I J T A
© Serials Publications
National Academy of Agricultural Science (NAAS) Rating : 3.03

Nutrient Status of Soil Under Different Spacings of Poplar (*Populus Deltoides*) Based Agroforestry System in Semi-arid Region of Haryana

Chhavi Sirohi* and K. S. Bangarwa

ABSTRACT: *A field experiment was conducted during rabi season of 2013-2014 on plantation of Populus deltoides established in the research farm of Department of Forestry, CCS Haryana Agricultural University, Hisar to evaluate the nutrient status under different spacings of poplar based agroforestry system at two stages of wheat growing season i.e. before sowing of wheat in October and after harvest of wheat in April. Availability of macro-nutrients (N, P and K) and organic carbon was determined under 5 m × 4 m, 10 m × 2 m and 18 m × (2 m × 2 m paired row) spacing of poplar plantation of surface soil (0-15 cm depths). The soil samples were also analyzed under control field or sole crop. Under this study, the organic carbon (0.61%) and N (224.3 kg ha^{-1}), P (17.6 kg ha^{-1}) and K (231.3 kg ha^{-1}) contents were recorded maximum under closer spacing at 5 m × 4 m of poplar based agroforestry system after the harvesting of wheat crop as compared to other spacings and sole crop. The macro-nutrients tended to increase with time due to higher inputs of organic matter with the age of tree.*

Keywords: *Agroforestry system, macro-nutrients, organic matter and* Populus deltoides.

INTRODUCTION

Indian agriculture is facing challenges and constraints due to growing demographic pressure, increasing food, feed and timber needs, natural resources degradation and climate change (Dhyani and Handa, 2013). Diversification of existing farming systems by developing suitable agroforestry models seems to be the need of the day (Dhillon *et al.* 2012). Appropriate selection of tree and crop species helps to increase yield, improve soil fertility, promote land sustainability and resource use efficiency (Sharma *et al*., 2004). Intercropping with high density short rotation tree species is the best option to meet increasing food and industrial raw material requirement through sustainable utilization of natural resources (Sarvade *et al*., 2014). There is growing interest among farming communities to integrate fast growing multipurpose trees in agroforestry systems to obtain early and good economic returns. *Populus deltoides,* is one such promising species recognized as important tree component in agroforestry system to prevent land degradation and obtain biological production on sustainable basis (Pandey, 2007). Due to its fast growth, high price, less competition with associated crops and pruning tolerant nature this species has been grown by farmers in Punjab, Haryana and Uttar Pradesh, as boundary or block plantation along with agricultural crops which improves the physico-chemical properties of soil through addition of organic matter in the soil and provides alternate sources of income and employment to the rural poor (Puri and Nair, 2004; Singh and Sharma, 2007). The system has proved to be economically viable and ecologically sustainable (Jain and Singh, 2000).

A large quantity of litterfall is added through tree species which upon its decomposition affects the organic carbon and nutrient status of soil. The quantity and quality of litter produced by trees depend on the species, age and density of trees (Moshin *et al.*, 1996; 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). 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

* Department of Forestry, CCS Haryana Agricultural University, Hisar (Haryana), India-125004, *E-mail: chhavisirohi22dec@gmail.com*

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. 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. Therefore, the objective of present study to evaluate the distribution of organic matter and available N, P and K in the soil under different spacings of poplar based agroforestry system in semi arid region of Haryana.

MATERIALS AND METHODS

Study Sites and Climate

The study on poplar-based agroforestry was carried out during rabi season of 2013-14 in the research farm of Department of Forestry, CCS Haryana Agricultural University, Hisar at $29^0 10^{'}$ N latitude and $75^0 40^{'}$ 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 under Poplar based Agroforestry System

To study the effect of poplar based agroforestry system under different spacings on soil organic carbon and available nutrients, an experiment was conducted where poplar were planted at 5 m × 4m, 10 m × 2 m and 18 m × (2 m × 2 m paired row) spacing during 2007. The wheat crop was raised with the recommended cultural practices under various spacing of poplar plantation during 2013-2014. In the adjoining field the same crop wheat was taken as control. Soil samples were collected from surface soil (0-15 cm depth) at two stages i.e. before sowing of the wheat crop in October and after harvest of wheat in April from different spacings of poplar and also from control field for the study of nutrient status and physico-chemical properties *viz.* available nitrogen, phosphorus and potassium and organic carbon. In this study, the available N in the soil was determined by Kjeldhal's method (Jackson, 1973), organic carbon by Walkley and Black method and available K by neutral normal ammonium acetate method (Jackson, 1973).

