Research Article

Soil Macronutrient Status Assessment of Saproon Valley in North Western Himalayas of India

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Abstract

Soil fertility refers to the inherent capacity of a soil to supply essential nutrients to plant in adequate amount, in correct proportion and at the right time. Although one or more essential nutrients are commonly applied to vegetable crops in Himachal Pradesh, India, the amount of nutrients removed in harvested crops are generally much higher than the quantity added and hence resulting in exhaustive mining of nutrients from the soil, thus increasing the nutrient related stresses and yield losses with time. The problem has been further aggravated due to introduction of heavy nutrient feeders and high yielding hybrid varieties. As the demand of nutrients for higher yields increases the plant's need for nutrients, nutrient deficiencies are likely to become more acute and since the limit of deficiency and toxicity is very narrow, the investment on a non-limiting nutrient is a waste and also has a deleterious effect on crops. In the present era of intensive agriculture, in view of sustainable crop production, it is being strongly felt that deficiency and sufficiency of nutrients must be assessed for different crops and specific locations. This valuable knowledge on the status of available nutrients is essential to formulate the strategies for amelioration of such deficiencies, timely and more precisely. Hence, the present study was undertaken to collect the reviews to understand the soil nutritional status of hilly areas.

Keywords: Soil fertility, macronutrients' status, Saproon Valley, Himachal Pradesh and sustainability

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Introduction

The demand for land, water and food has increased manifolds with population explosion. In its efforts to meet the basic needs, human kind is degrading these natural resources through unscientific exploitation and causing environmental problems. A soil resource inventory provides an insight into the potentialities and limitations of soils for its effective exploitation.

Poor soil fertility and inappropriate nutrient management strategies are the important major constraints contributing to food insecurity, malnutrition and eco- system degradation. Thus, any soil fertility evaluation research must provide highly valuable information that can be used to eliminate the above- mentioned constraints, and thus can lead to sustained food security and well- being of human society without harming the environment. The fact that at least 60 per cent of cultivated soils have plant growth limiting problems associated with nutrient deficiencies makes soil fertility evaluation research a major promising area for meeting the global demand for sufficient food production. Plant nutrients constitute a vital component of any system of sustainable agriculture and sustainable crop productivity. Increasing agricultural production by improving plant nutrition management, together with a better use of other production factors, is a complex challenge. Agricultural intensification requires increased flows of plant nutrients to crops, a higher nutrient uptake and higher stocks of plant nutrients in soils.

In order to increase the productivity, the excessive use of nutrients, inefficient management of cropping systems, and the inefficient use of residues and wastes result in losses of plant nutrients, which mean an economic loss for the farmer. Environmental hazards can be created by applying too much nutrient compared with the uptake capacity of cropping systems, while the depletion of nutrient stocks is a major, but often hidden, form of environmental degradation. Plant nutrition management depends largely on prevailing economic and social conditions. Farmers' decisions depend on their economic situation and their socio-economic environment, on their perception of economic signals and on their acceptance of risks.

Optimizing the management of plant nutrients, as a part of sound agricultural intensification, results from a balanced supply of plant nutrient sources, maintaining or increasing the capital of plant nutrients on the farm and the efficiency of the nutrients involved in crop production, and maximizing income for farmers within the local economic context. Advice on plant nutrition management should include assistance in decision making at plot and at farm level, in order to optimize the use of local resources and the ability of farmers to intensify production within the existing economic environment.

Thus, in order to address the important questions like national food security, nutritional security, maintenance of soil health, enhancement of soil and crop productivity and leaving a good heritage for the future generations, the country needs rational and scientific nutrient management as also other resources. The present study entitled "Soil macronutrient status assessment of Saproon Valley in North Western Himalayas of India" has been reviewed under the following heads:

Appraisal of soil fertility status, Primary Nutrients and Secondary Nutrients

Appraisal of soil fertility status

Soil fertility effects productivity of soils considerably. It is affected by the natural (climate, biosphere, parent material, topography and time) and artificial factors *viz*., management practices (fertilization, manuring, green-manuring, crop rotations etc.). The primary purpose of soil testing is to provide basis for location specific fertilizer recommendations for high yields. Parker *et al*. (1951) [1] advocated the use of Nutrient Index concept for comparing the levels of soil fertility between the soil series.

