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Evaluation of different soil parameters under poplar based agroforestry system

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Abstract
The field experiment was carried out in Agroforestry Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand during the *rabi* season for two years 2014-16. Soil properties such as soil pH, soil EC, soil organic carbon, available soil nitrogen, available soil potassium, available soil phosphorus were tested under poplar- wheat agroforestry system in randomized block design with three replications during both the years 2014-15 and 15-16.

Introduction
Agroforestry systems are generally considered to be sustainable and to improve soil properties. Growing trees in conjunction with annual crops or pastures is believed to offer a more intensive plant cover to protect the soil from erosion and a deeper or more prolific root system to improve nutrient cycling. Appropriate agroforestry systems improve soil physical properties, maintain soil organic matter, and promote nutrient cycling. The presence of trees in a crop field impacts soil structure via two fundamental phenomena. Firstly, the trees bring organic matter to the soil (litter fall, twigs, roots turnover and pruning by products) ; important increases have been observed in alley cropping systems planted with red alders (Seiter *et al*., 1999) [12]. Secondly, the trees develop important root systems that explore and improve notably deep and compacted soil layers that crop roots do not reach (Schroth, 1999) [11]. These two phenomena have seven major effects on soil structure. Also, deep roots of the trees can capture nutrients and minerals from the rock and the subsoil; pump it to the canopy so that it is an input in the nutrient cycle (Chander *et al*., 1998) [2]. Secondly, trees can be active drivers in the nutrient recycling processes. The presence of tree roots in the soil can be very beneficial for fertility and nutrient cycling.

Materials and Methods
The study was carried out in Agroforestry Research Centre (old site) near Horticulture Research Centre, Patharchatta of G.B. Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand during the *rabi* season for two years 2014-16 to Study the evaluation of different Soil parameters under Poplar based agroforestry system with five treatments (wheat varieties) i.e.; T1: PBW -343 (Timely Sown, Irrigated), T2: UP -2565 (Timely Sown, Irrigated), T3: WH - 711 (Timely Sown, Irrigated), T4: DBW -17 (Timely Sown, Irrigated) and T5: VL -907 (Timely Sown, Irrigated) were tested in randomized block design with three replications (under poplar plantation and in open field) with spacing 7m × 3m, date of wheat sowing 22. 11. 2014 and 21.11.2015 whereas, poplar planting was done in 2012.

Result and Discussion
Soil pH was observed lower under poplar based agroforestry system as compared to open farming system. Reduction in soil pH observed in 2015-16 as compared to 2014-15. Among different wheat varieties WH-711 had maximum pH at 0-15 cm and UP-2565 at 15-30 cm soil depth under poplar based agroforestry system and the difference was non-significant. Similar observations was reported by Sharma *et al.,* (2015) [15] in soils under poplar based agroforestry system. The soil EC was higher in agroforestry system as compared to open farming system during both the years.

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Similar observations were also reported by (Malik *et al.*, 1996; Sharma and Dadhwal, 2011; Sharma *et al.*, 2015) [7, 15, 13]. Higher soil organic carbon (%) during 2014-15 and 15-16 was observed under poplar based agroforestry system as compared to open farming system. Wheat variety PBW-343 had maximum soil organic carbon% at 0-15 cm and 15-30 cm soil depth among different wheat varieties studied under poplar based agroforestry system. Similar observations were reported by Young (1997) [17], Pandey *et al.*, (2000) [9]; Singh and Sharma (2007) [16]; Gupta *et al.*, (2009) [5] and Benbi *et al.*, (2012) [1] in different agroforestry systems. Maximum available soil nitrogen as observed in poplar based agroforestry system than open farming system. At 0-15 cm and 15-30 cm soil depth wheat variety VL-907 had maximum available soil nitrogen among different wheat varieties under poplar based agroforestry system. Similar observations were

also reported by Mohsin *et al.*, (1996) [8], Sharma and Dadhwal, (2011) in poplar – wheat agroforestry system. At 0-15 cm and 15-30 cm soil depth, more available soil phosphorus was found in poplar based agroforestry system than open farming system. Among different wheat varieties, VL-907 had maximum available soil phosphorus. Similar findings were also reported by (Sharma and Dadhwal, 2011 and Chauhan *et al.*, 2012) [13, 3]. Available soil potassium was more in poplar based agroforestry system than open farming system during 2014-15 and 15-16. At 0-15 cm and 15-30 cm soil depth wheat variety VL-907 had significantly higher available soil potassium. Similar findings were also observed by (Mohsin *et al.*, 1996; Sharma *et al.*, 2001; Lodhiyal *et al.*, 2002; Erika *et al.*, 2009; Rizvi *et al.*, 2011; Sharma and Dadhwal, 2011) [8, 14, 6, 4, 10, 13].

