.11-0.35 dSm^{-1}), calcium carbonate (0.08 to 0.15 %) and high in organic carbon content (0.72 to 1.47 %). The ranges of available N, P and K were 295.24 to 510.00 kg ha^{-1}, 10.03 to 20.36 kg ha^{-1}, 131.00 to 165.30 kg/ha, respectively. The pH has a negative and significant correlation with available nitrogen (r = - 0.915*) and phosphorous (r = - 0.931*). A significant and negative correlation of calcium carbonate was observed with available nitrogen (r = - 0.871*) and phosphorous (r = - 0.906). The organic carbon content bears significant and positive correlation with available nitrogen (r = 0.936*), phosphorous (r = 0.986*), respectively. The studies on nutrient status of maize growing soils are essential to generate information regarding efficiency of nutrient availability of soils in order to improve yield and maintain soil health. The information generated would be useful for subsequent research and development activities and shall guide in assessing possible cause of low yield and quality of maize production.

Keywords: Fertility, Handwara, correlation, Significant, Soil health

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Introduction

Maize can be grown successfully in wide range of soils from loamy sand to clay loam. However, soils with good organic matter content having high water holding capacity with neutral pH are considered good for higher productivity. Under rain fed production system, low productivity of crops is linked to the water stress, virtually no use of organic manures, poor recycling of crop residues and low use of nitrogen and phosphorus that leads to negative balance of nitrogen and phosphorus [1]. Fertilizers played a vital role in agriculture production and productivity in India, but continuous and imbalanced use of chemical fertilizer creates problem in the production potential and deterioration of soil health. Use of chemical fertilizer in combination with organic matter is required to improve the soil health [2]. Soil nutrient evaluation is a leading key for describing and understanding the status and qualities of the major nutrients in soil [3]. Assessing soil physico-chemical properties are used to understand the potential status of nutrients in soils of different land uses [4]. The decline in soil fertility followed by land degradation and low agricultural productivity are caused by land use change particularly from natural ecosystem to agricultural lands in general and to crop cultivation under poor management practices [5]. In order to sustain the productivity and promote the health of the soil fertilizer application on soil test based and combined use of organic and chemical fertilizers is imperative. There is hardly any soil on earth provided so adequately with nutrients, that high yield can be obtained over prolonged period without any fertilization. It is therefore, necessary to replenish the soil with balanced fertilization [6]. Soil fertility information at district level will benefit the farmers in determining site specific nutrient management to maintain soil health [7]. The studies on nutrient status of maize growing soils are essential to generate information regarding efficiency of nutrient availability of soils in order to improve yield and maintain soil health. The information generated would be useful for subsequent research and development activities and shall guide in assessing possible cause of low yield and quality of maize production.

Material and Methods

The details of the techniques followed and the materials used during the course of this investigation are presented below.

General description of the area

The UT of J & K is situated in the north western portion of the India has an area of about 222,870 sq. km. Tehsil Handwara, an efficient cropping zone for maize, is located within a latitude of 34.396ºE and longitude 74.296ºN (**Table 1**).

Table 1 Soil sampling sites of maize fields of Tehsil Handwara

Serial.No	Place of Collection
01.	Haripora shath
02.	Yaru Kecher
03.	Kargama
04.	Marathgam
05.	Chotpura
06.	Dorishpora
07.	Handwara
08.	Batkoot
09.	Machipora
10.	Baderher
11.	Nag redii
12.	Warpura
13.	Lachipora
14.	Khaipora
15.	Waripur
16.	Kulangam
17.	Chogul
18.	Hanga
19.	Babgund
20.	Tulwari

Collection of soil samples

Composite surface soil samples at representative sites of Tehsil Handwara were collected. The soil samples collected thereof were investigated for physico-chemical properties and the available nutrient status.

Field and laboratory investigation

Preparation of soil samples

The soil samples after collection were air dried, crushed, and sieved through 2mm sieve. A portion of each sample was separately sieved through 2mm sieve and stored in polythene bags for analysis. A portion of each sample was separately sieved through 0.5mm sieve and stored separately for estimation of organic carbon.

Method of analysis

Soil analysis

The analytical procedures followed for the determination of various chemical properties are mentioned as follows:

Chemical analysis

Soil reaction

The pH of the soil was measured in 1:2.5 soil water suspensions with the help of digital pH meter [8].