An effort has been made to review the fertility status of soils of Himachal Pradesh vis-à-vis India.

Primary Nutrients

Available Nitrogen

Nitrogen is the forth plant nutrient taken up by plants in greatest quantity next to carbon, oxygen and hydrogen, but it is one of the most deficient elements in the tropics for crop production [2-4]. The total N content of a soil is directly associated with its organic carbon content and its amount on cultivated soils is between 0.03 to 0.04 per cent by weight [3, 5].

Ramamoorthy and Bajaj (1969) [6] reported that the soils of India were low in available N. Thakur *et al*. (1971) [7] found that the cultivated soils of Seeraj and Karsog blocks in Mandi district of Himachal Pradesh were medium in available N. Verma *et al*. (1976) [8] reported that the cultivated soils of Kangra region of Himachal Pradesh were low in available N. Ghosh and Hasan (1980) [9] prepared a map of nitrogen status of Indian soils and found that many soils of hill regions including Himachal Pradesh were high in available N, while those of plains were low to medium in N status.

Verma and Tripathi (1982) [10] reported that available nitrogen content in Una and Hamirpur districts varied from 113 to 228 kg ha^{-1} while it ranged from 295 to 503 kg ha^{-1} in Kangra, Mandi, Bilaspur, Shimla and Sirmour districs of Himachal Pradesh. Raina (1988) [11] studied the citrus growing soils of Poanta valley of Himachal Pradesh and reported the soils as low in available N. Singh and Datta (1988) [12] for the Mizoram soils and Kaistha *et al*. (1990) [13] in the soils of North Western Himalayan region found a decreased content of different forms of available N with the increase in profile depth. The higher content of organic carbon in the surface layers was responsible for higher nitrogen content.

Brar (1998) [14] reported that soils of Punjab were deficient in available N. Sharma *et al*. (1998) [15] found the soils of Loon watershed of Kangra district as medium in available N status. According to Anonymous (2001) [16], 51, 36 and 59 per cent of Indian soils were high, medium and low in available N. Mahajan (2001) [17] reported the soils of Mandi district in Himachal Pradesh as medium in available N (384 to 492 kg ha^{-1}). Motsara (2002) [18] reported that out of 3,650,004 samples of Indian soils, per cent soil samples which fell in low, medium and high categories were 63, 26 and11 respectively in case of available N. Sharma *et al*. (2002) [19] reported that soils of Fatehpur block in Himachal Pradesh were low to high in available N. Sharma and Kumar (2003) [20] reported that soils of agricultural lands of mid-hill zone of Himachal Pradesh were medium to high in available N.

Tandon (2004) [21] reported that about 63 per cent of Indian soils were low in available N. Kumar and Verma (2005) [22] studied the fertility status of rice growing soils of Palam valley of Himachal Pradesh and reported that the soils were low to medium in available N. Laxminarayan (2006) [23] reported that available nitrogen content varied from 213 to 452 kg ha^{-1} in the soils of Mizoram. According to Mondal *et al*. (2007) [24], soils of Chattha area of Jammu were low in available N. Agricultural lands had better fertility status as compared to non agricultural lands.

In the sweet orange growing soils of Jalna District of Maharashtra, Dhale and Prasad (2009) [25] found that available nitrogen content varied from 68 to 33 kg ha^{-1}. The available nitrogen content of Andhra Pradesh soils varied from 133 to 188 kg ha^{-1} and the content decreased with depth [26]. Kumar and Prasad (2010) [27] characterized he sugarcane growing soils of Maharashtra and found the soils as medium in available N. Sahoo *et al*. (2010) [28] characterized the fertility status of agricultural lands of Manipur and rated the soils as medium to high in available N

(503 to 1078 kg ha^{-1}). Shilpashree *et al*. (2011) [29] revealed that soils of arecanut gardens in Karnataka were medium in available N.

The literature clearly indicates that available nitrogen content varied from low to medium in the country. The available nitrogen content showed a decreasing trend with increasing soil depth and in general, higher available N content was found in the surface horizons.

