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Effect of Important Agroforestry Tree Species on Soil Properties and Soil Nutrients

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Abstract:
The present study was conducted at Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni to study the "Effect of Important Agroforestry Tree Species on Soil Properties and Soil Nutrients" with the objective to determine the effect of different MPTs on soil properties including the quality and quantity of soil nutrient. The effect of MPTs on soil nutrient was studied in seven species viz., Grewia optiva, Morus alba, Celtisautralis, Aceroblongum, Meliaazedarach, Acacia catechu and Bauhinia variegata. The study was intended to explore the status of soil chemical characteristics under MPTs and compared these with control which is area devoid of vegetation. The study revealed higher nutrient contents at surface layer D1 (0–15 cm) which decrease with the increase of soil depth. The soil under the MPTs showed pronounced changes as compared to control. A comparison of soil chemical characteristics under MPTs and control revealed an improvement in soil Ec, Organic carbon and available nutrients. A general perusal of data revealed that Bauhinia variegata, Acer oblongum and Acacia catechu have more potential to ameliorate the soil chemical properties (soil pH, Organic carbon and available nutrients) as compared to other MPTs. The Bauhinia variegata and Acer oblongum are excelled amongst all studied tree species for improving available soil nutrients. The high and improved amount of available nutrients (N, P K) and organic carbon found at surface (0 – 15cm) layer which further decrease with the increase of soil depth.

Keywords: *Acacia catechu, Acer oblongum, Bauhinia variegata, Celtis autralis, Grewia optiva, Melia azedarach, Microbial Biomass, Morus alba, MPTs.*

1. Introduction
It is widely believed that Agroforestry holds considerable potential as a major land management alternative for conserving soil as well as maintain the soil fertility and productivity (Nair, 1992). On global basis, the productivity of Indian forest is extremely poor. Soil amelioration is not only effective, especially in salt affected wasteland in arid and semi- arid regions, but is also a method for ecological revival in terms of vegetation enrichment, soil amelioration as well as social benefits for hilly region too (Young, 1989). Agroforestry tree species producing high quality litter may enhance soil nutrient availability and crop yield through mineralization of soil organic matter and green manure (Kimaro, 2008). Tree species influences the soil properties including the quality and quantity of soil organic carbon by the complex of the climate, soil type and management (Lair, 2005). Tree exert a major effect on soil by influencing microclimate, soil properties, primarily by the amount and composition of litter deposited and by nutrient uptake and accumulation. Agroforestry techniques involving, planting multipurpose trees that are tolerant of adverse soil conditions have also been suggested as a management option for reclamation of degraded areas of acid savannas, abandoned shifting areas and extensive stretches of salt-affected soils. (King and Chandler, 1978). Several genera of economically useful trees have been identified as capable of growing in saline-alkaline conditions. Also the use of agroforestry systems is an economically feasible way to protect crop plants from extremes of microclimate and soil moisture and should be considered a potential adaptive strategy for farmers in areas that will suffer from extremes in climate (Liu, 2000). The problem of soil erosion has also been noticed more in hilly regions and raising plantations of forest tree species has been proved to be one of the best possible and feasible options. Trees not only reduce soil erosion but also ameliorate the site by adding nutrients and organic matter in the form of leaf litter (Nair, 1992). Dhyani et al. (1990) studied the effect of five tree species viz. *Bauhnia purpurea, Grewia optiva, Eucalyptus tereticornis, Leucaena leucocephala and Ougemiao ojeinensis* on the nutrient status in (0 – 15cm) soil depth and concluded that the total N, available P_2O_5 available K_2O, exchangeable Ca and Mg were higher in the soil under the tree species in comparison to area which were without trees.

