



Research Article

Soil nutrient status under different agro-climatic zones of Jammu region, India

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ABSTRACT

In the North Western Himalayas, particularly Jammu region, where 85% of people depend on agriculture and allied sectors, 70% of agriculture is rain-fed. Various factors, especially land use pattern and variations in climatic conditions affect the soil fertility and nutrient contents. However, information on essential nutrients in the soil across the region is meager. An attempt has been made to study the soil nutrient status under different agro-climatic zones of Jammu region. Seven hundred seventy surface soil samples (0-15 cm) from sub-tropical, intermediate and temperate zones of Jammu region were collected and analyzed for soil texture, pH, electrical conductivity (EC), organic carbon (OC), CaCO₃, CEC, available macro nutrients (N, P, K, S) and micronutrients (Fe, Cu, Zn, Mn). The results indicated large variation within the soils of each zone. The amount of all the available nutrients was more in the soils of temperate zone than those of other zones. The soils of sub-tropical zones were low in available N, P, S and Zn and to some extent in K. Organic matter content, clay and silt content of the soil *vis-à-vis* cation exchange capacity were found to be the main factors controlling the available nutrient content of the studied soils.

Keywords: Soil fertility, macro and micronutrients status, agro-climatic zones, Jammu region.

INTRODUCTION

Agriculture productivity is greatly determined by quality of the soil, especially availability of the nutrients. It plays key role in economy and overall social well-being of India (Mall *et al.*, 2006). The population of our country is increasing at a rapid rate, whereas the land and water resources for agriculture are diminishing continuously. Mountain ecosystems are changing rapidly. They are susceptible to accelerated soil erosion, landslides and rapid loss of habitat and genetic diversity (Sanjay-Swami, 2019). The rain-fed regions are also on verge of degradation and have low cropping intensity, low organic matter status, low microbial activity, low fertility and poor soil physical health. Yield efficiency of soil can be based on availability of nutrients in the soil and categorizing soil accordingly is important for appropriately planning agriculture (Gregorich and Carter, 1997). Soil test-based fertility management is an effective tool for increasing productivity of agricultural soils that have a high degree of spatial variability. An inventory of the

available nutrient status of soils helps in demarcating areas where application of a particular nutrient is needed for profitable crop production. The available nutrient status of the soils of some agro-climatic zones of Jammu region has been reported (Gupta and Verma *et al.*, 1975). However, soils vary in their physico-chemical characteristics even within the same contiguous area which markedly affect the availability of nutrients. Three agro-climatic zones have recently been established in Jammu region (Rana *et al.*, 2000). Therefore, an attempt has been made to find out the effect of important soils characteristics on the availability of nutrients in these agro-climatic zone *viz.* sub-tropical, intermediate and temperate zones to monitor the extent of nutrient deficiencies in soils of the studied area.

MATERIALS AND METHODS

Surface soil samples (0-15 cm) totaling 770 were collected from three agro-climatic zones *viz.* sub-

tropical, intermediate and temperate zones of Jammu region. The soil samples were air dried, ground in a wooden pestle and mortar and sieved through 2 mm plastic sieve. The pH and electrical conductivity (EC) of the soil samples were measured in 1:2 soil : water suspension. The organic carbon (OC), CaCO₃, available N, Olsen's P, available K was estimated according to standard procedures (Black, 1965). Texture was estimated by hydrometer method. The available Fe, Cu, Zn and Mn were estimated by DTPA method (Lindsay and Norvell, 1978). The contents of Fe, Cu, Zn and Mn in soil extracts were determined by atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

Soil fertility is a key component in its productivity and quality (Rao and Reddy, 2005). Despite agriculture being a prime component in Indian economy, regional database on essential nutrients in most of the areas in the country is incomplete. Some basic information on morphological and physico-chemical properties of the soils of various agro-climatic zones of Jammu region has been given by Rana *et al.*, (2000). However, brief descriptions of the physico-chemical properties of the three agro-climatic zones under study are given below:

Sub-tropical zone:

Soils are coarse loamy to fine loamy and mostly non-calcareous, imperfectly drained mostly from Ravi-Tawi command area. The soils are neutral to alkaline in reaction. The pH and EC of these soils ranged from 7.0 to 9.4 and 0.03 to 0.62 dSm⁻¹ respectively. The calcium carbonate content varied from 0.09 to 3.70 percent with a mean value of 0.65 percent (Table 1). The mean organic carbon content of these soils was 0.45 per cent with an overall range from 0.10 to 1.27 per cent. The CEC varied from 7.80 to 10.86 C mol (P⁺) kg⁻¹ with a mean value of 9.25 C mol (P⁺) kg⁻¹.

