

Evaluation of Poplar (*Populus Deltoides*) Boundary Plantation Based Agri-silvicultural System for Soil Chemical Properties

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ABSTRACT: The present investigation was carried out during rabi season of 2013-2014 on an established boundary plantation of *Populus deltoides* in east-west row direction in the research farm of Department of Forestry, CCS Haryana Agricultural University, Hisar to evaluate soil organic carbon and macro-nutrients in different aspects at different distances from tree line of poplar boundary plantation based agri-silviculture system at two stages of wheat growing season i.e. before sowing of wheat in October and after harvest of wheat in April and in control or sole crop. In both the aspects and at various distances from tree base, availability of macro-nutrients (N, P and K) and organic carbon were determined. The soil samples were also analyzed under control field or sole crop. Under this study, the organic carbon (0.56%) and N (220.3 kg ha⁻¹), P (15.3 kg ha⁻¹) and K (226.4 kg ha⁻¹) contents were recorded maximum under southern aspect at 2 m distance from tree line of poplar after the harvesting of wheat crop as compared to northern aspect, various distances and sole crop. The organic carbon and macro-nutrients tended to increase in the soil in different aspects and different distances has also been reflected in the leaf shedding pattern.

Keywords: Agri-silviculture system, crop growing season, macro-nutrients, organic matter, *Populus deltoides* and southern aspect.

INTRODUCTION

Trees under agroforestry besides providing the tree products, improves soil productivity through ecological and physico-chemical changes. *Populus deltoides* based agroforestry system is one of the viable alternate land use system to prevent further degradation and obtain biological production on sustainable basis (Pandey, 2007). Owing to its fast growth, deciduous nature, marketing acceptability and successful intercropping, this species has been grown by farmers in Punjab, Haryana and Uttar Pradesh, as farm boundary or block plantation along with agricultural crops which improves the physico-chemical properties of soil through addition of organic matter in the soil (Colman *et al.*, 2004) and provides alternate sources of income and employment to the rural poor (Puri and Nair, 2004; Singh and Sharma, 2007). Trees in association with agricultural crops increase the soil carbon status, though the changes depend upon the quality and quantity of litter produced by trees species, age and density of trees (Singh *et al.*, 2007). Rate of decomposition of litter is

directly related to the moisture availability, temperature, soil micro-organisms and physico-chemical properties of soil. Tree species have variable impact on soil organic carbon, nutrient status and other soil properties (Patel and Singh, 2000). Tree plantations improve soil physical, chemical and biological properties through accretion and decomposition of organic matter through litter-fall and roots. Deep and extensive root systems of trees enable them to absorb substantial quantities of nutrients below the rooting zone of crops and transfer them to surface soil. Mugendi and Nair (1997) have been reported that the decomposition and release of nutrients from organic matter is a function of biomass quality, soil conditions and climate. Poplar trees are characterized by higher rates of nutrient accumulation in soils through litter fall as compared to other deciduous tree species. Poplars are efficient in the cycling of nutrients and a large portion of nutrients utilized for annual growth are periodically involved in cycling. The leaf fall contribute to the addition of organic matter as well as nutrients to soil. Therefore,

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the present study was an attempt to determine the effect of *Populus deltoides* on soil chemical properties through poplar based agri-silviculture system.

MATERIALS AND METHODS

Study Sites and Climate

A field experiment was conducted during 2013-2014 in the research farm of Department of Forestry, CCS Haryana Agricultural University, Hisar at 29° 10' N latitude and 75° 40' E longitude. The climate of site is semi-arid and mainly characterized by a very hot summer, a short rainy season and a cold winter.

Soil Sampling

To study the effect of boundary plantation of poplar based agri-silviculture system on soil organic carbon and available nutrients, an experiment was conducted where poplar were planted as a windbreak in East-West row direction during 2007. The wheat crop was raised with the recommended cultural practices under poplar plantation during 2013-2014. In the adjoining field also with the same crop wheat was taken as control. The soil samples were collected from all the aspects (northern aspect and southern aspect) of East-West row direction at variable distances (2, 4, 6, 8 and 10 m) from the tree lines at 0-15 cm depths at two stages *i.e.* before sowing of wheat crop in October 2013 and after harvest of wheat in April 2014 and also from control field.

