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Characteristics and soil fertility appraisal of forest nursery soils of Bilaspur circle in Himachal Pradesh

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ABSTRACT

The survey of the management practices being followed in the forest nurseries and their physico-chemical characteristics was undertaken in district Bilaspur and Solan under Bilaspur Circle in Himachal Pradesh. The soil reaction was slightly acidic to neutral and electrical conductivity in safer limits, without any salinity hazards. A predominance of clay loam soil texture was observed with high organic carbon status. The soils were categorized as medium, high and medium with respect to available N, P and K, whereas high status of available Ca, Mg and S was observed.. It can be concluded from the results that loam texture, neutral soil reaction and good fertility status of the forest nurseries of Bilaspur circle have a great potential to produce healthy stock provided recommended package of practices coupled with balanced use of NPK fertilizers and organic manures are followed.

Key words :

Introduction

The forest has provided the human race with many of essentials for its survival. These vital commodities have included food, fuel and material for shelter and tools. Forest constitutes back-bone of economy and prosperity of the Himalayan region, especially of Himachal Pradesh, where forest occupies 23.46% of the total geographical area of the state. The productivity of forest nurseries in the state is dismal with acute gap between the desired and achieved level. Primary purpose of forest nurseries is to produce trees to form new forests and the knowledge of soil properties is as important as in successful agriculture. There numerous factors which govern the performance of vegetation including fatigue, multi-nutrient deficiencies and decrease in input use efficiency are also posing major challenges to maintain declining land productivity. It has been emphasized that the physical and chemical characteristics of soil, next to the climate are the most important factors which determine the magnitude of healthy nursery stock. Systematic information on characteristics, assessment and nutritional status of soils is an essential pre-requisite for efficient and effective follow-up of required external inputs and management practices to obtain good quality healthy stock. Attempts have been made in the past for characterization and assessment of soil resources in respect of forest soils/nursery soils by Chaudhari *et al.*1977, Ghabru and Ghosh, 1980 and Raina and Kumar, 2000. However, comprehensive information on forest nursery soils of state has not been documented so far. The present study was, therefore, undertaken with the view to assess the physico-chemical characteristics and fertility status of nursery soils of the Bilaspur division of Himachal Pradesh.

Material and Methods

The investigation was carried out in the Bilaspur, Kunihar and Nalagarh forest divisions under

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Bilaspur forest circle in Himachal Pradesh. The division lies between $31^0 12' 30''$ to $31^0 35' 30''$ North latitude and $76^0 23' 45''$ to $76^0 55' 40''$ East longitude. The mean annual temperature varies between 12^0C to 35^0C and the area receives an annual rainfall of 1330 mm. A detailed survey of forest nurseries was conducted and ten forest nurseries were selected for the present study (Table 1). Surface and sub- surface soil samples were collected from each nursery in triplicate and processed samples (<2mm) were analyzed for various physico-chemical characteristics, following standard procedures. (Piper, 1966 and Jackson, 1973). The nutrient status of the nurseries was estimated before sowing of the seeds/ planting of cuttings and after lifting of forest nursery seedlings. The nutrient index was calculated following the procedure outlined by Parker *et al.* 1951.

Results and Discussion

Physical characteristics of the soils

The particle size distribution of nursery soils showed the dominance of sand sized fractions which varied from 37 to52 and 40 to 57 % with mean values of 45 and 48%, in surface and sub-surface layers, respectively (Table 1). In general, the soil texture in the surface and sub-surface soils varied from silt loam to clay loam and a predominance of clay loam texture was observed in the nurseries. The clay content decreased with increase in soil depth, which might be due to variability in weathering at different depths. These results are in close conformity with Sharma, 2005, who has also reported clay loam and silt loam texture in forest nurseries of Solan and Rajgarh forest division. Surface soils exhibited bulk density in the range of 1.20-1.51Mg m^{-3} with a mean value of 1.33 Mg m^{-3}. The corresponding figures for sub-surface soils were 1.27-1.57 Mg m^{-3} with mean value of 1.39 Mg m^{-3}. The bulk density increased with depth in all the nurseries and this may be due to more compaction of finer particles in deeper layers caused by over-head weight of the surface soils (Jewitt *et al.*, 1979) and also due to low organic carbon. The available water content (AWC) of surface and sub-surface soils varied from 13.10 to 17.72 % with average value of 14.85 and 13.60 %, respectively. These differences were due to variations in the clay and organic matter content. The sub-surface soils exhibited low values of AWC, which may be attributed to low clay and organic matter contents in

