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Changes in Soil Chemical Properties under Eucalypts (*Eucalyptus Tereticornis*) Based Agroforestry System in Semi-arid Region of Haryana

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ABSTRACT: *The present investigations were taken during the winter season of 2013-2014 at CCS Haryana Agricultural University, Department of Forestry, for analysis the soil properties under different spacings of Eucalypts based agroforestry system at two stages of crop 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 were determined under 3 m × 3 m, 6 m × 1.5 m and 17 m × 1 m × 1 m (paired row) spacing of Eucalypts plantation of surface soil (0-15 cm depths). The soil samples were also analyzed under control (sole crop). Under this study, the organic carbon (0.47%) and N (199.8 kg ha^{-1}), P (15.6 kg ha^{-1}) and K (226.4 kg ha^{-1}) contents were recorded maximum under 3 m × 3 m spacing of Eucalypts based agroforestry system after the harvesting of wheat crop as compared to other spacings and sole crop.*

Keywords: *Agroforestry, biomass, eucalypts, macro-nutrients and spacings*

INTRODUCTION

Agroforestry may be one of the solutions to increase forest area to one third of the total geographical area of our country. It will help in carbon sequestration and maintenance of soil productivity by reducing soil erosion and improving salt affected soils by lowering down the water table. Agroforestry can also be an appropriate technology in areas with fragile ecosystem and subsistence farming. Land degradation is a major factor constraining world food production and the sodification is a large component of that degradation. Trees play a vital role in mitigating the ill effects of environmental degradation vis-a-vis enhancing the productivity in terms of fuel, fodder and timber. To meet the ever growing need for wood, and to restore an ecological balance, it has become essential to bring large areas under tree cover. Agroforestry is proposed as strategy to combat soil degradation, improve soil fertility and increase crop yields (Rai *et al*., 1999). Among the agroforestry tree species, Eucalypts is of paramount importance due to small canopy as compared to most of the agroforestry tree species and straight growing habit. Trees tend to improve the site by changing the chemical properties, physical structure, microclimate, infiltration capacity and moisture regime of the soil (Prinsely and Swift, 1986). With time, process such as litter fall, nitrogen fixation, root extension, crown expansion and nutrient cycling contribute to nutrient and organic matter build-up in the top soil leading to physical, chemical and biological improvement in the critical rooting zone (Gill *et al.,* 1987; Evans, 1992; Garg and Jain, 1992). Farmers do realize the importance of trees in a combined production system not only to meet their basic needs but also for cash benefits (Puri and Monga, 1990). Moreover, tree- crop combinations have been found to give better economic returns than tree or annual crops alone (Dogra *et al.,*2007; Burgreess *et al*., 2000). Apart from being an important source of organic matter and nutrient return to the soil, litterfall results in the formation and renewal of forest floor also. It protects the soil from erosion and reduces weed growth (Bell, 1973). Salinization of soil and water is an important factor for increased desertification in arid and semi-arid regions of the world (Szabolcs, 1992). Eucalyptus is one of many tree species that has been planted successfully under a variety of ecological conditions of Pakistan (Siddiqui *et al*., 1984). *Eucalypts* clones have revolutionized the productivity and profitability of the plantations in many states of our country (Lal 2005). *Eucalyptus* is the most popular choice to be planted along the edges