Available Phosphorus

Ramamoorthy and Bajaj (1969) [6] reported that the soils of India were low in available P. Thakur *et al*. (1971) [7] found that the cultivated soils of Seeraj and Karsog blocks in Mandi district of Himachal Pradesh were low in available P. Verma *et al.* (1976) [8] reported that the cultivated soils of Kangra region of Himachal Pradesh were low in available P. Ghosh and Hasan (1979) [30] reported that available P status of Indian soils was medium, low and high to the extent of 52, 46 and 2 per cent, respectively. Verma *et al.* (1985) [31] characterized the soils of Kangra, Kullu, Mandi and Sirmour areas of Himachal Pradesh and found the contents of available P ranging from 2.69 to 28.22 kg ha^{-1}. Raina (1988) [11] studied the citrus growing soils of Poanta valley of Himachal Pradesh and reported the soils as medium to high in available P.

A decrease in available phosphorus with increase in soil depth has been reported by various workers [32, 33]. Available P status was found to be low in Dehra, Nurpur, Lambagaon, Badsar and Sundernagar blocks of Himachal Pradesh (Anonymous, 1993) [34]. Patgiri and Datta (1993) [35] have reported that available phosphorus content varied from 13.44 to 20.16 kg ha^{-1} in tea growing soils of Assam. Khan *et al.* (1997) [36] reported that available phosphorus was high in the surface and decreased downward in the profile. Sharma *et al*. (1998) [15] found the soils of Loon watershed of Kangra district as medium in available P status. Pandey *et al.* (2000) [37] reported that wide variability in the availability of P was observed in different soil associations of district Kanpur in Uttar Pradesh. Contents of available P ranged from 7.7 to 55.4 kg ha^{-1} and correlation studies revealed that availability of P was significantly and positively influenced by organic matter and finer soil particles.

According to Anonymous (2001) [16] 6, 45 and 49 per cent of Indian soils were high, medium and low in available P. Mahajan (2001) [17] reported the soils of Mandi district in Himachal Pradesh as medium in available P (17 to 22 kg ha^{-1}). Sharma *et al*. (2001) [38] reported that majority of soils of Himachal Pradesh were deficient in P. Motsara (2002) [18] reported that out of 3,650,004 samples of Indian soils, per cent soil samples which fell in low, medium and high categories were 42, 38 and 20, respectively in case of available P.

Sharma *et al*. (2002) [19] reported that soils of Fatehpur block in Himachal Pradesh were low to high in available P. Sharma and Kumar (2003) [20] reported that soils of agricultural lands of mid-hill zone of Himachal Pradesh were low to medium in available P. Tandon (2004) [21] reported that about 44 per cent of Indian soils were low in available P. Kumar and Verma (2005) [22] studied the fertility status of rice growing soils of Palam valley of Himachal Pradesh and reported that the soils were low to medium in available P. Tripathi *et al.* (2007) [39] studied the status of nitrogen, phosphorous and potassium in the hill soils of North-Western Himalayas. They reported that mean phosphorous content was found to be 28 kg ha^{-1}.

Available phosphorus showed wide variation in its content at different locations of the country. In general, available phosphorus followed a decreasing trend with increase in soil depth.

Available Potassium

Ramamoorthy and Bajaj (1969) [6] reported that the soils of India were medium in available K. Thakur *et al*. (1971) [7] found that the cultivated soils of Seeraj and Karsog blocks in Mandi district of Himachal Pradesh were low in available K. Ghosh and Hasan (1976) [40] rated majority of Indian soils as medium, high and low in available K to the extent of 42, 38 and 20 per cent, respectively. Verma *et al.* (1976) [8] reported that the cultivated soils of Kangra region of Himachal Pradesh were low in available K. Verma *et al.* (1985) [31] characterized the soils of Kangra, Kullu, Mandi and Sirmour areas of Himachal Pradesh and found the contents of available K ranging from 4.26 to 1507 kg ha^{-1}. Raina (1988) [11] studied the citrus growing soils of Poanta valley of Himachal Pradesh and reported the soils as medium in available K.