Electrical conductivity

The electrical conductivity of soil water extract was measured in 1:2.5 soil water suspensions by conductivity meter [8].

Calcium carbonate

The Calcium carbonate was estimated by adopting Rapid Titration Method [9].

Organic carbon

Organic carbon was determined by Walkley & Black method [10]

Available nitrogen

Available nitrogen was determined by Alkaline Permanganate Method [11]

Available phosphorus

Available phosphorus was determined by Olsen's method [12]

Available potassium

Available potassium was determined on a Flame Photometer after extraction with Neutral Normal Ammonium Acetate [8]

Results and Discussion

Physico-chemical properties of soils

Soil reaction

The data presented in **Table 2** indicated that pH ranged from 6.10 to 7.48 with mean value of 6.96. In general, the soils were slightly acidic to slightly alkaline in reaction. The pH of the soils in the present investigation was within the ranges as reported by [13] and [15]. Relatively higher pH value was observed at Tulwari village which could be ascribed to the comparatively less leaching loses of bases. The lower value of soil pH may be due to its highest microbial oxidation that produces organic acids, which provide H^+ ions to the soil solution that lowers its soil pH value reported by [5].

Electrical conductivity

The data revealed that the electrical conductivity varied from 0.11 to 0.35 with the mean value of 0.20 dSm^{-1} (Table 2). Similar findings were reported by [14] and [15]. All soils are non-saline in nature as the electrical conductivity of soils was lesser than 4 dS m^{-1}, indicating the presence of very low amount of soluble salts in all the locations.

Calcium carbonate

The calcium carbonate content varied from 0.08 to 0.15 per cent with mean value 0.10 per cent (Table 2). The data revealed maximum calcium carbonate content was at location 20 and minimum was at location 5. In general soils are non-calcareous in nature. The calcium carbonate of the soils in the present investigation is within the ranges as reported by [13]. The low content of calcium carbonate in the surface soils can be attributed due to leaching of calcium carbonates to sub-surface layer of soils.

Organic carbon

The organic carbon content varied from 0.72 to 1.47 per cent with mean value of 1.14 per cent (Table 2). The status of organic carbon was medium to high. The high organic carbon content in these soils might be due to low rate of mineralization because of lower soil temperatures. The organic carbon content in the soils in the present investigation is within the ranges as reported by [16] and [15].

Table 2 Physico-chemical properties of maize growing soils of Tehsil Handwara of North Kashmir

Serial No.	pH (1:2.5)	EC (dsm^{-1})	$CaCO_3$ (%)	Organic carbon (%)
L_1	7.13	0.19	0.10	1.13
L_2	7.00	0.21	0.10	1.20
L_3	6.62	0.14	0.09	1.38
L_4	7.18	0.17	0.10	1.02
L_5	6.10	0.17	0.08	1.47
L_6	6.57	0.22	0.08	1.38
L_7	6.95	0.35	0.09	1.22
L_8	6.23	0.31	0.08	1.41
L_9	6.78	0.26	0.09	1.31
L_{10}	6.95	0.22	0.10	1.21
L_{11}	7.33	0.21	0.11	0.87
L_{12}	6.91	0.22	0.09	1.24
L_{13}	7.15	0.11	0.10	1.12
L_{14}	6.44	0.28	0.08	1.41
L_{15}	7.42	0.16	0.12	0.76
L_{16}	7.32	0.21	0.11	0.87
L_{17}	7.47	0.20	0.12	0.75
L_{18}	7.24	0.18	0.11	0.95
L_{19}	6.89	0.10	0.09	1.31
L_{20}	7.48	0.12	0.15	0.72
Mean	6.96	0.20	0.10	1.14
Range	6.10-7.48	0.11-0.35	0.08-0.15	0.72-1.47
C.D ($p \leq 0.05$)	0.022	0.018	0.006	0.020

Nutrient status of soils

Available nitrogen

The available nitrogen content of soils varied from 295.24 to 510.00 kg ha^{-1} with mean value of 414.55 kg ha^{-1} represented in **Table 3**. The status of soils was medium to high in available nitrogen. The status of soils was medium to high in available nitrogen. Perusal of data indicated that the available nitrogen content was highest in all locations this might be due to higher organic carbon content. These findings were in good agreement with the findings of [17] and [18]