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or bunds of agricultural fields, and appears to be well incorporated and accepted in agroforestry in India (Tejwani, 1994). Saline and alkaline soils are of widespread occurrence in arid and semiarid regions of northern India. More than 2.5 million ha of otherwise arable lands in the Indo-Gangetic plains have become unsuitable for cultivation due to soil sodicity (Abrol and Bhumbla, 1971). These soils are characterized by high pH throughout the soil profile, high exchangeable sodium and low soil organic matter content (Gupta et al., 1984), a sparse cover of natural vegetation (Rana and Parkash, 1987) and low microbial activity (Kaur *et al.,* 1998; Pathak and Rao, 1998). The productive capacity of alkaline soils has been found to improve by growing plants adapted to sodic soils (Gupta *et al.*,1990). Reclamation agroforestry systems have been reported to improve biological production and ameliorate sodic conditions of soils by increasing soil organic matter content and availability of soil inorganic nitrogen (Singh, 1995; Singh *et al.,*1997). The soil microbial biomass is a labile pool of organic matter and comprises 1–3% of total soil organic matter (Jenkinson and Ladd, 1981). The soil microbial biomass acts as a source and sink of the plant nutrients (Singh *et al.,* 1989; Smith and Paul, 1990) and regulates the functioning of the soil system. Plant cover through its effects on the quantity and quality of organic matter inputs influences the levels of soil microbial biomass (Wardle, 1992). The specific respiratory activity of soil microbial biomass has been used to analyze the effects of environmental factors, crop management, and organic inputs on the microbial populations (Anderson and Domsch, 1990, 1993; Campbell *et al.,* 1991). It is sensitive to the changes in the quantity and quality of soil organic matter and ecosystem stability (Insam, 1990). 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).

MATERIALS AND METHODS

Study Sites and Climate

The study on Eucalypts-based agroforestry was carried out during winter 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 Eucalypts based Agroforestry System

To study the effect of Eucalypts based agroforestry system under different spacings on soil organic carbon and available nutrients, an experiment was conducted where Eucalypts were planted at 3 m x 3m, 6 m x 1.5 m and 17 m x 1 m x 1 m (paired row) spacing during 2007. The wheat crop was raised with the recommended cultural practices under Eucalypts plantation during 2013-2014. The adjoining field also with 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 Eucalypts and also from control field for the study of nutrient status and physico-chemical properties *viz.* available nitrogen, phosphorus and potassium, organic carbon , pH and EC. In this study, the soil pH and electrical conductivity (EC) were determined in soil:distil water suspension (1:2). 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 EC and pH

The soil EC and pH content were significiantly lower in the closer spacing (3 m × 3 m) of *Eucalyptus tereticornis* based agroforestry system before the sowing of wheat crop and the trend of increase in average contents of soil EC and pH in agroforestry system was observed with the wider spacing of Eucalypts plantation (Fig. 1 & 2). The closer spacing in the previous year EC & pH were higher and next year EC & pH were lower due to the increase in the tree growth which added the organic matter decomposition in soil and increase the soil health. Year by year increase in the tree growth soil incorporation also increase under agroforestry system as compared to control. The average contents of EC and pH in Eucalypts based agroforestry system were lower by 8.09, 8.19, 8.45 and 9.2 respectively over sole crop.

Soil organic carbon and available macronutrients: The soil organic carbon and available N, P and K content were significiantly higher in the closer spacing (3 m × 3 m) of *Eucalyptus tereticornis* 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 was observed with the wider spacing of Eucalypts plantation (Fig. 1). Among all the different tree spacings the status of organic carbon, N, P, and K were significantly higher in 3 m × 3 m spacing where as it was lowest under control. The average contents of organic carbon in Eucalypts based agroforestry system were higher by 0.37, 0.33, 0.24 and 0.12%, respectively over sole crop. The higher organic carbon and available nutrient content in Eucalypts based agroforestry system over the agriculture system may be attributed to litter-fall addition from Eucalypts trees as well as addition of root residues of crops and trees.

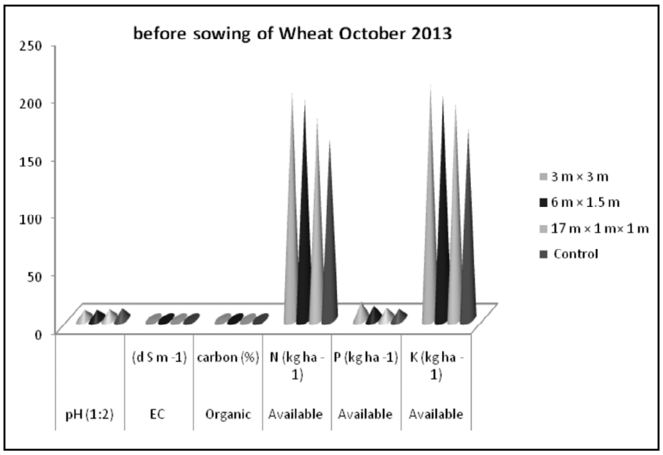

Figure 1: Effect of different Eucalypts spacing and land use on change in soil chemical properties *before sowing* of wheat crop in October 2013

Among all the different tree spacings, the status of organic carbon (0.47 %), N (199.8 kg ha^{-1}), P (15.6 kg ha^{-1}), and K (226.4 kg ha^{-1}) were also significantly higher in 3 m × 3 m spacing where as it was lowest under control (Fig. 2). The higher organic carbon and nutrient status under closer spacing 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.