Table 1: Soil pH among different wheat varieties under poplar based agroforestry system at 0-15 and 15- 30 cm profile depths

Treatments	pH							
	0-15 cm				15-30 (cm)			
	2014-15	% Reduction	2015-16	% Reduction	2014-15	% Reduction	2015-16	% Reduction
PBW-343	7.46 (7.56)*	1.32	7.38 (7.57)*	2.50	7.56 (7.63)*	0.91	7.57 (7.62)*	0.65
UP-2565	7.39 (7.54)	1.98	7.36 (7.53)	2.25	7.57 (7.62)	0.65	7.58 (7.61)	0.39
WH-711	7.47 (7.51)	0.53	7.47 (7.59)	1.58	7.53 (7.60)	0.92	7.56 (7.62)	0.78
DBW-17	7.45 (7.52)	0.93	7.43 (7.58)	1.97	7.55 (7.60)	0.65	7.58 (7.64)	0.78
VL-907	7.41 (7.51)	1.33	7.38 (7.56)	2.38	7.49 (7.61)	1.57	7.53 (7.60)	0.92
SEm±	0.05		0.07		0.03		0.03	
CD at 5%	NS		NS		NS		NS	
CV	1.39		1.63		0.70		0.79	

*Figures in parentheses are respective values for control (open)

Table 2: Soil EC (dSm^{-1}) among different wheat varieties under poplar based agroforestry system at 0-15 and 15-30 cm profile depths

Treatments	EC (dSm^{-1})							
	0-15 cm				15-30 cm			
	2014-15	% Increment	2015-16	% Increment	2014-15	% Increment	2015-16	% Increment
PBW-343	0.59 (0.55) *	7.27	0.57 (0.54) *	5.55	0.63 (0.6) *	5.0	0.61 (0.59) *	3.38
UP-2565	0.60 (0.57)	9.52	0.58 (0.56)	3.57	0.66 (0.63)	4.76	0.65 (0.63)	3.17
WH-711	0.58 (0.56)	3.57	0.55 (0.52)	5.76	0.62 (0.61)	1.63	0.60 (0.59)	1.69
DBW-17	0.60 (0.57)	5.26	0.57 (0.55)	3.63	0.63 (0.59)	6.77	0.63 (0.60)	5.0
VL-907	0.57 (0.54)	5.55	0.56 (0.54)	3.70	0.59 (0.57)	3.50	0.60 (0.58)	3.44
SEm±	0.01		0.0089		0.0079		0.0095	
CD at 5%	NS		NS		0.025		0.031	
CV	3.07		2.71		2.19		2.66	
*Figures in parentheses are respective			values for control (open)					

Table 3: Soil organic carbon (%) among different wheat varieties under poplar based agroforestry system at 0 - 15 and 15 - 30 cm profile depths

Treatments	Organic carbon (%)							
	0-15 cm				15-30 cm			
	2014-15	% I	2015-16	% I	2014-15	% I	2015-16	% I
PBW-343	1.09 (1.06) *	2.83	1.07 (1.04) *	2.88	0.87 (0.83) *	4.81	0.89 (0.86) *	3.48
UP-2565	1.04 (1.01)	2.97	1.05 (1.02)	2.94	0.84 (0.80)	5.0	0.86 (0.83)	3.61
WH-711	1.04 (0.99)	5.05	1.05 (1.00)	5.0	0.81 (0.79)	2.53	0.84 (0.82)	2.43
DBW-17	1.02 (0.98)	4.08	1.04 (1.00)	4.0	0.78 (0.75)	4.0	0.81 (0.79)	2.53
VL-907	1.08 (1.03)	4.62	1.06 (1.04)	1.92	0.85 (0.81)	1.23	0.87 (0.82)	5.74
SEm±	0.013		0.011		0.011		0.005	
CD at 5%	0.043		NS		0.037		0.018	
CV	2.18		1.91		2.38		1.12	