RESULT AND DISCUSSION

Soil organic carbon and other chemical properties:

A decreasing trend in soil organic carbon were observed with the increasing distance from tree row in both the aspects of East -West row direction and plots without poplar trees. It was low in the control plot compared to the spots near the tree line (Fig. 1 & 2.). The differences in organic carbon were observed with directional aspects also. Before sowing of wheat crop, the organic carbon (0.46%) was higher in southern aspect at 2 m distance from tree line than the northern aspect, however the control plots had minimum organic carbon. The increase organic build-up in the top layer near the tree lines was due to the addition of litter, pruning material and tree roots. Similar observations were reported earlier also (Singh and Sharma, 2007; Peichl *et al.*, 2006; Singh, 2005). Available N, P and K contents were also significantly higher in the southern aspect at 2 m distance from tree line as compared to northern aspect before sowing of wheat crop and the trend of decrease in

average contents of N, P and K with the increasing distance from tree base (Fig. 1). Addition of leaf litter in row direction and distances from the boundary plantation revealed significantly different values on both the aspects and distances.

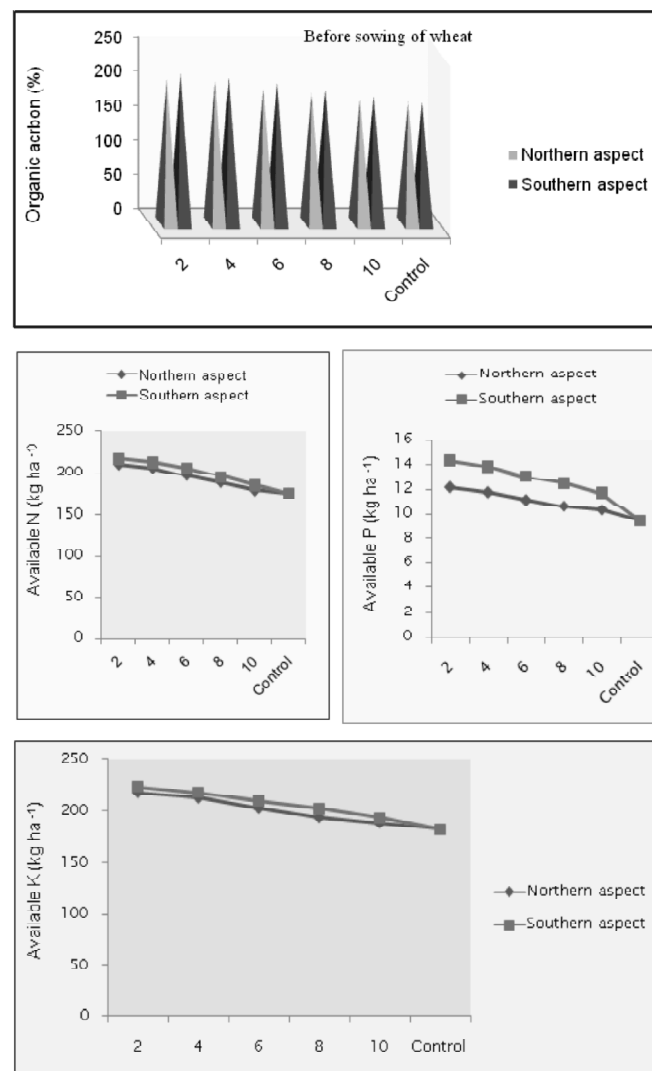


Figure 1: Soil nutrient status in two aspects (northern and southern) and control in poplar boundary plantation at various distances from tree rows (2, 4, 6, 8 & 10 m) before sowing of wheat crop

In poplar based agri-silviculture system, the average contents of organic carbon (0.56%) and N (220.3 kg ha^{-1}), P (15.3 kg ha^{-1}) and K (226.4 kg ha^{-1}) were also significantly higher in southern aspect at 2 m distance from tree line (Fig. 2). The higher organic carbon and nutrient status in southern aspect might be due the addition of large quantity of leaf litter. The higher decomposition of leaf litter favors the higher nutrient status of the soil. Similar findings were also observed by Singh and Sharma (2007).

