EFFECT OF POPLAR TREE INTERCROPPING AT VARIOUS DENSITIES ON THE POST HARVEST SOIL NUTRIENT CONTENTS

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An agroforestry system comprising of Poplar (*Populus deltoides* clone AY-48) and wheat, fodder maize crops was designed, to compare the effect of agroforestry system and conventional agricultural system on soil. Poplar (*Populus deltoides* clone AY-48) was planted at a density of 455trees/ha, 305trees/ha, and 230trees/ha at the spacing of 3.66 x 6.10m (D1), 3.66 x 9.10m (D2) and 3.66 x 12.10m (D3) respectively. Agricultural crops namely, wheat (*Triticum aestivum*) variety Inqalab-91 and fodder maize *(Zea mays*) variety Neelum were sown alternately during "Rabi" and "Kharif" seasons each year throughout the entire study periods in poplar plots. To compare the differences among sole crop and intercropping the wheat and fodder-maize were also sown in separate plots (Dw/f). Significantly highest 0.65% total mean value of organic matter was observed in the treatment D2 while lowest quantity of organic matter (0.46%) was observed in sole wheat, fodder maize treatment (Dw). Nitrogen fertility increased (6.6%) in intercropping treatments during the year 2000-2001 compared to 1999-2000 while it decreased 0.45% slightly in sole wheat, fodder maize treatments (Dw). Mean post wheat harvest phosphorus content of soil in sole wheat, fodder maize treatment (Dw) was 10.97ppm while it ranged from 13.20ppm to 13.47ppm in intercropping treatments. Potassium fertility increased from 1.8ppm to 2.7ppm in intercropping treatments during the year 2000-2001 compared to 1999-2000 while it decreased in sole wheat, fodder maize treatment to 0.9ppm.

Keywords: Poplar, intercropping, wheat, nutrient, fertility

INTRODUCTION

Soils of Pakistan are characteristically low in fertility and especially deficient in organic matter due to low rainfall and high temperature. On average soils of country contain less than 0.1% organic matter (Mian, 1992)

In conventional agricultural cultivation, which involves only growing of crops, result only in depletion of organic matter and other nutrients from soil.

Continuous growing of exhaustive crops, on a long run, can convert fertile land into desert. While on the other hand agroforestry system not only provides economic benefit but also improve the soil fertility (Mohsin *et al.* 1996). Pakistan has a long tradition of agroforestry. Farmers and landowners in different part of country integrate a variety of wood perennials in their crop and livestock production fields depending upon the agro climatic conditions and local needs. Pandey *et al.* (2000) observed that soil organic C, total N, total P, and mineral N (NO_3^- -N and NH_4^+-N) and P were greater under mid canopy edge positions compared to canopy gaps in *Acacia nilotica* under agroforestry system. Soil water infiltration was 5 times greater under multispecies riparian buffer vegetation than under cultivated fields and pastures. The established multispecies buffer seemed to improve soil quality after 6 years. (Bharati *et al*., 2002).

According to Hussain *et al.* (1999) almost all agroforestry system are being practiced in the province of Punjab. But most common system being practiced was "agrisilvicultural". Various efforts have recently been made at Govt. level to boost up the wood production and presently farm forestry is, therefore, being emphasized as pragmatic alternative. For this purpose the indigenous slow growing species are being replaced by some fast growing exotic species. Poplar *(Populus deltoides*) is one of the most popular amongst the species introduced recently. There are reports that poplar (*P. deltoides*) trees grow better under agroforestry conditions. (Singh *et al.*, 1998; Chaturvedi, 1992).

In forestry or agroforestry systems, litter is one of the important pathways for nutrients to the soil. Amongst exotic species, poplar (*Populus deltoides*) is winter deciduous tree species, which produces maximum litter in a single flush (Lodhiyal *et al*., 2002). Similarly soil working for arable crop cultivation breaks down

fine roots network that also adds to soil fertility (MeClaugherty *et al*., 1982). Poplar being shallow rooted contributes more root biomass to soil (Mohsin *et al.*, 2000). Therefore, litter fall and fine roots are major components for maintaining the soil fertility in agroforestry systems. In the case of poplar (*P. deltoids)* considerable amount of nutrients was recycled to the soil through leaf fall. The return of nutrients through leaf litter into the soil decreased in the order of Ca>Mg>K>P (Sharma *et al.* 2000).
The purpose of this study was to evaluate the organic matter and other nutrient contents under agroforestry system with the intercropping of wheat, fodder maize in the poplar. Hence an attempt has been made to determine the effect of intercropping on soil conditions.