RESULT AND DISCUSSION

Soil organic carbon and available macronutrients: The soil organic carbon and available N, P and K content were significiantly higher in the closer spacing (5 m × 4 m) of *Populus deltoides* based agroforestry system before the sowing of wheat crop and the trend of decrease in average contents of soil organic carbon, N, P and K in agroforestry system with the wider spacing of poplar plantation (Fig. 1). Among all the different tree spacings, the status of organic carbon, N, P, and K were significantly higher in 5 m × 4 m spacing where as it was lowest under control. The average contents of organic carbon in poplar based agroforestry system were higher by 0.52, 0.43, 0.36 and 0.12%, respectively over sole crop. The higher organic carbon and available nutrient content in poplar based agroforestry system over the agriculture system may be attributed to litter-fall addition from poplar trees as well as addition of root residues of crops and trees. On account of recycling of organic matter, higher organic carbon and available N, P and K contents were observed in the soil under intercropped poplar plantations than at a site without trees and the contents varied depending upon the intercrops (Singh *et al.*, 1989; Moshin *et al.*, 1996).

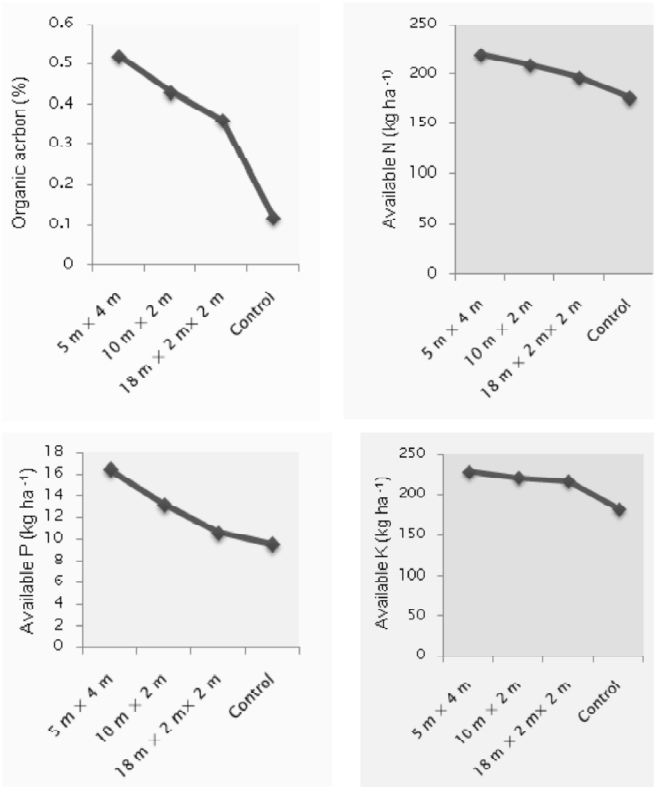

Figure 1: Effect of different poplar spacing and land use on change in soil chemical properties *before sowing* of wheat crop in October 2013

Among all the different tree spacings, the status of organic carbon (0.61%), N (224.3 kg ha^{-1}), P (17.6 kg ha^{-1}), and K (231.3 kg ha^{-1}) were also significantly higher in 5 m × 4 m spacing where as it was lowest under control (Fig. 2). The higher organic carbon and nutrient status under closer spacing might be due to 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).

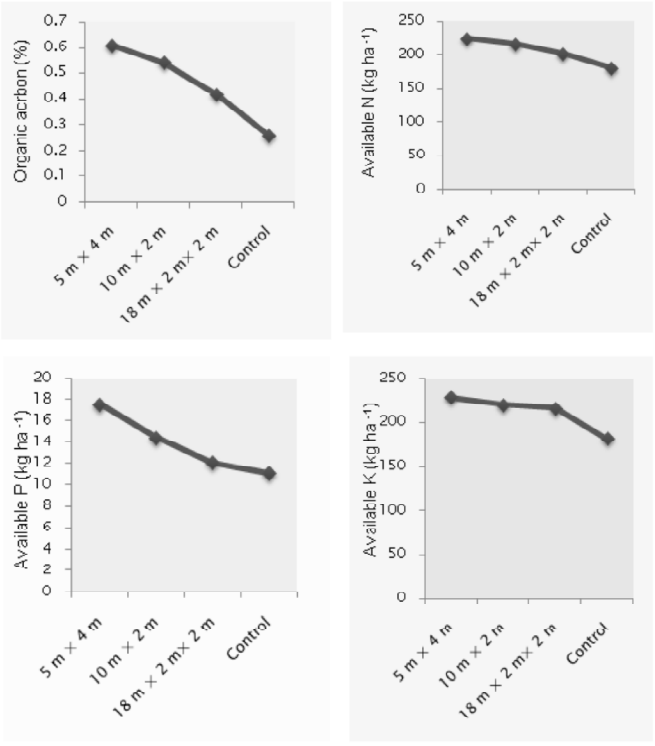

Figure 2: Effect of different poplar spacing and land use on change in soil chemical properties *after harvest* of wheat crop in April 2014