Available phosphorous

The available phosphorous content of soils varied from 10.03 to 20.36 kg ha^{-1} with mean value of 15.74 kg ha^{-1} represented in Table 3. The status of soils were medium in available phosphorous. The status of soils were medium to high in available phosphorous which could be attributed due to favorable soil reaction and formation of organo-phosphate complexes and coating of iron and almunium particles by humus as also justified in the research works of [19] and [18]

Available potassium

The available potassium content varied from 131.00 to 165.30 kg ha^{-1} with mean value of 144.72 kg ha^{-1} represented in Table 3. The soils were medium in available potassium. The higher values of potassium could be attributed to illitic nature of these soils which is further supported by the dominance of illitic clay in these soils [13]. Similar findings were reported by [20] and [17].

Correlation studies of available Macro nutrients with physico-chemical properties of the soils

The correlation coefficient values (r-values) of pH, electrical conductivity, calcium carbonate and organic carbon of the soils with the available macro nutrients have been worked out (**Table 4**), revealed that the pH has a negative and

significant with available nitrogen (r = - 0.915*), phosphorous (r = - 0.931*). A significant and negative correlation of calcium carbonate was observed with available nitrogen (r = - 0.871*), phosphorous (r = - 0.906. There was no significant relation with other nutrient elements (**Table 5**). The organic carbon content bears significant and positive correlation with available nitrogen (r = 0.936*), phosphorous (r = 0.986*), sulphur (r = 0.745, respectively. The availability of nitrogen decreases with the increase in pH because of leaching of nitrogen as ammonium in alkaline conditions. A significant and negative correlation between pH and nitrogen has been supported by findings of [21], [22]. Similarly, the availability of phosphorous decreases with the increase in pH due to its conversion to insoluble phosphates. The significant negative relationship between pH and phosphorous has been supported by finding of [23].

Table 3 Macro- nutrient status of maize growing soils of Tehsil Handwara of North Kashmir

Serial No.	Nitrogen (kg ha^{-1})	Phosphorous	Potassium
L_1	410.22	14.77	139.28
L_2	441.22	16.10	140.36
L_3	481.35	19.05	159.00
L_4	366.73	13.17	137.19
L_5	510.53	20.36	165.30
L_6	485.34	19.10	162.76
L_7	452.00	17.77	141.26
L_8	508.36	20.03	165.34
L_9	480.45	19.03	157.19
L_{10}	450.23	17.02	141.18
L_{11}	317.25	12.13	133.77
L_{12}	462.43	18.01	142.38
L_{13}	391.34	14.23	137.26
L_{14}	492.32	20.00	163.82
L_{15}	316.25	11.02	132.00
L_{16}	322.33	12.16	134.26
L_{17}	298.76	10.04	131.23
L_{18}	336.24	12.68	136.24
L_{19}	472.35	18.02	143.59
L_{20}	295.24	10.03	131.00
Mean	414.55	15.74	144.72
Range	295.24-510	10.03-20.36	131.00-165.30
C.D ($p \leq 0.05$)	0.019	0.021	0.020

Table 4 Correlation Coefficient between physico-chemical properties and available nutrient of maize growing soils of Tehsil Handwara of North Kashmir

Soil properties	Available nutriets		
	N	P	K
pH	-0.915*	-0.931*	0.039
EC	0.333	0.404	0.356
CaCO3	-0.871*	-0.906*	0.214
OC	0.936*	0.986*	0.282
CEC	0.946*	0.369	0.869*
* Significant at 1% level			

A negatively significant correlation was observed between calcium carbonate and available nitrogen and phosphorous (Table 4) in these soils could be ascribed due to its precipitation into tricalcium phosphate and hydroxy phosphate. The results were in agreement with those of [24]. The significant positive correlation between organic carbon and available nitrogen could be ascribed to the association of nitrogen with organic matter and adsorption of NH_4–N by humus complex in soil [25]. The positive and significant correlation of organic carbon with phosphorous is due to formation of organo-phosphate complexes and in agreement with the results of [26].

Conclusion

The study work on soil fertility status of maize growing soils will be essential to generate information regarding efficiency of nutrient availability of soils in order to improve yield and maintain soil health. The information generated would be useful for subsequent research and development activities and shall guide in assessing possible cause of low yield and quality of maize production in this area.

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