Table 1. Physical characteristics of forest nursery

Sr. No.	Name of nursery	Depth (cm)	Particle size distribution			Textural class	Bulk density (Mg/m^3)	AWC (%)
			Sand	Silt	Clay			
1.	Jandhutta	0-20	52.0	26.0	22.0	scl	1.51	13.10
		20-40	57.0	22.0	21.0	scl	1.57	13.01
2.	Ghumarwin	0-20	49.0	26.0	24.0	scl	1.42	14.09
		20-40	52.0	25.0	23.0	scl	1.47	13.30
3.	Sandouli	0-20	50.0	24.0	26.0	scl	1.43	14.40
		20-40	53.0	22.0	25.0	scl	1.48	12.35
4.	Kharsa Changar	0-20	38.0	30.0	32.0	cl	1.29	15.68
		20-40	45.0	25.0	30.0	cl	1.32	14.99
5.	Patta	0-20	49.0	27.0	24.0	scl	1.40	13.90
		20-40	51.0	26.0	23.0	scl	1.46	12.34
6.	Chandi	0-20	37.0	31.0	32.0	cl	1.20	14.24
		20-40	43.0	31.0	26.0	cl	1.29	12.91
7.	Pathragal	0-20	50.0	32.0	18.0	l	1.21	15.34
		20-40	52.0	30.0	18.0	l	1.38	14.74
8.	Sani Majra	0-20	42.0	20.0	38.0	cl	1.24	17.72
		20-40	44.0	21.0	35.0	cl	1.27	16.35
9.	Ladae ki bain	0-20	43.0	30.0	27.0	cl	1.33	13.93
		20-40	44.0	29.0	27.0	cl	1.38	10.10
10.	Kuthar	0-20	39.0	31.0	30.0	cl	1.24	16.09
		20-40	40.0	30.0	30.0	cl	1.39	15.91
	Mean	0-20	45.0	28.0	27.0	-	1.33	14.85
		20-40	48.0	26.2	26.0	-	1.39	13.60

the sub-surface layers, which is also supported by positive and significant correlation of available water contents with clay and organic carbon (Gupta *et al.*, 1974 and Kumar, 1996).

Chemical characteristics of the soils

The soil pH in forest nurseries soils ranged from 5.92-7.68 and from 6.22-7.88 in surface and sub-surface soils, respectively. The soil pH increased with depth, which may be attributed to lower content of organic matter and weathered soil conditions at lower depth. In general, the soil reaction was neutral, which is ideal for the availability of most of the mineral nutrients from the soil as well from those applied through fertilizers. The average EC was 0.26 and 0.20 dSm^{-1} in surface and sub-surface layers, respectively, suggesting low amounts of soluble salts without any salinity hazards and suitable for all crops.

The $CaCO_3$ content remained absent owing to the nature of the parent material except Sandouli and Sani Majra, where $CaCO_3$ varied from 7.00 to 11.80 g kg^{-1} (Table 2).