2. Material and Methods
The present study entitled "Studies on nutrient status and carbon sequestration potential of important MPTs of Himachal Pradesh" was conducted at the Experimental farm of the Department of Silviculture and Agroforestry, Dr Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan-173230, Himachal Pradesh during 2013-2014. The site from where samples had been taken is located at an

elevation of 1200m above mean sea level in the mid- Himalayan zone. It lies between 30°51´ N latitude and 76°11´ (Survey of Indian Topo Sheet Number 53F/1). The areas fall in the mid-hill zones of Himachal Pradesh. The soil is well drained and of silty loamy type. The terrain is undulating, hilly and marked with elevation and depressions and has a gentle slope towards the south- eastern aspect. The trial was laid out in a factorial experiment in Randomized Block Design with 8 treatments viz T1 (*Acacia catechu*), T2 (*Melia azedarach*), T3(*Grewia optiva*),T4 (*Celtis australis*),T5(*Acer oblongum*), T6 *(Bauhinia variegata*),T7(*Morus alba)*, T8(Control). The treatments were replicated thrice and the sample plot size is 33m×33m (0.1 ha). During the present study, the following observations were recorded; Soil pH, Electrical conductivity, Soil bulk density, Soil organic carbon, Available Nitrogen, Available Phosphorous, and Available Potassium. Soil samples were collected in the month of November from the plot. Soil samples from plot area were obtained by digging profiles up to 0-15 cm, 15-30 cm. Samples were air dried in shade, grinded with wooden pestle, passed through 2 mm sieve and stored in cloth bags for further laboratory analysis. Soil pH was recorded by digital pH meter, by making 1: 2.5 soil water suspensions (Jackson, 1957). Electrical conductivity was recorded with the help of conductivity meter. Organic carbon was determined by rapid titration method as given by Walkley and Black (1934). Available nitrogen was estimated with the help of the method given by Alkaline potassium permanganate method of Subbiah and Asija (1956). Available Potassium was determined with the help of Flame photometer method of Merwin and Peach (1951). Available Phosphorus was determined with the of Olsen method (1954). The data obtained were subjected to statistically analysis using RBD of experimentation as per the procedure suggested by Gome and Gomez (1984). Wherever, the effects exhibited significance at 5% level of probability, Critical difference (CD) was calculated.

3. Results and Discussion

Acritical appraisal of data (Table1) indicates that soil pH under different treatments varied between 6.76 –7.60. The soil pH increases with depth which may be attribute to lower content of organic matter and weather soil conditions at lower depths. It may also because upper horizon receives maximum leaching and rainfall and by dissolved carbonic acid and organic acid which remove metal cations and replace with the hydrogen ions whereas lower horizon is not so strongly leached. Similar results were also reported by Raina (1988); Sharma (1991); Raina and Kumar (2000). In general soil reaction was neutral which is ideal for the availability of most of the available nutrients from the soil, as well as from those applied through fertilizers. Ec in soil under different treatments varies from 0.2 – 0.34 dS/m, suggesting the low amount of soluble salts. Therefore, the soil under study were in safe limits of Ec i.e. < 0.8 dS/m. and evidence significant variation under species (Table 2). The results indicate that Ec under tree canopies increased considerably as compared to the area devoid of vegetation. Raina and Kumar (2000) and Verma (2003) have also reported average Ec value in the range of 0.370 - 3.80 dS/m in the soils of forest of Rajgarh and Solan Division. The reveals from the (table 3) that the organic carbon decrease with increase in depth which may be due to the addition of more litter fall on the surface soils. The results of the present investigation (Table 3) showed variation under treatments value ranging from 2.36-0.54%. It was improved markedly under *Bauhinia variegata*, followed by *Acacia catechu*, *Melia azedarach*, *Acer oblongum*, *Morus alba*, *Celtis australis*, *Grewiaoptiva* and control. The higher accumulation under *Bauhinia variegata* may be attributed to more production of litter and lower rate of organic matter decomposition. Conversely the lowest Organic -C accumulation under *Grewia optiva* may be ascribed to low litter production and faster rate of decomposition. Table 4 showed the significant variation under tree species from 173.97 kg/ha under control to 373.63 kg/ha under *Bauhinia variegata*. The nitrogen was noticeably higher under tree canopies compared to area devoid of vegetation, indicating maximum improvement under *Bauhinia variegata* closely followed by *Acacia catechu*, *Melia azedarach*, *Acer oblongum*, *Morus alba, Grewia optiva*, *Celtis australis,* and control. It is evident from the (Table 5) soil available P differed significantly under MPTs and demonstrated a discernible improvement under tree canopies. The available P improved remarkably under tree canopies in comparison to area devoid of vegetation which reinforces the earlier findings Aggarwal *et al.* (1993). The soil available K showed significant variation under different tree species as well as different depth of soil (Table 6). Available K found higher under all tree species in comparison with area devoid of vegetation. Dhyani *et al.* (1990) concluded that soil under *Bauhinia purpurea, Grewia optiva, Eucalyptus tereticornis, Leucaena leucocephala* contained more available K_2O in comparison to area which was without trees. The result presented in Table 7 reveals that the microbial biomass significantly differs under different tree species. Since each tree species support a specific set of rhizosphere flora, the variability in the microbial species composition may contribute to such variability. Moreover, the top soil being the natural habitat of most of the soil microbes because of better aeration, their activity would be more in that zone, which is reflected in the higher amount of nutrient in the top soil(D1). Generally, the control soils which is devoid of any vegetation showed lower microbial biomass than different MPTs and same results shown by Singh *et al.* (2003). The critical examination of the data presented in Table 7 inferred significant variations in the bulk density (BD) values for different agroforestry tree species. The bulk density values however, increased with soil depth. The increase in clay content and soil compaction with the increasing soil depth was accompanied by a decrease in organic carbon content and this may be responsible for the increasing bulk density values in the surface soils.