Tripathi *et al.* (1992) [41] reported that concentration of exchangeable potassium ranged from 0.11 to1.74 me 100 g^{-1}, in the soils of Himachal Pradesh. Sharma *et al*. (1998) [15] found the soils of Loon watershed of Kangra district as medium in available K status. According to Anonymous (2001) [16] 52, 39 and 9 per cent of Indian soils were high, medium and low in available K. Mahajan (2001) [17] reported the soils of Mandi district in Himachal Pradesh as medium in available K (231 to 235 kg ha^{-1}). Motsara (2002) [18] reported that out of 3,650,004 samples of Indian soils, per cent soil samples which fell in low, medium and high categories were 13, 37 and 50, respectively in case of available K. Sharma *et al*. (2002) [19] reported that soils of Fatehpur block in Himachal Pradesh were low to medium in available K. Tripathi *et al.* (2007) [39] studied the status of nitrogen, phosphorous and potassium in the hill soils of North-Western Himalayas. They reported that mean potassium content was found to be 289 kg ha^{-1}.

Sharma and Kumar (2003) [20] reported that soils of agricultural lands of mid-hill zone of Himachal Pradesh were low to high in available K. Tandon (2004) [21] reported that about 21 per cent of Indian soils were low in available K. Kumar and Verma (2005) [22] studied the fertility status of rice growing soils of Palam valley of Himachal Pradesh and reported that the soils were low to high in available K. Shetty *et al.* (2008) [42] reported that the majority of Karnataka soils were medium in available potassium. Vara Prasad Rao *et al*. (2008) [43] characterized the grassland soils of Andhra Pradesh as medium to high in available K. Dhale and Prasad (2009) [25] while characterizing and classifying the sweet orange growing soils of Jalna district of Maharashtra found that available potassium content of soils ranged from 195 to 1287 kg ha^{-1}. In the soils of Andhra Pradesh, available potassium content varied from 110 to 389 kg ha^{-1} and it decreased with depth [26]. Kumar and Prasad (2010) [27] characterized the sugarcane growing soils of Maharashtra and found the soils as medium to high in potassium. Sahoo *et al*. (2010) [28] characterized the fertility status of agricultural lands of Manipur and rated the soils as low to high in available K (79 to 44 kg ha^{-1}). Shilpashree *et al*. (2011) [29] revealed that soils of arecanut gardens in Karnataka were medium in available K.

The literature clearly indicates significant variations in available potassium content across the country. In general, available potassium showed a decreasing trend with soil depth.

Secondary Nutrients

Exchangeable Calcium

Exchangeable calcium was found to vary from 2.2 to 10.5 [cmol (p^+) kg^{-1}] in the soils of North-West Himalaya [44], 3.7 to 15.3 [cmol (p^+) kg^{-1}] in the soils of Central Himalaya of Himachal Pradesh representing sub humid temperate highlands [45] and 2.1 to 20.0 [cmol (p^+) kg^{-1}] in the wet temperate zone soils of Himachal Pradesh (Minhas *et al*., 1997) [46]. Nair and Chamuah (1988) [47] and Bala and Sahu (1993) [48] found exchangeable calcium as dominant cation in the soils of pine forest of Himachal Pradesh and middle Andaman and Orissa, respectively and on an average exchangeable calcium accounted for 70-80 per cent of the exchange capacity.

Mahajan (2001) [17] reported the soils of Mandi district in Himachal Pradesh as high in exchangeable Ca (4.0 to 5.1 [cmol (p^+) kg^{-1}]). Sharma *et al*. (2001) [38] reported that majority of soils of Himachal Pradesh were deficient in Ca. Sharma *et al*. (2002) [19] reported that soils of Fatehpur block in Himachal Pradesh were sufficient in exchangeable Ca. Dhale and Prasad (2009) [25] characterized and classified sweet orange growing soils of Jalna district of Maharashtra and found the exchangeable Ca content to vary from 24.48 to 55.61 [cmol (p^+) kg^{-1}]. Shilpashree *et al*. (2011) [29] revealed that soils of arecanut gardens in Karnataka were sufficient in Ca.

