International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(5): 1023-1025

Received: 01-07-2019
Accepted: 03-08-2019

Anjali
Ph. D. (Soil Science) Student, Department of Soil Science, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, Himachal Pradesh, India

VK Sharma
Professor (Soil Science), Department of Soil Science, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, Himachal Pradesh, India

Gazala Nazir
Assistant Professor (PAU), Ludhiana, Punjab, India

Deepika Suri
Ph. D. (Soil Science) College of Agriculture, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur, Himachal Pradesh, India

Correspondence
Anjali
Ph. D. (Soil Science) Student, Department of Soil Science, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, Himachal Pradesh, India

Fertility characterization of sugarcane growing soils in low hill subtropical zone of Himachal Pradesh

Anjali, VK Sharma, Gazala Nazir and Deepika Suri

Abstract
The present investigation was carried out to assess the soil fertility status of soils under sugarcane based cropping sequences in low hill subtropical zone of Himachal Pradesh. Based on the standard GPS based soil sampling methodology, surface soil samples (0-15 cm) from fifteen representative sites were collected from soils under sugarcane based cropping sequences in Una and Sirmaur districts of Himachal Pradesh and analyzed for available nutrient status. The available N (kg ha^{-1}), P (kg ha^{-1}), K (kg ha^{-1}), Ca {cmol(p+)kg^{-1}}, Mg {cmol(p+)kg^{-1}}, S (kg ha^{-1}), Cu (mg kg^{-1}), Fe (mg kg^{-1}), Mn (mg kg^{-1}) and Zn (mg kg^{-1}) in cultivated soils ranged from 245 to 492, 7.2 to 13.8, 124 to 196, 2.8 to 4.4, 1.0 to 1.6, 16 to 32, 0.22 to 0.40, 4.6 to 10.2, 1.6 to 3.6 and 0.44 to 0.74, respectively. Per cent of total soil samples found deficient in N, P, S and Zn were 27, 53, 80 and 40, respectively. Such a spatial variation in soil fertility may be attributed to natural factors/processes as well as land management practices. It may be concluded from the present investigation that soil test based fertilizer application may be one of the important key to sustain soil productivity in low hill subtropical zone of Himachal Pradesh.

Keywords: Sugarcane, fertility characterization, soil nutrient index

Introduction

Agro-climatically, the State has been divided into four zones *viz.*, low hill sub-tropical zone, mid hill sub-humid zone, high hill wet temperate zone and high hill dry temperate zone, covering 16.4, 21.3, 23 and 39.3 per cent of its total geographical area (55, 673 km^2), respectively. Among all, the low hill sub-tropical zone has greater agricultural and horticultural significance in the State. It lies between 30°6′ N to 32°5′ N latitude and 75°5′ E to 77°5′ E longitude, with an altitude ranging from 350 to 650 m above mean sea level. It is spread over an area of 9.13 lakh hectares in Una, Bilaspur, Hamirpur, Sirmaur, Kangra and Solan districts of Himachal Pradesh. It comprises of 39.5 per cent of total cultivated area of Himachal Pradesh (9, 386 km^2). The soils of region are diverse in character and belong mainly to *Entisols* and *Inceptisols* (Sidhu *et al.* 1997) [8]. The region is generally characterized by the subtropical climate.

Sugarcane is a tropical plant and grown as cash crop in the world. In India, it is grown in both tropical and sub-tropical regions over an area of 49.18 lakh hectares. In Himachal Pradesh, it is grown in an area of 1.94 thousand hectares (Anonymous 2017) [1]. Sugarcane based cropping sequences are one of the major agricultural land use types of the low hill subtropical zone of Himachal Pradesh. However, information on fertility status of soils under sugarcane cultivation in the low hill conditions of Himachal Pradesh is lacking. Therefore, the present study was undertaken to assess the fertility status of sugarcane growing *Entisols* and *Inceptisols* of low hill subtropical zone of Himachal Pradesh.