The average contents of organic carbon and N, P and K in Eucalypts based agroforestry system were higher at 3 m x 3 m spacing after the harvesting of wheat as compared to before sowing of wheat (Fig. 1 and 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. 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 Eucalypts plantations with the advancement of its age, the increase in available nutrients was sufficiently higher under closer spacing (3 m × 3 m) after the harvesting of wheat.

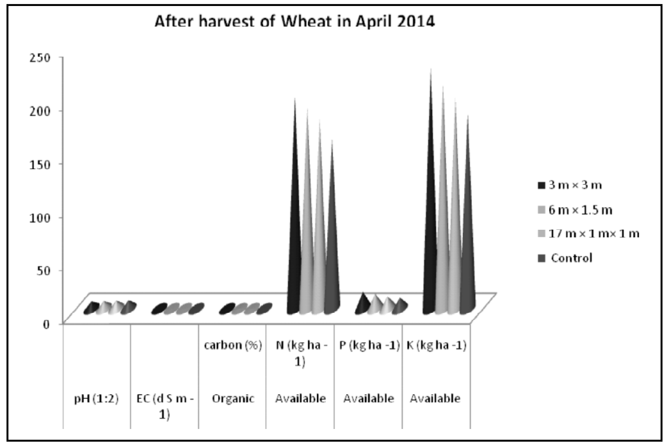

Figure 2: Effect of different Eucalypts spacing and land use on change in soil chemical properties *after harvest* of wheat crop in April 2014

CONCLUSION

Therefore, it may be concluded that the organic carbon and available N, P and K contents of soil improved in Eucalypts based agroforestry system. Under different spacings of Eucalypts, 3 m × 3 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, Eucalypts based agroforestry system can sustain the soil health by improving various soil parameters.

REFERENCES

Abrol, I.P., Bhumbla, D.R., (1971), Saline and alkali soils in India; their occurrence and management, World Soil Resources Reports. FAO, Rome, Vol. **41**, pp. 42–51.

Anderson, T.H., Domsch, K.H., (1990), Application of eco-physiological quotients (*q*CO2 and *q*D) on microbial biomass from soils of different cropping histories. *Soil Biol. Biochem*. 22, 251–255.

Burgess, P.J., Seymour, I., Incoll, L.D., Corry , D.T., Hort, B. and Beaton, A. (2000), The application of silvoarable agroforestry in UK. *Aspects of App. biol*, **62**: 269-276.

Campbell, C.A., Biederbeck, V.O., Zentner, R.P., Lafond, G.P., (1991), Effect of crop rotations and cultural practices on soil organic matter, microbial biomass and respiration in a thin black chernozem, microbial biomass and respiration in a thin black chernozem. *Can. J. Soil Sci*. **71**, 363–376.

Dogra, A.S., Upadhyay, A., Sharma, S.C. and Chauhan, S.K. (2007), Potential of agroforestry as a land use option in Punjab, India. *Indian For*, **133** (11):1437-1148.

Evans, J. (1992), Plantation Forestry in Tropics. Oxford University Press, New York.

Garg, V.K. and Jain, R.K. (1992), Influence of fuelwood trees on sodic soils. *Can. J. For. Res*. **22**: 729–735.

Gill, H.S., Abrol, I.P. and Sharma, J.S. (1987), Nutrient recycling through litter production in young plantations of *Acacia nilotica* and *Eucalyptus tereticornis* in a highly alkaline soil. *Forest Ecol. Manage*. **22**: 57–69.

