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Physico-chemical characteristics of soil of semi-arid regions of Haryana experiencing mortality of shisham (*Dalbergia sissoo*)

M.K. Singh and Ravi Kumar*
Department of Forestry, C.C.S. Haryana Agricultural University, HISAR (HARYANA) INDIA

ABSTRACT
In order to study the physico-chemical properties of soils under healthy as well as dead trees of *Dalbergia sissoo* six different locations in Chaudhary Charan Singh Haryana Agricultural University and nearby places were selected. Six depth wise soil samples upto 150cm were collected and analyzed for important physico-chemical characteristics i.e pH, $CaCO_3$, Bulk density, Particle density of the soil was found higher in the soils under dead trees as compared to healthy trees of *Dalbergia sissoo.* The paired t-test values showed that the pH, $CaCO_3$, Bulk density in the soil under dead *Dalbergia sissoo* their were significantly higher than in the soils under healthy trees

Key words : Physico-Chemical, Mortality, *Dalbergia sissoo*

INTRODUCTION

Dalbergia sissoo (shisham) belong to family leguminoseae, sub-family papilionaceae. It is one of the most important timber species in India. It attaining a height upto 30m tall and 2.4m girth in favourable localities.

Environment stresses which includes both abiotic (air, water, soil, increase in temperature and erratic rainfall) and biotic stresses (like pests/diseases, over-grazing, more human interferences), edaphic conditions such as soil physical properties (viz., soil air-water balance), and nutrient deficiencies may also contribute to sissoo parching. Adverse hydrological conditions primarily water logging leads to lengthy soil moisture regimes at saturation and sub saturation level which, in turn, influencing the mortality shisham to a great extent. Stagnation of water for a long period creates an anaerobic condition in the root zone of trees and ultimately causes death of the feeder roots due to asphyxiation. Such conditions were more pronounced in Rohtak, Sonipat, Jind and Karnal areas where the large scale mortality of trees in general and shisham is particular were recorded. Therefore, the present study was undertaken to evaluate the possible soil related reasons for the mortality of shisham trees in the CCSHAU, Hisar campus and nearby places.

MATERIALS AND METHODS

Healthy and dead trees of *Dalbergia sissoo* were selected from the campus and nearby places. The distances between healthy and dead trees were about 4-5m. The trees were about 10-15 years of age, their girth varied from 68 to 69cm and height from 8-14m. From each location, two trees one healthy and one dead (which died within 2 to 3 years or so) were selected. From the base of the trees, four points at a distance of 1.5meter in East, West, North and South directions were marked. From these points with the help of an auger, soil sample were drawn at a depth of 0-15, 15-30, 30-60, 60-90, 90-120 and 120-150cm. From all the four directions. All the four samples from each direction and depth were mixed together and one composite sample was drawn. In this way samples were collected from six different locations under dead and healthy trees. Soil sample were air dried, ground with pestle and mortar and passed through 2mm sieve and analyzed of pH, E.C, Bulk density and Particle density and $CaCO_3$ as per Kalra and Maynard,1991.

RESULTS AND DISCUSSION

Soil pH

The soil pH values (1:2 soil water ratio) at different depth and at various locations are presented in Table-1, In general the soil pH values were higher in soils under dead trees as compared to healthy trees at all the locations and depth. Among healthy trees the lowest pH values i.e. 7.5 was recorded at the surface layer of location L3 and highest 9.1 at lowest depth at location L_6. In case of dead trees pH values varied from 7.9 (in surface level at location L_3) to 9.3 in the soil sample at lower most depth at location L_6. In both the cases the pH values increased with the increasing in soil depth.

The low pH values of upper surface layer may be attributed to the higher accumulation of organic matter on surface due to higher litter fall and its subsequent decomposition and formation of organic acid. Subhanu (2002), Nandi *et al*., (1991) and Kumar *et al*., (1998) also reported the lowering of soil pH under *Acacia nilotica,Dalbergia Sissoo* plantations.

The paired t-test value showed that at location L_1, L_3 and L_6 these values under dead trees were significantly higher than the healthy trees, values being 4.401, 2.868 and 3.683 respectively. Sharma *et al*., 1998 reported that the soil pH of dead *Dalbergia sissoo* plantation varied from 7.5 to 9.7 as compared to near neutral pH in healthy localities.