Materials and Methods

Collection of soil samples

Based on the available information on soil-terrain databases from different sources (Tewari and Awasthi 1978; Singh *et al.* 1990; Sidhu *et al.* 1997) [11, 9, 8] and field traversing during 2016, fifteen (15) soil sampling sites were selected to represent the sugarcane growing soils (*Entisols* and *Inceptisols*) in Una and Sirmaur districts of Himachal Pradesh. An area of about one kanal (400 m^2) belonging to individual farmer was selected in each site for soil sampling as per recommended procedures. Composite surface soil samples (0-15 cm depth) were collected from selected sites.

Analysis of samples

The collected soil samples were air dried, lightly crushed in wooden pestle and mortar, sieved and stored in polythene bags for analysis. The soil samples were analyzed for available nutrient status *viz.*, available nitrogen (N) (Subbiah and Asija 1956) [10], available phosphorus (P) (Olsen *et al.* 1954) [6], available potassium (K) (Black 1965), available calcium (Ca), magnesium (Mg) and sulphur (S) (Jackson 1973) [3] and available iron (Fe), copper (Cu), manganese (Mn) and zinc (Zn) (Lindsay and Norvell 1978) [5]. Available macronutrient status of soils was categorized as low, medium and high by using the same limits as adopted by the State Soil Testing Laboratories. A soil having available nutrient content ranging from 280 to 560 kg N ha^{-1}, 10 to 25 kg P ha^{-1}, 118 to 280 kg K ha^{-1}, 1.5 to 2.5 cmol(p+) Ca kg^{-1}, 0.5 to 1.0 cmol(p+) Mg kg^{-1} and 22.4 to 44.8 kg S ha^{-1} is rated as medium in the respective nutrient status. Using 0.2 mg Cu kg^{-1}, 4.5 mg Fe kg^{-1}, 1.0 mg Mn kg^{-1} and 0.6 mg Zn kg^{-1} as critical limits, soils were rated as deficient or sufficient in the respective micronutrient. Soil nutrient indices (SNI) were also worked out to depict the overall available status of each macro-nutrient in soils by using the formula proposed by Parker *et al.* (1951) [7] as given below:

$$\text{Soil Nutrient Index} = \{(N_l \times 1) + (N_m \times 2) + (N_h \times 3)\} / N_t$$

Where,

N_l = Number of samples falling in low category of nutrient status

N_m = Number of samples falling in medium category of nutrient status

N_h = Number of samples falling in high category of nutrient status

N_t = Total number of samples analyzed for a nutrient in any given area.

Further, on the basis of SNI, soil fertility level in respect of different nutrients was categorized as low (<1.67), medium (1.67 to 2.33) and high (>2.33).

Results and Discussion

Available nutrient status of soils

Available N (kg ha^{-1}), P (kg ha^{-1}), K (kg ha^{-1}), Ca {cmol(p+) kg^{-1}}, Mg {cmol(p+) kg^{-1}} and S (kg ha^{-1}) in cultivated soils under sugarcane based cropping sequences varied from 245 to 492, 7.2 to 13.8, 124 to 196, 2.8 to 4.4, 1.0 to 1.6 and 16 to 32 with mean values of 337, 10.0, 159, 3.6, 1.3 and 21, respectively (Table 1). On the basis of SNI values, soils were rated as medium (1.73), low (1.47), medium (2.00), high (3.00), high (2.87) and low (1.20) in available N, P, K, Ca, Mg and S, respectively. Per cent of total soils rating low in available N, P, & S were 27, 53 & 80, respectively (Fig. 1).

Mean available N (kg ha^{-1}), P (kg ha^{-1}), K (kg ha^{-1}), Ca {cmol(p+) kg^{-1}}, Mg {cmol(p+) kg^{-1}} and S (kg ha^{-1}) were 300, 9.0, 156, 3.5, 1.3 and 19 in *Entisols* and 394, 11.4, 164, 3.8, 1.4 and 24 in *Inceptisols*, respectively (Table 1). *Inceptisols* had higher mean values of available N, P, K, Ca, Mg and S as compared to *Entisols*. The SNI values revealed that available N, P, K, Ca, Mg and S status was low (1.56), low (1.22), medium (2.00), high (3.00), high (2.78) and low (1.11) in *Entisols* and medium (2.00), medium (1.83), medium (2.00), high (3.00), high (3.00) and low (1.33) in *Inceptisols*, respectively.