Gupta, R.K., Bhumbla, D.R., Abrol, I.P., (1984), Effect of soil pH, organic matter and calcium carbonate on dispersion behavior of alkali soils. *Soil Sci.* **137**, 245–251.

Gupta, S.R., Sinha, A., Rana, R.S., (1990), Biomass dynamics and nutrient cycling in a sodic grassland. *Int. J. Ecol. Environ. Sci*. **16**, 57–70.

Insam, H., (1990), Are the soil microbial biomass and basal respiration governed by the climate regime? *Soil Biol. Biochem*. **22**, 525–532.

Jenkinson, D.S., Ladd, J.N., (1981), Microbial biomass in soil: measurement and turnover. In: Paul, E.A., Ladd, J.N. (Eds.), Soil Biochemistry, Vol. **5**. Marcel Dekker, New York, pp. 415–471.

Kaur, B., (1998), Organic matter dynamics and nitrogen mineralization in agroforestry systems. Ph.D. Thesis, Kurukshetra University, Kurukshetra, India, 161 pp.

Kaur, B., Aggarwal, A.K., Gupta, S.R., (1998), Soil microbial biomass and nitrogen mineralization in salt affected soils. *Int. J. Ecol. Environ. Sci*. **24**, 103–111.

Lal, P. (2005), Integrated development of agroforestry plantations and wood based industries. *In*: Agroforestry in 21 century (Eds. K. Chauhan, S.S. Gill, S.C. Sharma and Rajni Chauhan). Agrotech Publishing Academy, Udaipur. pp. 296-303

Pathak, H., Rao, D.L.N., (1998), Carbon and nitrogen mineralization from added organic matter in saline and alkali soils. *Soil Biol. Biochem*. **30**, 695–702.

Prinsely, R.J. and Swift, M.J. (1986), Amelioration of Soils by Trees: A Review of Current Concepts and Practices. Commonwealth Science Council, London, UK.

Puri, S. and Monga, B.D. (1990), Use of *Prosopis spp.* in the farming system in arid regions of Haryana. (In) *Agroforestry,* pp 51-57.

Rai, P., Solanki, K.R. and Rao, G.R. (1999), Silvipasture research in India- A review. *Indian J. Agroforestry,* **1**: 107-120.

Sarvade, S., Mishra, H.S., Rajesh Kaushal, Sumit Chaturvedi, Salil Tewari and Jadhav, T.A., (2014), Performance of wheat (*Triticum aestivum* L.) crop under different spacings of trees and fertility levels. *African Journal of Agricultural Research* 9 **(9)**, 866-873.

Siddiqui, K.M., J.A. Khan and S.M. Yasin. (1984), Eucalyptus camaldulensis DEHN, its growth properties and utilization. Bulletin Number 4, Pak. Forest Institute Peshawar, Pakistan.

Singh, G., (1995), An agroforestry practice for the development of salt lands using *Prosopis juliflora* and *Leptochloa fusca*. *Agrofor. Syst*. **29**, 61–75.

Singh, G., Singh, N.T., Dagar, J.C., Singh, H., Sharma, V.P., (1997), An evaluation of agriculture, forestry and agroforestry practices in a moderately alkali soil in northwestern India. *Agrofor. Syst.* **37**, 279–295.

Singh, J.S., Raghubanshi, A.S., Singh, R.S., Srivastava, S.C., (1989), Microbial biomass acts as a source of plant nutrients in dry tropical forest and savanna. *Nature* **338**, 499–500.

Smith, J.L., Paul, E.A., (1990), The significance of soil microbial biomass estimations. In: Bollag, J.M., Stotzky, G. (Eds.), *Soil Biochemistry*, Vol. **6**. Marcel Dekker, New York, pp. 357–396.

Szabolcs, I. (1992), Salinization of soil and water and its relation to Desertification. Desertification Control Bulletin. **21**:32-37.

Tejwani, K.G. (1994), Agroforestry in India. Oxford and IBH, New Delhi. pp 10-47.

Wardle, D.A., (1992), A comparative assessment of factors which influence microbial biomass carbon and nitrogen levels in soil. Biol. Rev. **67**, 321–358.