The average contents of organic carbon and N, P and K in poplar based agroforestry system were higher at 5 m × 4 m spacing after the harvesting of wheat as compared to before sowing of wheat (Fig. 1 & Fig. 2). High organic matter and available N, P and K contents in the intercropping treatments could be ascribed to the fact that leaf fall before and during crop sowing period on the soil which incorporates in to the soil through tillage practices and their partial decomposition adds to the soil organic matter. These findings were supported by (Gupta and Sharma; 2009, Das and Chaturvedi; 2005, Yadav *et al.,* 2008). The reduction of soil pH and EC under the tree cover can be attributed to accumulation and subsequent decomposition of organic matter which releases organic acids (Gupta and Sharma, 2009). Thus, despite the higher addition of litter-fall in closer spacing of poplar plantations with the advancement of its age, the increase in available nutrients was sufficiently higher under closer spacing (5 m × 4 m) after the harvesting of wheat. The impact of agroforestry systems on soil fertility in terms of higher organic matter content, total nitrogen, available phosphorus and potash in the top soil has been reported by Rizvi *et al.,* (2011).

CONCLUSION

Therefore, it may be concluded that the organic carbon and available N, P and K contents of soil improved in poplar based agroforestry system. Under different spacings of poplar, 5 m × 4 m spacing was found more suitable for improving the soil fertility by the addition of leaf litter in a large quantity with the advancement of tree age. Thus, poplar based agroforestry system can sustain the soil health by improving various soil parameters.

REFERENCES

Das, D.K., Chaturvedi, O.P. (2005), Structure and function of *Populus deltoides* agroforestry system in eastern India: 1 Dry matter dynamics. *Agroforestry Systems* **65 (**3): 215-221.

Dhillon, W.S, Chauhan, S.K., Jabeen, N., Singh, C. and Singh, N. (2012), Growth performance of intercropping system components and nutrient status of soil under horti-silviculture system. *International Journal of Environment and Resource* **1** (1): 31-38.

Dhyani, S.K., and Handa, A.K. (2013), India needs agroforestry policy urgently: Issues and challenges. *Indian Journal of Agroforestry* **15** (2): 1-9.

Gupta, M.K., Sharma, S.D. (2009), Effect of tree plantation on soil properties, profile morphology and productivity index: poplar in Yamunagar district of Haryana. *Annals of Forestry* **17** (1): 43-70.

Jain, S.K. and Singh, P. (2000), Economic analysis of industrial agroforestry: poplar (*Populus deltoides*) in Uttar Pradesh (India). *Agroforestry Systems* **49**: 255-273.

Jckson, M.L. (1973), Soil chemical analysis. Prentice hall of India Pvt. Ltd., New Delhi.

Moshin, F., Singh, R.P. and Singh, K. (1996), Nutrient cycling of poplar plantation in relation to stand age in agroforestry system. *Indian Journal of Agroforestry* **19**: 302-310.

Mugendi, D.N., Nair, P.K.R. (1997), Predecting the decomposition patterns of tree biomass in tropical highland microregins of Kenya. *Agroforestry Systems* **35**: 187-201.

Pandey, D.N. (2007), Multifunctional agroforestry systems in India. *Current Science* **92**: 455-463.

Patel, N.L. and Singh, S.P. (2000), Effect of different tree species on site amelioration. *Indian Journal of Forestry* **23**: 192-196.

Puri, S. and Nair, P.K.R. (2004), Agroforestry research for development in India: 25 years of experiences of a national program. *Agroforestry Systems* **61**: 437-452.

Rizvi, R.H., Dhyani, S.K., Yadav, R.S. and Singh, R. (2011), Biomass production and carbon stock of poplar agroforestry systems in Yamunagar and Saharanpur districts of northwest India. *Current Science* **100** (5): 736-742.

Sarvade, S., Mishra, H.S., Kaushal, R., Chaturvedi, S. and Tewari, S. (2014), Wheat (*Triticum aestivum* L.) yield and soil properties as influenced by different agri-silviculture systems of terai region, northern India. *International Journal of Bio-resource and Stress Management* **5** (3): 350-355.

Sharma, P., Rai, S.C., Sharma, R. and Sharma, E. (2004), Effects of land use change on soil microbial C, N and P in a Himalyan watershed. *Pedobiologia* **48**: 83-92.

Singh, B, Gill, R.I.S. and Kaur, N. (2007), Litterfall and nutrient return in poplar plantation varying in row directions and spacings. *Indian Journal of Agroforestry* **9**: 33-37.

Singh, B. and Sharma, K.N. (2007), Tree growth and nutrient status of soil in a poplar (*Populus deltoides* Bartr) based agroforestry system in Punjab, India. *Agroforestry Systems* **70**: 125-134.

Singh, K., Chauhan, H.S., Rajput, D.K. and Singh, D.V. (1989), Report of a 60 month study on litter production, changes in soil chemical properties and productivity under poplar (*Populus deltoides*) and eucalypts (*Eucalyptus hybrid*) interplanted with aromatic grasses. *Agroforestry Systems* **9**: 37-45.

Yadav, R.S., Yadav, B.L., Chhipa, B.R. (2008), Litter dynamics and soil properties under different tree species in a semi-arid region of Rajasthan, India. *Agroforestry Systems* **73**: 1-12.