*Figures in parentheses are respective values for control (open), I = Increment

Table 4: Available soil nitrogen kg ha^{-1} among different wheat varieties under poplar based agroforestry system at 0 -15 and 15 -30 cm profile depths

Treatments	Available soil nitrogen (kg ha^{-1})							
	0-15 cm				15-30 cm			
	2014-15	% I	2015-16	% I	2014-15	% I	2015-16	% I
PBW-343	227.38 (224.25) *	1.39	225.03 (222.02) *	1.35	211.25 (207.91) *	1.60	209.58 (205.61) *	1.93
UP-2565	224.55 (220.55)	1.81	225.25 (220.55)	2.13	208.45 (206.10)	1.14	207.59 (204.62)	1.45
WH-711	220.42 (219.64)	0.35	221.28 (217.97)	1.51	207.17 (205.02)	1.04	206.83 (201.02)	2.89

DBW-17	218.69 (216.12)	1.18	220.75 (216.83)	1.80	204.35 (203.74)	2.99	202.22 (200.62)	0.79
VL-907	229.69 (227.60)	0.91	226.31 (223.27)	1.36	213.97 (209.27)	2.24	210.17 (207.88)	1.10
SEm±	1.93		1.533		4.49		3.23	
CD at 5%	6.31		NS		NS		NS	
CV	1.49		1.18		3.72		2.706	

*Figures in parentheses are respective values for control (open), I= Increment

Table 5: Available soil phosphorus kg ha^{-1} among different wheat varieties under poplar based agroforestry system at 0 -15 and 15 – 30 cm profile depths

Treatments	Available soil phosphorus (kg ha^{-1})							
	0-15 cm				15-30 cm			
	2014-15	% I	2015-16	% I	2014-15	% I	2015-16	% I
PBW-343	20.82 (20.69)*	0.62	19.06 (18.36)*	3.81	16.85 (15.96)*	5.57	16.36 (15.56)*	5.14
UP-2565	20.65 (20.2)	2.22	18.86 (18.2)	3.62	16.81 (15.85)	6.05	16.30 (15.5)	5.16
WH-711	19.95 (18.53)	7.66	18.83 (18.06)	4.26	16.71 (15.6)	7.11	15.53 (15.06)	3.12
DBW-17	19.57 (18.2)	7.52	18.43 (17.93)	2.78	16.69 (15.43)	8.16	15.70 (15.3)	2.61
VL-907	20.87 (21.09)	1.04	19.66 (18.86)	4.24	16.91 (16.03)	5.48	16.56 (15.73)	5.27
SEm±	0.48		0.23		0.21		0.37	
CD at 5%	NS		NS		NS		NS	
CV	4.13		2.17		2.17		4.08	

*Figures in parentheses are respective values for control (open), I = Increment

Table 6: Available soil potassium kg ha^{-1} under open farming and poplar based agroforestry systems at 0 -15 and 15 -30 cm profile depths

Treatments	Available soil potassium kg ha^{-1}							
	0-15 cm				15-30 cm			
	2014-15	% I	2015-16	% I	2014-15	% I	2015-16	% I
PBW-343	229.15 (210.22)*	9.03	224.16 (204.69)*	9.51	205.65 (180.65)*	13.83	195.55 (174.74)*	11.90
UP-2565	226.97 (208.65)	8.78	220.56 (202.66)	8.83	203.85 (179.45)	13.48	194.18 (173.04)	11.81
WH-711	220.19 (205.89)	6.94	217.39 (201.76)	7.87	202.41 (174.98)	15.67	192.22 (172.73)	11.28
DBW-17	219.53 (204.46)	7.37	215.64 (199.62)	8.02	201.54 (175.13)	15.0	191.70 (170.65)	12.33
VL-907	235.26 (213.32)	10.28	227.89 (208.42)	9.34	207.19 (183.98)	12.61	197.74 (177.20)	11.59
SEm±	1.690		1.345		1.065		1.031	
CD at 5%	5.50		4.345		3.471		3.3620	
CV	1.294		1.053		0.937		0.919	

*Figures in parentheses are respective values for control (open), I = Increment

Conclusion
Different soil parameters such as soil EC, organic carbon, available soil nitrogen, phosphorus and potassium was higher while pH was lower under poplar based agroforestry system as compared to open farming system. All the soil nutrients (N, P and K) were found maximum in the wheat variety VL-907. At 0-15 cm soil depth the values of nutrients (N, P and K) were higher as compared to 15-30 cm soil depth.

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