Electrical conductivity (dSm^{-1})

The electrical conductivity of soils increased with depth in case of soils under healthy as well as dead trees of *Dalbergia Sissoo* (Table 2). In general, the EC was higher in the soil under dead trees as compared to healthy trees at all the six locations. Under the healthy trees the EC value varied from 0.30 dSm^{-1} (surface) at location L_3 and L_6 to 0.45 dSm^{-1} (lower most depth) at location L_1. Among the dead trees minimum EC was found on the surface (0.32) at location L_4 and maximum in lower most depth (0.47) at location L_1. It is evident from the data that the trees helped in lowering down the salt concentration in soil. The reduction was maximum under the healthy trees of *Dalbergia sissoo.* The effectiveness of *Dalbergia sissoo* in improving soil by lowering its EC values might be attributed to its relative tolerance under adverse soil conditions, amount of litter fall and its chemical composition. The results are in conformity with the finding of Kumar *et al*., (1998) and Nandi *et al*., (1991) and Subhanu (2002). They also reported the lowering down of EC under *Dalbergia, Eucalyptus* and *Acacia* plantation in arid conditions.

Paired t test value showed was no significant difference in EC values in soils under dead and healthy trees.

Bulk density (gm/cc)

The data presented in Table-3,revealed that the bulk density of the soils in the profile ranged from 1.39 gm/cc on the surface at location L_2 and L_4 to 1.65 gm/cc in the lower most soil depth (120-150cm) at location L_3 in the soil under healthy trees and 1.40 gm/cc on the surface layer at locations L_2 and L_4 and maximum in the lower most soil depth 1.65 gm/cc at locations L_1 and L_6 in case of soils under dead trees. In general, the bulk density increased with increasing soil depth both in the soil of healthy as well as dead trees. On an average the bulk density was found higher in soil under dead trees in comparison to the soils under healthy trees of *Dalbergia sissoo* which

***Author for correspondence**

Table 1:pH (1:2 soil water ratio) of the soil under healthy and dead trees of *D. sissoo*

Depth (cm)	L_1		L_2		L_3		L_4		L_5`		L_6	
	H	D	H	D	H	D	H	D	H	D	H	D
0-15	8.0	8.1	7.9	7.9	7.5	7.9	7.8	8.0	7.9	8.0	8.1	8.4
15-30	8.1	8.3	8.2	8.0	7.9	8.0	8.1	8.2	8.0	8.1	8.2	8.2
30-60	8.2	8.4	8.3	8.1	8.0	8.1	8.3	8.3	8.3	8.2	8.5	8.6
60-90	8.4	8.7	8.3	8.2	8.1	8.2	8.7	8.5	8.4	8.7	8.5	8.7
90-120	8.5	9.0	8.4	8.6	8.2	8.9	8.8	8.7	8.8	8.7	8.6	9.1
120-150	8.6	9.1	8.5	8.9	8.2	9.0	8.8	8.8	9.1	9.0	9.1	9.3
Mean	8.300	8.600	8.266	8.283	7.983	8.350	8.416	8.416	8.416	8.450	8.500	8.716
Mean difference	-0.300		-0.017		-0.367		0.000		-0.034		-0.216	
SE	0.216	0.365	0.197	0.352	0.240	0.434	0.379	0.278	0.421	0.367	0.321	0.380
t	4.401*		-1.021		2.868*		0.000		0.448		3.368*	
t, 5%	2.015											

* Significant, H = Healthy, D= Dead, SE= Standard Error

Table 2:Electrical conductivity (dSm^{-1}) of the soil under healthy and dead trees of *D. sissoo*