Treatments	Depth (cm)		Mean
	D_1(0- 15)	D_2 (15 -30)	
T_1 (*Acacia catechu*)	7.03	7.16	7.09
T_2 (*Melia azedarach*)	7.30	7.35	7.33
T_3 (*Grewia optiva*)	7.51	7.55	7.53
T_4(*Celtis australis*)	7.19	7.27	7.23
T_5 (*Acer oblongum*)	7.53	7.66	7.60
T_6 (*Bauhinia variegata*)	7.09	7.19	7.14
T_7 (*Morus alba*)	7.14	7.27	7.21
T_8 (Control)	6.67	6.85	6.76
Mean	7.18	7.29	

Table 1: Effect of different multipurpose tree species on soil pH
CD (p=0.05) T= 0.09 D=0.03 T X D=0.12

Treatments	Depth (cm)		Mean
	D_1(0- 15)	D_2 (15 -30)	
T_1(*Acacia catechu*)	0.27	0.19	0.24
T_2(*Melia azedarach*)	0.29	0.21	0.23
T_3(*Grewia optiva*)	0.23	0.21	0.22
T_4(*Celtis australis*)	0.28	0.23	0.26
T_5(*Acer oblongum*)	0.38	0.35	0.37
T_6(*Bauhinia variegata*)	0.26	0.23	0.25
T_7 (*Morus alba*)	0.35	0.32	0.34
T_8(Control)	0.21	0.20	0.20
Mean	0.28	0.25	

Table 2: Effect of different multipurpose tree species on Electrical conductivity (dS/m)
CD (p=0.05) T=0.01 D= NS T X D=0.01

Treatments	Depth (cm)		Mean
	D_1(0- 15)	D_2 (15 -30)	
T_1(*Acacia catechu*)	2.38	2.30	2.34
T_2(*Melia azedarach*)	2.18	2.02	2.10
T_3(*Grewia optiva*)	1.94	1.79	1.87
T_4(*Celtis australis*)	1.87	1.68	1.78
T_5(*Acer oblongum*)	2.05	1.88	1.97
T_6(*Bauhinia variegata*)	2.42	2.29	2.36
T_7 (*Morus alba*)	1.94	1.80	1.87
T_8(Control)	0.65	0.44	0.54
Mean	1.93	1.77	