The organic carbon content in the surface and sub-surface soils varied from 12.90 to 27.50 and 8.90 to 18.90 g kg^{-1} with an average of 21.1 and 14.7 g kg^{-1}, respectively. Similar results were reported by Raina and Kumar, 2000 and Verma, 2003. The forest nursery at Sani Majara registered highest organic carbon content(Table 2), because this nursery is covered by deciduous plantations all-around , thus heavy litter fall and its subsequent decomposition may have contributed to the higher organic matter status. Further, application of compost, may have also contributed in improving organic matter content. The organic carbon content of soils decreased with depth, which may be ascribed to the additions of organic manures and litter fall on the surface of the soil. Verma, 2003 also reported decrease in organic carbon contents with increasing soil depth. These soils exhibited CEC from 12.20 to 17.70 and 9.60 to 15.30 cmol (p^+) kg^{-1} in surface and sub-surface soils, respectively. The CEC values decreased with increasing soil depth. Soils having high organic carbon possessed relatively higher values of CEC, irrespective of their enrichment with illuviated clay. Cation exchange sites were invariably dominated by calcium followed by magnesium, potassium and sodium in decreasing order. These observations are in agreement with the finding of Gupta *et al.*, 1983 and Sharma, 2005.

Table 2. Chemical characteristics of the forest nursery soils

Sr. No.	Name of nursery	Depth (cm)	pH (1:2.5)	EC (dS/m)	$CaCO_3$ (gKg^{-1})	OC (g/kg)	CEC [c mol (p^+)/kg]
1.	Jandhutta	0-20	7.24	0.36	-	26.0	16.80
		20-40	7.46	0.24	-	18.90	13.70
2.	Ghumar-win	0-20	7.38	0.33	-	22.10	16.40
		20-40	7.65	0.22	-	16.20	14.70
3.	Sandouli	0-20	7.60	0.24	10.6	17.20	15.20
		20-40	7.88	0.13	11.8	13.20	14.20
4.	Kharsa Changar	0-20	7.12	0.22	-	25.0	14.90
		20-40	7.32	0.20	-	17.60	12.80
5.	Patta	0-20	6.90	0.15	-	17.20	14.50
		20-40	6.22	0.12	-	12.20	12.50
6.	Chandi	0-20	6.66	0.23	-	20.80	16.80
		20-40	7.42	0.13	-	16.40	14.90
7.	Pathragal	0-20	6.58	0.29	-	12.90	12.20
		20-40	6.70	0.38	-	8.90	9.80
8.	Sani Majra	0-20	7.68	0.25	7.0	27.50	17.70
		20-40	7.78	0.25	10.0	17.00	15.30
9.	Ladae ki Bain	0-20	7.22	0.36	-	27.20	14.20
		20-40	7.52	0.22	-	17.30	9.60
10.	Kuthar	0-20	5.92	0.12	-	15.20	14.80
		20-40	6.60	0.08	-	9.20	13.80
	Mean	0-20	7.03	0.26	8.5	21.10	15.30
		20-40	7.25	0.20	10.0	14.70	13.10

Available nutrient status:

The available nitrogen content in the surface and sub-surface soils was found to vary from 344.9 to 419.2 kg ha^{-1} and 271.3 to 386.9 $kgha^{-1}$ with mean values of 376.2 and 331.5 kg ha^{-1}, respectively. The maximum available nitrogen was recorded in the soils of Sani Majra, which also registered high organic carbon content. The available nitrogen content decreased with soil depth, which might be due to decreasing trend of organic carbon with depth. Considering a range of 280-560 kg ha^{-1} as medium, all samples were categorized as medium. The nutrient index values for surface and sub-surface were found to be 2.00 and 1.80, respectively (Table 4), thus suggesting, in general a medium status of available N in the soils of these nurseries. Minhas (1986), Raina and Kumar (2000) and Verma (2003) have also reported most of the forest soils of mid hill region of Himachal Pradesh as low to medium in their available N status.

The available phosphorus content varied from 34.70 to 45.6 and 28.10 to 44.8 kg ha^{-1} with mean value of 40.2 and 35.4 kg ha^{-1} for surface and sub-surface soils, respectively (Table 3). The maximum available P content was recorded in Sani Majra forest nursery soils, which may be attributed to the maximum organic carbon content of these soils (Table 2). In light of the suggested critical limits, soils of nurseries were rated high in their available P status. The nutrient index values for surface and sub-surface were found to be 2.90 (Table 4), thus suggesting, in general a high status of available P in the soils of these nurseries. Similar results were also reported by Sharma (2005), who have reported high P status in forest nursery soils of district Sirmour and Solan.