Depth (cm)	L_1		L_2		L_3		L_4		L_5`		L_6	
	H	D	H	D	H	D	H	D	H	D	H	D
0-15	0.34	0.36	0.32	0.34	0.30	0.33	0.29	0.32	0.28	0.33	0.30	0.33
15-30	036	0.38	0.32	0.35	0.35	0.38	0.30	0.34	0.29	0.31	0.32	0.35
30-60	0.41	0.42	0.35	0.36	0.36	0.34	0.35	0.37	0.32	0.30	0.37	0.39
60-90	0.40	0.46	0.36	0.38	0.37	0.38	0.39	0.37	0.32	0.33	0.37	0.40
90-120	0.45	0.43	0.37	0.38	0.38	0.36	0.40	0.43	0.34	0.36	0.39	0.41
120-150	0.45	0.47	0.42	0.40	0.41	0.43	0.44	0.42	0.40	0.39	0.43	0.40
Mean	0.401	0.420	0.357	0.368	0.361	0.370	0.361	0.375	0.325	0.336	0.363	0.381
Mean difference	0.018		0.011		0.008		0.013		0.012		0.016	
SE	0.018	0.017	0.015	0.009	0.015	0.014	0.024	0.017	0.017	0.013	0.019	0.131
t	0.799		1.660		0.880		0.900		1.151		1.752	
t, 5%	2.015											

* Significant, H = Healthy, D= Dead, SE= Standard Error

Table 3:Bulk density (gm/cc) of the soil under healthy and dead trees of *D. sissoo*

Depth (cm)	L_1		L_2		L_3		L_4		L_5`		L_6	
	H	D	H	D	H	D	H	D	H	D	H	D
0-15	1.42	1.45	1.39	1.40	1.42	1.45	1.39	1.40	1.40	1.45	1.43	1.42
15-30	1.45	1.47	1.45	1.46	1.45	1.47	1.40	1.42	1.44	1.47	1.46	1.45
30-60	1.49	1.49	1.48	1.48	1.49	1.49	1.42	1.44	1.49	1.49	1.48	1.49
60-90	1.53	1.51	1.51	1.53	1.53	1.51	1.46	1.47	1.55	1.51	1.54	1.53
90-120	1.59	1.56	1.56	1.55	1.59	1.65	1.50	1.53	1.59	1.56	1.58	1.59
120-150	1.63	1.65	1.60	1.60	1.65	1.63	1.56	1.57	1.63	1.63	1.63	1.65
Mean	1.518	1.521	1.498	1.503	1.521	1.533	1.455	1.471	1.516	1.518	1.520	1.521
Mean difference	-0.003		-0.008		-0.012		-0.016		-0.002		-0.001	
SE	0.354	0.271	0.296	0.302	0.354	0.348	0.268	0.270	0.363	0.271	0.313	0.354
t	-0.337		-2.712*		-0.914		-5.000*		-0.119		-0.307	
t, 5%	2.015											

* Significant, H = Healthy, D= Dead, SE= Standard Error

Table 4:Particle density (gm/cc) of the soil under healthy and dead trees of *D. sissoo*

Depth (cm)	L_1		L_2		L_3		L_4		L_5`		L_6	
	H	D	H	D	H	D	H	D	H	D	H	D
0-15	2.56	2.58	2.57	2.56	2.57	2.58	2.57	2.57	2.54	2.56	2.56	2.59
15-30	2.56	2.56	2.60	2.58	2.56	2.56	2.58	2.60	2.57	2.57	2.59	2.58
30-60	2.57	2.57	2.57	2.56	2.57	2.57	2.57	2.57	2.58	2.58	2.60	2.60
60-90	2.56	2.56	2.58	2.57	2.56	2.56	2.59	2.56	2.59	2.61	2.58	2.59
90-120	2.58	2.57	2.59	2.59	2.58	2.57	2.58	2.58	2.60	2.59	2.58	2.58
120-150	2.59	2.59	2.66	2.61	2.59	2.59	2.60	2.59	2.60	2.58	2.59	2.60
Mean	2.570	2.572	2.595	2.578	2.572	2.572	2.582	2.572	2.580	2.582	2.583	2.590
Mean difference	0.002		0.017		0.00		0.010		0.002		0.007	
SE	0.516	0.477	0.138	0.792	0.477	0.477	0.477	0.477	0.930	0.703	0.557	0.365
t	-0.415		1.274		0.000		1.936		-0.255		-1.195	
t, 5%	2.015											

* Significant, H = Healthy, D= Dead, SE= Standard Error

Table 5:Calcium Carbonate (%) of the soil under healthy and dead trees of *D. sissoo*