The literature clearly indicates a significant variation in exchangeable calcium content. In general, lower exchangeable calcium content was reported under high rainfall areas and Ca content decreased with depth.

Exchangeable Magnesium

Shankhyan (1972) [49] observed no relationship of exchangeable magnesium content with the depth of the soils in Saproon valley of Himachal Pradesh. Lombion (1979) [50] while evaluating the Mg supplying power of Nigerian soils found Mg content to vary from 0.43 to 0.74 [cmol (p^+) kg^{-1}] and rated these soils as low in exchangeable Mg. Mahajan (2001) [17] reported the soils of Mandi district in Himachal Pradesh as high in Mg (1.7 to 2.4 [cmol (p^+) kg^{-1}]). Singh and Raman (1982) [51] observed a decreasing trend of exchangeable magnesium with the increase in soil depth in the North-Eastern Himalayan soils. Mandal *et al*. (1990) [52] have reported exchangeable Mg content to be related to organic carbon and $CaCO_3$ content in the soils of upper hill forest of eastern Himalayan soils. Singh *et al*. (1991) [53] in their study on mid-Shiwalik and North-West Himalayan soils reported surface soils as poor in Mg than the sub-surface soils.

Exchangeable magnesium varied from 0.1 to 4.2 [cmol (p^+) kg^{-1}] in the soils of Central Himalayas of Himachal Pradesh representing sub-humid temperate highlands (Kaistha and Gupta, 1993) [45], 0.7 to 10.5 [cmol (p^+) kg^{-1}] in the soils of North-Western Himalayas (Gupta and Tripathi, 1996) [54] and 1.0 to 6.6 [cmol (p^+) kg^{-1}] in the soils of Assam valley (Bhattacharya *et al*., 1997) [55]. Mahajan (2001) [17] reported the soils of Mandi district in Himachal Pradesh as high in Mg (1.7 to 2.4 [cmol (p^+) kg^{-1}]).Sharma *et al*. (2001) [38] reported that majority of soils of Himachal Pradesh were deficient in Mg. Sharma *et al*. (2002) [19] reported that soils of Fatehpur block in Himachal Pradesh were sufficient in exchangeable Mg. Shekhar (2009) [56] observed that exchangeable magnesium content in surface soils of forest, grassland and cultivated lands of high rainfall areas in Kangra, Chamba and Mandi districts of

Himachal Pradesh varied from 0.63 to 1.03, 0.36 to 0.75 and 0.75 to 0.88 [cmol (p^+) kg^{-1}], and respective values in sub surface soils were 0.40 to 0.93, 0.20 to 0.65 and 0.59 to 0.79 [cmol (p^+) kg^{-1}].

The literature clearly indicates a significant variation in exchangeable Mg content and its content decreased with soil depth.

Available Sulphur

Tripathi and Singh (1992) [57] reported that soluble sulphate sulphur content ranged from 5.5 to 21.2 mg kg^{-1} and showed a decreasing trend with the depth. Low content of this form was recorded in sub-surface horizons. Pandey *et al.* (2000) [37] reported that wide variability in the availability of S was observed in different soil associations of district Kanpur in Uttar Pradesh. Available S contents varied from 5.8 to 53.8 mg kg^{-1}. In correlation studies S availability was found significantly and positively affected by organic matter, CEC, and finer soil particles. According to Anonymous (2001) [16] 20 to 25 per cent of soil samples studied were deficient in available S. Sharma *et al*. (2001) [38] reported that majority of soils of Himachal Pradesh were deficient in S. Tandon (2004) [21] reported that about 37 per cent of Indian soils were low in available S.

Conclusion

The literature clearly indicates that available nitrogen content varied from low to medium in the country due to low organic matter content in Indian soils. Available phosphorus showed wide variation in its content at different locations of the country. In general, available phosphorus followed a decreasing trend with increase in soil depth. The potassium content is becoming evident with more and more places coming under medium potassium availability. The literature clearly indicates a significant variation in exchangeable calcium content. In general, lower exchangeable calcium and magnesium content was reported under high rainfall areas.

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