As regard distribution of micronutrients, available Cu, Fe, Mn and Zn in soils ranged from 0.22 to 0.40, 4.6 to 10.2, 1.6 to 3.6 and 0.44 to 0.74 mg kg^{-1} with mean values of 0.28, 7.6, 2.8 and 0.60 mg kg^{-1}, respectively (Table 1). All soils studied were sufficient in available Cu, Fe and Mn. Per cent of total soils rating deficient in available Zn were 40 (Fig. 1).

Mean available Cu, Fe, Mn and Zn in soils were 0.26, 7.1, 2.6 and 0.55 mg kg^{-1} in *Entisols* and 0.31, 8.2, 3.0 and 0.66 mg kg^{-1} in *Inceptisols*, respectively. *Inceptisols* contained higher mean available Cu, Fe, Mn and Zn values than those *Entisols* (Table 1).

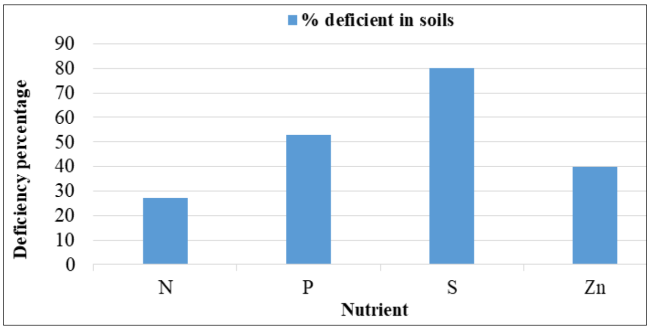

Fig 1: Nutrient deficiency status in sugarcane growing soils of low hill subtropical zone of Himachal Pradesh

A perusal of results on available nutrient content/ status (Table 1) revealed that soils varied considerably in available nutrient content/ status. It may be attributed to the differences in pedo-genesis (gains, losses, transformation and translocation of materials), soil management practices, land use types, plant nutrient recycling processes, etc. In nutshell, soil fertility is controlled by soil forming factors/ processes and land management practices. Similar observations were also made by Kanwar (1979) [4] in agriculturally important valleys of Himachal Pradesh and Verma *et al.* (2016) [13] in sugarcane growing soils of Punjab. Tisdale *et al.* (1993) [12] ascribed the spatial/ vertical distribution of micronutrients mainly to the variation in their mineral sources, organic matter and soil pH.

Table 1: Available nutrient status of soils under sugarcane based cropping sequences in low hill zone of Himachal Pradesh

Sl. No.	Site	Available macronutrients						Available micronutrients			
		N	P	K	Ca	Mg	S	Cu	Fe	Mn	Zn
		(kg ha^{-1})			{cmol (p+) kg^{-1}}		(kg ha^{-1})	(mg kg^{-1})			
					Entisols						
1	Jankaur-I	310	10.2	172	3.8	1.5	20	0.28	8.6	3.0	0.54
2	Nangran	257	8.0	124	2.8	1.0	18	0.22	4.6	1.6	0.48
3	Jankaur-II	310	9.2	168	3.8	1.3	19	0.28	7.4	2.5	0.48
4	Kuthar Kalan	278	7.8	138	3.0	1.1	18	0.24	5.5	2.0	0.44
5	Takarla	298	9.0	138	3.3	1.0	20	0.22	5.5	2.2	0.60
6	Suketi	410	12.0	180	3.9	1.5	23	0.32	9.2	3.5	0.57
7	Bhera	245	7.2	172	3.9	1.4	16	0.22	7.8	2.8	0.57