Average content of available potassium in the nurseries was recorded to be 251.8 and 202.7 kg ha^{-1} in surface and sub-surface soils, respectively. The higher content of potassium in surface soils may be attributed to more intense weathering and release of labile K from organic residues.

The Ca and Mg content in the surface and sub-surface soils ranged from 2884 to 4291 and 607 to 837 kg ha^{-1} with respective average value of 3646 and 548 kg ha^{-1}. In general, Ca and Mg content decreased with increasing depth. The nutrient index value was found to be 3.0 for both the elements (Table 4).

A critical appraisal of data (Table 4) indicated that available SO_4-S content in the surface and sub-

Table 3. Nutritional status of forest nursery soils

Sr. No.	Name of nursery	Depth (cm)	Available nutrient (kg/ha)					
			N	P	K	Ca	Mg	S
1.	Jandhutta	0-20	370.52	43.60	241.40	3521	709	63.80
		20-40	335.70	42.10	192.80	3140	586	55.80
2.	Ghumarwin	0-20	362.70	42.00	246.70	3242	712	64.60
		20-40	290.20	32.60	212.67	2837	507	48.67
3.	Sandouli	0-20	382.31	42.40	264.32	3520	735	62.40
		20-40	352.62	38.56	189.54	3819	521	45.34
4.	Kharsa Changar	0-20	372.32	35.40	272.10	4124	837	51.40
		20-40	338.68	32.60	179.20	3871	514	41.67
5.	Patta	0-20	364.40	37.20	297.80	3241	607	61.20
		20-40	288.10	34.50	278.40	4007	406	45.80
6.	Chandi	0-20	381.42	37.90	212.60	4291	736	62.50
		20-40	355.64	32.40	175.52	4007	791	51.32
7.	Pathragal	0-20	344.91	34.70	161.30	2884	659	65.30
		20-40	317.87	28.10	113.00	2543	410	43.20
8.	Sani Majra	0-20	419.20	45.62	328.80	4051	829	67.50
		20-40	386.88	39.87	356.40	4387	652	50.35
9.	Ladae ki bain	0-20	386.32	38.20	279.80	3742	714	57.20
		20-40	271.31	28.70	144.50	3142	512	47.80
10.	Kuthar	0-20	378.32	45.20	213.40	3846	769	65.50
		20-40	377.52	44.81	184.80	3422	582	55.00
	Mean	0-20	376.24	40.22	251.82	3646	730	62.14
		20-40	331.45	35.42	202.67	3410	548	48.49

Table 4. Nutrient index of forest nursery soils

Sr. No.	Nutrient	Surface	Sub-surface
1.	N	2.00 (Medium)	1.80 (Medium)
2.	P	2.90 (High)	2.90 (High)
3.	K	2.20 (Medium)	2.10 (Medium)
4.	Ca	3.00 (High)	3.00 (High)
5.	Mg	3.00 (High)	3.00 (High)
6.	SO_4-S	3.00 (High)	3.00 (High)

surface soils varied between 51.4 to 67.5 and 41.7 to 55.8 kg ha^{-1} with mean value of 62.1 and 48.5 kg ha^{-1}, respectively. The maximum and minimum available sulphur was recorded in soils of Sani Majra and Khasara Changar forest nurseries, respectively. The surface soils contained more available sulphur than deeper layer which could be due to higher amounts of organic matter in surface layer. In light of the suggested threshold value of 22.4 kg ha^{-1} all the samples were rated high in their available sulphur. The higher value of SO_4-S in soils of Himachal Pradesh may be attributed to gypsiferous and ferruginam nature of parent material.

Conclusion

It can be concluded from the results described herein that loam texture, neutral soil reaction and good fertility status of forest nurseries of Bilaspur circle have a good potential to produce healthy stock provided recommended package of practices coupled with balanced use of NPK fertilizers and organic manures are applied. P additions can be achieved byb applying 25 percent less amount of recommended dose for various tree species.

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