Table 3: Effect of different multipurpose tree species on organic carbon (%)
CD (p=0.05) T=0.06 D= 0.02 T X D=0.08

Treatments	Depth (cm)		Mean
	D_1(0 – 15)	D_2(15 – 30)	
T_1(*Acacia catechu*)	373.21	355.96	364.59
T_2(*Melia azedarach*)	361.91	346.90	354.41
T_3(*Grewia optiva*)	243.80	232.16	237.98
T_4(*Celtis australis*)	219.59	212.93	216.26
T_5(*Acer oblongum*)	335.07	322.87	328.97
T_6(*Bauhinia variegata*)	390.77	356.49	373.63
T_7 (*Morus alba*)	281.38	249.96	265.67
T_8(Control)	180.33	167.60	173.97
Mean	298.26	280.61	

Table 4: Effect of different multipurpose tree species on available nitrogen (kg/ha)
CD (p=0.05) T=8.61 D= 2.64 T X D=12.17

Treatments	Depth (cm)		Mean
	D_1(0 – 15)	D_2 (15 – 30)	
T_1(*Acacia catechu*)	41.35	36.07	38.71
T_2(*Melia azedarach*)	34.98	30.10	32.54
T_3(*Grewia optiva*)	25.34	20.70	23.02
T_4(*Celtis australis*)	26.23	21.51	23.87
T_5(*Acer oblongum*)	31.64	27.09	29.37
T_6(*Bauhinia variegata*)	43.35	32.23	37.79
T_7 (*Morus alba*)	26.99	20.29	23.64
T_8(Control)	12.10	10.87	11.48
Mean	30.25	24.86	

Table 5: Effect of different multipurpose tree species on available Phosphorus (kg/ha)
CD (p=0.05) T=2.07 D= 0.63 T X D=2.92

Treatments	Depth (depth cm)		Mean
	D_1(0 – 15)	D_2(15 – 30)	
T_1 (*Acacia catechu*)	342.70	323.87	333.28
T_2 (*Melia azedarach*)	304.87	288	296.44
T_3 (*Grewia optiva*)	216.62	207.60	212.11
T_4 (*Celtis australis*)	210.78	196.77	203.78
T_5 (*Acer oblongum*)	224.03	213.42	218.73
T_6 (*Bauhinia variegata*)	353.37	343.04	348.20
T_7 (*Morus alba*)	221.69	211.33	216.51
T_8 (Control)	172.87	166.14	169.51
Mean	255.87	243.77	

Table 6: Effect of different multipurpose tree species on available Potassium (kg/ha)
CD (p=0.05) T=3.11 D= 0.95 T X D=4.40

Treatments	Depth (cm)		Mean
	D_1 (0 – 15)	D_2 (15 – 30)	
T_1 (*Acacia catechu*)	1.10	1.13	1.11
T_2 (*Melia azedarach*)	1.07	1.20	1.13
T_3 (*Grewia optiva*)	1.09	1.19	1.14
T_4 (*Celtis australis*)	1.09	1.17	1.13
T_5 (*Acer oblongum*)	1.04	1.12	1.08
T_6 (*Bauhinia variegata*)	1.06	1.16	1.11
T_7 (*Morus alba*)	1.07	1.19	1.13
T_8 (Control)	1.17	1.30	1.24
Mean	1.07	1.16	

Table 7: Effect of different multipurpose tree species on Bulk density (g cm^{-3})
CD (p=0.05) T=0.06 D= 0.02 T X D=0.09

4. Conclusion

MPTs have potential to ameliorate the soil chemical properties viz soil pH, organic carbon, available N, P, K in comparison to open condition. The high and improved amount of available nutrients (N, P K) and organic carbon and microbial biomass found at surface (0 – 15cm) layer which further decrease with the increase of soil depth.

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