8	Sarsan	278	8.2	168	3.6	1.4	18	0.26	8.2	3.5	0.62
9	Charara	310	9.2	142	3.4	1.2	19	0.28	7.4	2.5	0.68
	Mean ± SD	300±47.75	9.0±1.45	156±20.14	3.5±0.40	1.3±0.20	19±1.94	0.26±0.04	7.1±1.58	2.6±0.65	0.55±0.08
Inceptisols											
10	Kotli Byas	386	11.4	168	3.9	1.5	22	0.30	6.8	2.5	0.60
11	Sainwala	325	10.2	138	3.4	1.3	20	0.24	9.2	3.6	0.74
12	Rampur Majri-I	298	9.0	132	3.1	1.1	19	0.24	5.0	1.8	0.60
13	Rampur Majri-II	492	13.8	196	4.4	1.6	32	0.39	10.2	3.6	0.70
14	Parduni-I	468	12.8	180	4.2	1.5	28	0.40	9.2	3.5	0.70
15	Parduni-II	394	11.4	172	3.6	1.5	22	0.30	8.8	3.0	0.62
	Mean ± SD	394±76.32	11.4±1.73	164±24.74	3.8±0.49	1.4±0.18	24±5.08	0.31±0.07	8.2±1.93	3.0±0.73	0.66±0.06
Overall Mean ± SD		337±75.29	10.0±1.95	159±21.66	3.6±0.44	1.3±0.20	21±4.17	0.28±0.06	7.6±1.74	2.8±0.68	0.60±0.09

Conclusion

It may be concluded from the present investigation that sugarcane growing soils of low hill subtropical zone of Himachal Pradesh were medium in available N & K, low in available P & S, high in available Ca & Mg, sufficient in available Cu, Fe & Mn and deficient to sufficient in available Zn. The deficiency of four nutrients, *viz.*, N, P, S and Zn may impose threat to sustain the soil productivity in this region. Thus, there is urgent need to adopt soil test based balanced nutrient management for enhancing sugarcane productivity and profitability in the region.

References

1. Anonymous. Statistical Year Book of Himachal Pradesh. Department of Economics & Statistics, Himachal Pradesh, Shimla, 2017.
2. Black CA. Methods of Soil Analysis. Part II. Chemical and mineralogical properties. American society of Agronomy, Madison, Wisconsin, USA, 1965, 1572p.
3. Jackson ML. Soil Chemical Analysis. Prentice Hall, India Private Limited, New Delhi, 1973, 678p.
4. Kanwar BB. Status and distribution of micronutrient cations in agriculturally important valleys of Himachal Pradesh with special reference to emphasis on zinc. Ph D Thesis, Department of Soil Science, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, India, 1979, 176p.
5. Lindsay WL, Norwell WA. Development of DTPA soil test for Zn, Cu, Fe and Mg. Soil Science Society of America Journal. 1978; 42:421-428.
6. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus by extraction with sodium bicarbonate. United States Department of Agriculture, Washington DC, Circular No. 1954; 939:19.
7. Parker FW, Nelson WL, Winters E, Miles IE. The broad interpretation and application of soil test information. Agronomy Journal. 1951; 43:105-112.
8. Sidhu GS, Rana KPC, Sehgal J, Velayutham M. Soils of Himachal Pradesh for optimizing land use. National Bureau of Soil Survey and Land Use Planning, Nagpur, India, 1997, p. 44.
9. Singh LN, Singh CM, Sharma PK, Saini AS, Kharwara PC. NARP Status Report: Sub-montane and low hills sub-tropical zone. Himachal Pradesh Krishi Vishvavidyalaya, Palampur, 1990.
10. Subbiah BV, Asija GL. A rapid procedure for estimation of available nitrogen in soils. Current Science. 1956; 25:259-260.
11. Tewari SC, Awasthi OP. Inventory of Resources in Kangra district (Himachal Pradesh). CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, 1978, 280p.
12. Tisdale SL, Nelson WL, Beaton JD, Halvin JL. Soil Fertility and Fertilizers. Macmillan Publishing Company, New York, 1993, 634p.
13. Verma RR, Srivastava TK, Singh KP. Fertility status of major sugarcane growing soils of Punjab, India. Journal of the Indian Society of Soil Science. 2016; 64(4):427-431.