MATERIALS AND METHODS

This study was conducted at the research garden, Punjab Forestry Research Institutes, Faisalabad. The site is well-drained, alluvial and fine loamy soil. It is located in aridic moisture regime with 300mm precipitation having longitude 73.11˚E, Latitude 31.28˚N and elevation 183m from sea level.
Poplar (*Populus deltoides* clone AY-48) was planted at a density of 455trees/ha, 305 trees/ha, and 230 trees/ha at the spacing of 3.66 x 6.10m (D1), 3.66 x 9.10m (D2) and 3.66 x 12.10m (D3) respectively, by digging 75cm deep and 30cm wide pits during first week of February, 1994. The soil was prepared by using mechanical means before planting of poplar. It was ploughed 4-5 times with tractor-mounted cultivator, followed by planking and leveling. Planting was done by using one year old, bare rooted entire nursery plants of uniform size. Good compaction and ramming of the plants was done after planting. First irrigation with canal water was given immediately after planting. After 24 hours of irrigation the leaning and wind fallen plants were straightened by adding and compacting more soil. Average height and diameter of plants was 4.5m and 5cm respectively at the time of planting. There were four rows of poplar under each treatment. The orientation of rows was south-east to north-west. The study was replicated three times.
Agricultural crops namely, wheat (*Triticum aestivum*) variety Inqalab-91 and fodder maize (*Zea mays*) variety Neelum were sown alternately during “Rabi” and “Kharif” seasons each year throughout the entire study periods in poplar plots. To compare the differences among sole crop and intercropping the wheat and fodder-maize were also sown in separate plots (Dw/f). Wheat was sown during third week of November through board cast method using 125kg seed per hectare each year. Fertilizers (Urea, Di-ammonium phosphate (DAP) and Sulphate of potash (SOP) were applied at the rate of 125kg/ha. DAP and SOP were applied at the time sowing while urea was applied at the time of first and third irrigation in equal doses. Similarly fodder maize was sown during third week of July through broadcast method using 100kg seed per hectare. Fertilizer (Urea) was applied at the rate of 125kg/ha at the time of first and fourth irrigation. Soil Sampling was done for each treatment after the harvest of wheat crop from study area during the years 1999-2000 and 2000-2001 from the depths of 0-15cm, 16-30cm, 31-60cm, 61-90cm and 91-120cm. Soil was chemically tested to determine the chemical characteristic by using the standard methods according U.S salinity laboratory staff (Richard, 1954). In soil, organic matter, total nitrogen, available phosphorus, and extractable potassium were determined.

RESULTS AND DISCUSSION

Organic matter

Data regarding post wheat harvest organic content of soil from different intercropping treatment plots are shown in Table 1. Significantly higher values of OM 0.96% and 0.98% was observed in surface soil from 0-15cm depth during the year 1999-2000 and 2000-2001 respectively. The organic matter content decreased with an increase in soil depth during both the year in all treatments. The least value of 0.24% and 0.23% was observed in soil from the deepest horizon (91-120 cm) during both the years. As for as treatments are concerned, significant differences were observed in the organic matter content among various treatments. Significantly highest 0.65% total mean value of organic matter was observed in the treatment D2. Significantly low quantity of organic matter (0.46%) was observed in sole wheat, fodder maize treatment (Dw). An increase in organic matter (about 5%) except control (Dw) treatment was observed in poplar tree intercropping treatment during the year 2000-2001 compared to the year 1999-2000. High organic matter content in the intercropping treatment could be ascribed to the fact that foliage of trees fell on the soil and more root density in the soil upon decomposition adds to the organic

matter of soil. These results are in lined with Mohsin *et al.* (1996), Osman *et al*. (2001), Singh *et al*. (1989) and Singh *et al.* (1997).

Nitrogen content

Data regarding post wheat harvest nitrogen content of soil from different intercropping treatment plots are shown in Table 2. The results indicated overall post wheat harvest nitrogen content of soil in Dw treatment was significantly lower compared with intercropping treatments while these treatment were not significantly different from each other. Nitrogen fertility increased (6.6%) in intercropping treatments during the year 2000-2001 compared to 1999-2000 while it decreased 0.45% slightly in sole wheat, fodder maize treatments (Dw). This increase in N content of soil under poplar tree intercropping systems is attributed to addition of organic matter in soil in the form of leaf fall and tree root density. Sahu *et al.* 1996, Osman *et al.* (2001), Singh *et al*. (1989) and Singh *et al.* (1997) reported similar results.

Table 1. Post harvest organic matter content of soil (%) as influenced by intercropping system at various poplar tree densities

Poplar tree density	Years												Total mean
	1999-2000 (Soil sampling depths (cm))						2000-2001(Soil sampling depths (cm))						
	0-15	16-30	31-60	61-90	91-120	Mean	0-15	16-30	31-60	61-90	91-120	Mean	
D1	0.96a	0.94a	0.47d	0.43ab	0.27bc	0.61b	0.98a	0.95a	0.50a	0.45a	0.30b	0.64b	0.62b
D2	0.93a	0.91a	0.52a	0.49a	0.34ab	0.64a	0.95ab	0.93b	0.50a	0.48a	0.48a	0.67a	0.65a
D3	0.91a	0.91a	0.48c	0.42b	0.39a	0.62ab	0.91b	0.90c	0.50a	0.43a	0.48a	0.64b	0.63b
Dw/f	0.64b	0.63b	0.51b	0.31c	0.24c	0.47c	0.63c	0.62d	0.49a	0.31b	0.23c	0.46c	0.46c
Mean	0.86a	0.85a	0.50b	0.41c	0.31d		0.87a	0.85a	0.50b	0.42c	0.37d		
Year's mean	0.58b						0.60a						