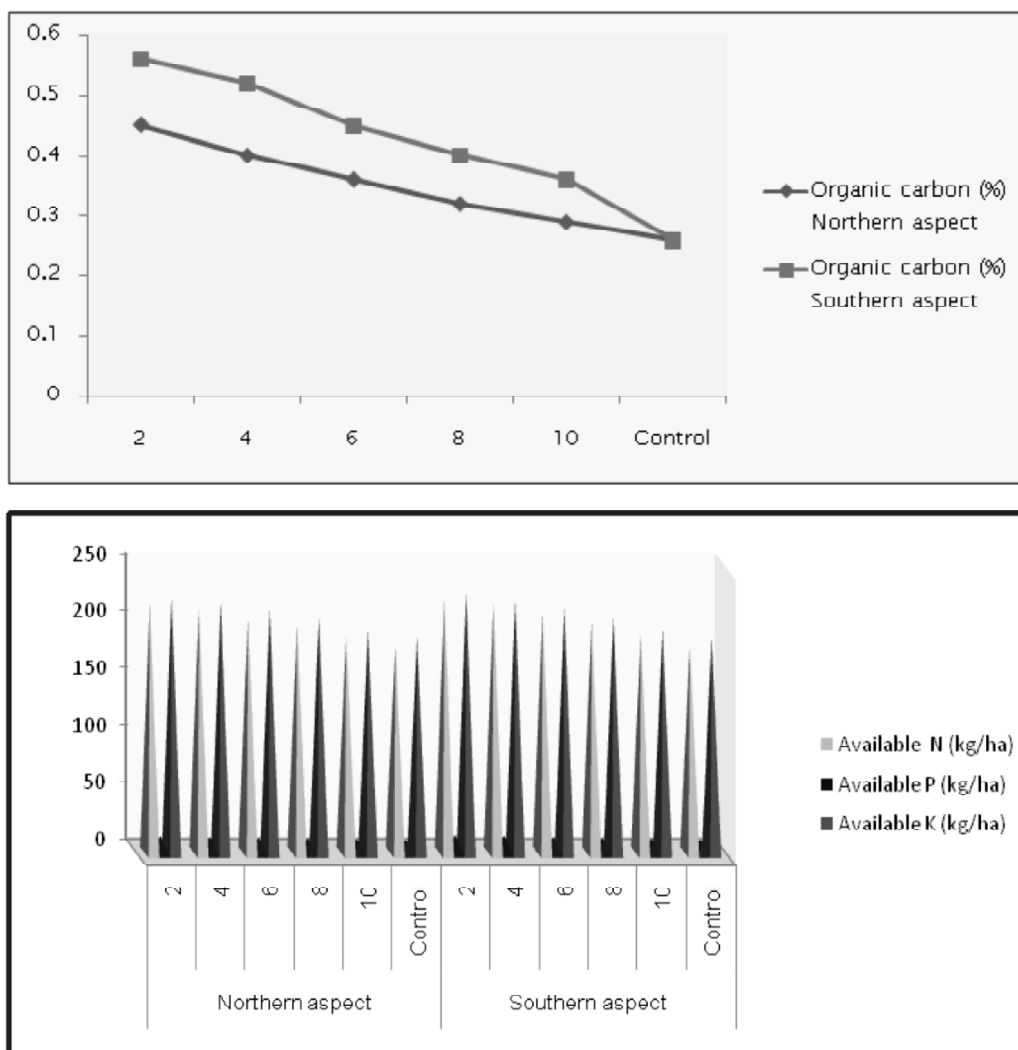


Figure 2: Soil nutrient status in two aspects (northern and southern) and control in poplar boundary plantation at various distances from tree rows (2, 4, 6, 8 & 10 m) after harvest of wheat crop

The average contents of organic carbon and N, P and K in poplar boundary plantation were higher at 2 m distance from tree line in southern aspect after the harvesting of wheat as compared to before sowing of wheat (Fig. 1 & 2). The higher nutrient content in southern aspect near the tree base than the northern aspect might be due to the nutrient cycling and surface enrichment through biomass. Thus, despite the higher addition of litter-fall near the tree base in southern aspect of poplar plantation and the increase in available nutrients were also sufficiently higher in southern aspect at the distance of 2 m from tree base after the harvesting of wheat.

CONCLUSION

The above results revealed that the organic carbon and available N, P and K contents of soil improved

through poplar based agri-silviculture system. Under row direction of poplar, soil fertility found to be improved in southern aspect by the addition of leaf litter in a large quantity. Thus, poplar boundary plantation can sustain the soil health by improving the soil organic carbon and macro-nutrients.

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