Intermediate zone:

The soils are non-calcareous, perfectly drained with *udic* to *ustic* moisture regimes. Soils of this agro-climatic zone were sandy loam to loam in texture; pH ranged between 6.5 and 8.4 with a mean value of 6.5. Electrical conductivity varied from 0.03 to 0.36 dSm⁻¹ with an average value of 0.12 dSm⁻¹. The mean OC and CaCO₃ were 0.85 and 0.15 per cent with their respective overall range of 0.37 to 1.72 and 0.0 to 2.80 per cent, respectively. The CEC varied from 8.02 to 13.80 C mol (P⁺) kg⁻¹ with a mean value of 11.62 C mol (P⁺) kg⁻¹ (Table 1).

Temperate zone:

These soils are shallow to deep, some what excessively to excessively drained mostly loamy-skeletal. They are most non-calcareous slightly acidic to neutral in reaction with pH varying from 4.5 to 7.8 with a mean of 6.5. The variation in OC content was from 0.90 to 3.30 per cent with an average value of 1.09. The CaCO₃ content was generally low and ranged between 0.00 to 1.15 content with a mean value of 0.09 per cent. There

were small variation in CEC and it ranged from 13.98 to 14.93 C mol (P⁺) kg⁻¹ with a mean value of 14.42 C mol (P⁺) kg⁻¹ (Table 1)

Macronutrient status

Nitrogen:

The available N content of the three agro-climatic soils varied from 180 to 460 kg ha⁻¹. In the sub-tropical zone soils, it varied from low to medium with mean value of 267 kg ha⁻¹ and most of these soils (65%) were low in available N status. In intermediate zone soils, 62% of the soils were medium and 38% were low in available N with a range of 170-384 kg ha⁻¹. All the soils of temperate zone were medium in available N and it ranged from 332-425 kg ha⁻¹ with a mean value of 379 kg ha⁻¹ (Table 2). The N deficiency is more in sub-tropical zone soils due to low organic carbon content of these soils. Higher vegetation content in the area favors higher degradation rate and removal of organic matter leading to nitrogen deficiency. The variation in N content may be related to soil management practices, application of FYM and fertilizer to previous crops. Nagaraj (2001) observed a similar trend of nutrient status in black soils of North Karnataka. For obtaining potential crop yield and full benefits from costly inputs of fertilizer etc., it is imperative to mitigate N deficiency from these soils with FYM and nitrogen application.

Phosphorus:

The available P content in all the soils studied in the present study was in the medium range. It varied from 4.2 to 18.2, 12.2 to 20.7 and 16.3 to 19.2 kg P ha⁻¹ in sub-tropical, intermediate and temperate zone soils, respectively (Table 2). Available P deficiency was noticed in some sub-tropical zone soils and this could be due to intensive cropping pattern in these soils than the soils of other two zones. Similar status of available phosphorus was obtained by Jatav *et al.*, (2011) and was due to the lesser use of super phosphate by the farmers who prefer FYM at a rate depending upon its availability at the site.

Potassium:

The available K content in the sub-tropical soils varied from low to medium category, the range being 105-210 kg ha⁻¹ with a mean value of 151 kg ha⁻¹ (Table 2). All the soils from the intermediate zone and temperate zone were found to be medium to high in available potassium status. Earlier analysis reports of early eighties indicated that the available K status of sub-tropical zone soils varied from medium to high status and this trend is now decreasing due to intensive cropping in this zone. About 15% soil samples of this zone were deficient in available K (less than 110 kg ha⁻¹) and the potential deficient areas were Dehiyan, Samba, Raya, Dyalachak and Lakhanpur in sub-tropical zone. These soils need immediate application of K for sustainability as well as for obtaining optimum yields.