*Means following different letters are significant at 0.050 P

Table 2. Post harvest nitrogen content of soil (%) as influenced by intercropping system at various poplar tree densities

Poplar tree density	Years												Total mean
	1999-2000 (Soil sampling depths (cm))						2000-2001(Soil sampling depths (cm))						
	0-15	16-30	31-60	61-90	91-120	Mean	0-15	16-30	31-60	61-90	91-120	Mean	
D1	0.045a	0.044a	0.022a	0.020a	0.013a	0.029ab	0.046a	0.045a	0.027a	0.019a	0.017a	0.031a	0.030a
D2	0.045a	0.043a	0.024a	0.023a	0.016a	0.030a	0.045a	0.044a	0.026a	0.023a	0.023a	0.032a	0.031a
D3	0.043a	0.048a	0.025a	0.022a	0.016a	0.030a	0.043a	0.042a	0.028a	0.025a	0.022a	0.032a	0.031a
Dw/f	0.030b	0.030b	0.024a	0.015a	0.011a	0.022b	0.030b	0.030b	0.020a	0.015a	0.011a	0.021b	0.022b
Mean	0.041a	0.041a	0.024b	0.020bc	0.014c		0.041a	0.040a	0.025b	0.021b	0.018b		
Year's mean	0.028 b						0.029 a						

*Means following different letters are significant at 0.050 P

Phosphorus content

As reflected from Table 3, mean post wheat harvest phosphorus content of soil in sole wheat, fodder maize treatment (Dw) was 10.97ppm while it ranged from 13.20ppm to 13.47ppm in intercropping treatments. Phosphorus fertility increased from 0.75% to 1.5% in intercropping treatments during the year 2000-2001 compared to 1999-2000, while increase in sole wheat, fodder maize treatment was only 0.35%. This increase in phosphorus content of soil under poplar tree intercropping system is attributed to addition of organic matter in soil in the form of leaf fall and tree root density. The results are in agreement with Mohsin *et al.* (1996), Osman *et al.* (2001), Singh *et al*. (1989) and Singh *et al.* (1997).

Potassium content

Table 3. Post harvest Phosphorous content of soil (ppm) as influenced by intercropping system at various poplar tree densities

Poplar tree density	Years												Total mean
	1999-2000 (Soil sampling depths (cm))						2000-2001(Soil sampling depths (cm))						
	0-15	16-30	31-60	61-90	91-120	Mean	0-15	16-30	31-60	61-90	91-120	Mean	
D1	13.67a	11.67b	14.00a	13.33ab	12.67a	13.00b	13.67ab	12.33b	14.67a	13.33b	13.00b	13.40a	13.20b
D2	12.33b	14.00a	13.00b	14.33a	13.00a	13.33a	12.67 b	14.33a	13.00b	14.33a	13.33b	13.53a	13.43ab
D3	14.00a	13.33a	13.67a	12.33bc	13.33a	13.33a	14.00 a	13.67a	14.00a	12.33c	14.00a	13.60a	13.47a
Dw/f	10.67a	10.33a	10.00a	12.00a	11.67b	10.33a	10.33a	10.33a	10.33a	10.33a	11.00b	10.67a	

mean	12.65 b	12.88 a

Table 4. Post harvest Potassium content of soil (ppm) as influenced by intercropping system at various poplar tree densities

Poplar tree density	Years												Total mean
	1999-2000 (Soil sampling depths (cm))						2000-2001(Soil sampling depths (cm))						
	0-15	16-30	31-60	61-90	91-120	Mean	0-15	16-30	31-60	61-90	91-120	Mean	
D1	249a	243a	233a	186b	176b	217.4a	257a	251a	240	189b	177b	222.8a	220.1a
D2	234b	231b	221c	181c	171c	207.6b	242b	238b	228b	186bc	171c	213.0b	210.3b
D3	230b	227b	227b	181c	174bc	207.9b	238b	234b	230b	181c	175bc	211.6b	209.7b
Dw/f	168c	162c	186d	213a	210a	187.8c	165c	159c	183c	213a	210a	186.0c	186.9c
Mean	220.3a	215.7b	216.7b	190.2c	182.7d		225.5a	220.5b	220.3b	192.3c	183.3d		
Year's mean	205.2 b						208.3 a						

As described from Table 4, post harvest potassium content of soil, where poplar trees were intercropped with wheat-fodder maize crop (D1) was higher as compared to other treatments. Potassium fertility increased from 1.8ppm to 2.7ppm in intercropping treatments during the year 2000-2001 compared to 1999-2000 while it decreased in sole wheat, fodder maize treatment to 0.9ppm. The potassium content of soil under poplar treatments was higher (22.8-33.2ppm) from sole wheat, fodder maize treatment due to addition of organic matter in the soil in the form of leaf fall and tree root density. The results are in agreement with Mohsin *et al.* (1996), Osman *et al.* (2001), Singh *et al*. (1989) and Singh *et al.* (1997).

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