Depth (cm)	L_1		L_2		L_3		L_4		L_5		L_6	
	H	D	H	D	H	D	H	D	H	D	H	D
0-15	0.71	0.68	1.00	0.70	0.90	1.00	0.60	0.90	1.00	1.30	0.60	0.80
15-30	0.70	0.69	1.10	0.90	1.20	1.30	0.90	1.00	0.90	0.80	0.80	1.00
30-60	1.00	0.96	1.60	1.30	1.50	1.60	1.90	1.80	0.70	0.90	1.00	1.30
60-90	0.69	0.70	2.10	1.90	1.90	2.00	2.20	2.30	1.50	1.70	1.20	1.50
90-120	1.90	2.00	2.60	2.50	2.40	2.60	2.90	2.90	1.40	2.00	1.50	1.80
120-150	2.50	2.60	2.80	2.60	2.60	2.80	3.00	3.20	1.90	2.30	1.70	2.00
Mean	1.250	1.271	1.866	1.650	1.750	1.883	1.916	2.016	1.233	1.500	1.133	1.400
Mean difference	0.022		0.216		0.013		0.100		-0.267		0.266	
SE	0.314	0.377	0.309	0.330	0.274	0.292	0.407	0.391	0.182	0.246	0.170	0.188
t	-0.842		7.050*		-6.325*		-1.732		-2.794*		12.649*	
t, 5%	2.015											

* Significant, H = Healthy, D= Dead, SE= Standard Error

might be due to comparative low organic carbon content in soil under dead trees (Table-6). Reduction in bulk density under healthy trees as compared to dead trees might be due to higher annual litter return by trees which resulted in high organic matter content in soil (Soni *et al*,. 1985, Subhanu, 2002, Min and Lee, 1986 and Slay *et al*., 1987) Kumar *et al*, (1998) also reported similar results for soil under *Dalbergia sissoo* plantations.

The paired t-test value showed that at location L_2 and L_4 these values under dead trees were significantly higher as compared to healthy trees, values being (-2.712) and (-5.000) respectively, which shows compaction of soils under dead trees.

Particle density (gm/cc)

The particle density values at different depth and at various locations are presented in Table 4. In general the particle density values were higher in the soils under dead trees as compared to the soils under healthy trees at all the six locations. Among healthy trees the minimum particle density (2.54 gm/cc) was recorded at surface layer of location L_5 and highest 2.66 gm/cc at lowest depth of location L_2. In case of dead trees particle density varied from 2.56 gm/cc (in surface level at locations L_2 and L_5) to 2.61 gm/cc in the soil sample at lower most depth at location L_2. In both the cases the particle density values increased with increase in soil depth. The maximum reduction in particle density in upper layer under *Dalbergia sissoo* might be due to higher annual litter return (Hosur and Dasog, 1995). The particle desntiy increased with increasing in soil depth under both the healthy as well as dead trees. This can be attributed to the increase in clay and silt fraction and reduction in organic matter content with depth. Similar observation were observed by Kumar *et al*., 1998 and Subhanu, 2002. There was no significant difference in particle density in the soils under healthy and dead trees as indicated by pair t test values.

$CaCO_3$ (%)

A perusal of data in Table-5,revealed that the $CaCO_3$ contents in the soils under healthy trees varied from 0.60 to 3.00 per cent at the surface and lower most soil depth at location L_4 and in the soil under dead trees it varied from 0.68 per cent at the surface of location L_1 and 3.20 (maximum) at the lower most soil depth of location L_4. In general, $CaCO_3$ content was lowest at surface level and increased with depth under both healthy as well as dead tree soils. Similar observation were reported by Subhanu, 2002 and Kumar, 1998 and Dahayia *et al*., 2002.

The $CaCO_3$ contents was more in dead tree soils as compared to the soils under healthy trees. The paired t-test values found significantly higher in case of soils under dead tree as compared to healthy tree at locations L_2, L_3, L_5 and L_6 values being 7.050, 6.325, -2.794 and 12.649 respectively. High $CaCO_3$ content in the soil of dead trees might be responsible for the decline of *Dalbergia sissoo*. Similar results were obtained by Dahiya *et al*., 2002

CONCLUSION

Among physico-chemical characteristics values of Ph, CaCO3, and Bulk density significantly higher in soils under dead trees while the values for E.C and Particle density did not differ significantly. These values were not of that magnitude which can cause mortality in trees.

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