Table 1: Physico-chemical characteristics of the soils of Jammu region

Agro-climatic zone	Elevation (m)	No. of soil samples	Texture	pH		EC (dSm ⁻¹)		OC (%)		CaCO ₃ (%)		CEC (C mol (P ⁺) kg	
				Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Sub-tropical	215-360	480	Sandy loam to silty clay	7.0-9.4	8.1	0.03-0.62	0.27	0.10-1.27	0.45	0.09-3.70	0.65	7.80 - 10.86	9.25
Intermediate	360-1000	220	-do-	6.5-8.4	6.7	0.03-0.36	0.12	0.37-1.72	0.85	0.00-280	0.15	8.02-13.80	11.62
Temperate	1000-2500	70	-do-	4.5-7.8	6.5	0.10-0.18	0.13	0.90-3.30	1.09	0.00-1.15	0.09	13.98-14.93	14.42

Table 2: Available macronutrient status of the soils of Jammu region

Agro-climatic zone	Elevation (m)	No. of soil samples	Macro-nutrients (kg ha ⁻¹)								Sulphur (mg kg ⁻¹)	
			N		P		K		S		Mean	Range
			Mean	Range	Mean	Range	Mean	Range	Mean	Range		
Sub-tropical	215-360	480	267	180-460	12.3	4.2-18.2	151	105-210	20.4	8.0-34.3		
Intermediate	360-1000	220	295	170-384	16.3	12.2-20.7	253	143-293	23.8	10.0-35.7		
Temperate	1000-2500	70	379	332-425	17.5	16.3-19.2	343	291-419	29.6	9.6-51.1		

Table 3: Available micronutrient status of the soils of Jammu region

Agro-climatic zone	Elevation Range (m)	No. of soil samples	Micro-nutrients (mg kg ⁻¹)			
			Fe	Cu	Zn	Mn
Sub-tropical	215-360	491	4.1-54.3 (13.50)	0.2-0.92 (0.45)	0.18-6.10 (1.11)	3.2-52.60 (18.2)
Intermediate	360-1000	1242	1.14-54.3 (10.55)	0.23-3.26 (0.71)	0.10-6.10 (1.31)	1.88-49.64 (9.54)
Temperate	1000-2500	81	3.3-17.4 (9.06)	0.31-1.21 (0.67)	0.28-6.40 (1.52)	4.9-248 (13.80)

Sulphur:

The content of available S in these soils varied from 8.0 to 51.1 mg kg⁻¹ with mean values of 20.4, 23.8 and 29.6 mg kg⁻¹ in sub-tropical, intermediate and temperate zone soils, respectively (Table 2). Considering 10 ppm as the critical limit, Raya, Lakhanpur and Samba soils in the sub-tropical zone and accounting for 20% soils, were deficient in this element.

Micronutrient status**Zinc:**

The available Zn content in the soils of three agro-climatic zones varied from 0.18 to 6.40 mg kg⁻¹ with mean values of 1.11, 1.31 and 1.52 mg kg⁻¹ in sub-tropical, intermediate and temperate zone soils respectively (Table 3). Considering 0.60 mg kg⁻¹ as the critical level of Zn deficiency (Bansal *et al.*, 1980) the percentage of samples deficient in sub-tropical, intermediate and temperate soils were 26, 24 and 10 per cent, respectively. The Zn deficiency is more in sub-tropical zone soils due to higher pH, low organic matter and to some extent sodic nature of some soils. The potential deficient areas are R.S. Pura,

Hiranagar, Dayalachak and Samba, as this is food bowl of Jammu region and for obtaining potential crop yields and full benefit from costly inputs of fertilizers etc., it is imperative to mitigate Zn deficiency from these soils with zinc application.

Copper:

The amount of available Cu varied from 0.20 to 3.26 mg kg⁻¹ (Table 3). The mean values of Cu were much higher than the critical limit of 0.2 ppm (Follet and Lindsay, 1970). None of the soil samples were deficient in Cu. Although the content of OC was low in sub-tropical zone soils, still the nature of metallo-organic complexes of Cu could be such that have constituted the bulk of the available Cu pool in the investigated soils.

Manganese:

The content of DTPA-available Mn in these soils varied from 1.88 to 52.60 mg kg⁻¹ with mean values of 18.2, 9.54 and 13.80 mg kg⁻¹ in sub-tropical, intermediate and temperate zone soils respectively (Table 3). Considering 1.0 mg kg⁻¹ DTPA-extractable Mn (Follet and

Lindsay, 1970) as the critical limit, none of these soils samples were deficient in Mn.

Iron:

The available Fe content of the soils under investigation varied from 1.14 to 54.3 mg kg⁻¹ (Table 3). Considering 4.5 mg kg⁻¹ DTPA extractable Fe as the critical limit (Lindsay and Norvell, 1978) the percentage of soil samples deficient in Fe were only 3 in intermediate zone soils. The soil samples analysis compliment the information that the soils of three agro-climatic zones are deficient in N, K, S and Zn and are adequate in Fe, Mn, Cu and P. The pH, EC, OC, CEC, primary and secondary macro and micronutrients vary significantly across the three agro-climatic zones.

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