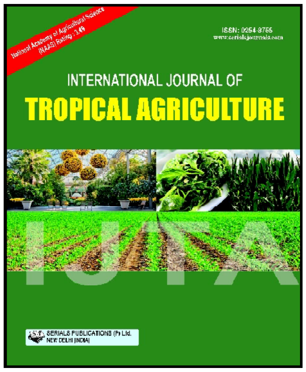

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Distribution of fine roots of well-established *Phyllanthus emblica* (Aonla) based agroforestry system in Bundelkhand region of Central India

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Abstract: The aonla based agroforestry system was started in 1996 with a spacing of 10x10 m i.e., with average density of 100 trees per hectare. In this field, greengram-mustard cropping system is continuing. In the present investigation, during the summer of 2017, fine root sampling was done in the field with the soil core method. The samples were drawn from 6 horizontal spaces, 0.5, 1.0, 1.5, 2.0, 2.5 and 3 m distances from tree base. Similarly, the vertical distribution of tree fine roots were, sampled from 0-15, 15-30, 30-45, 45-60, 60-75 and 75-90 cm soil depths. It was found that during summer season the fine root length varies from 43.83 cm in 0-15 cm soil depth at a distance of 0.5 m from tree base to 2.47 cm in 75-90 cm soil depth at a distance of 1 m from tree base. The fine root length density (RLD) varied from 0.046 cm cm^{-3} in 0-15 cm depth to 0.003 cm cm^{-3} in 75-90 cm depth. Thus the general trend is fine root length as well as fine root length density decreases with depth and also as we go away from tree base, there is sharp decline in fine root parameters.This might be due to the fact that, maximum of the organic matter confined to the surface layers and nearby tree bases. This in turn allowed the fine roots to distribute accordingly. The understanding of fine roots variation gives us to know the biogeochemical fluxes at the face of climate change and environmental changes.

Keywords: Aonla, Agroforestry, Fine roots, Root length density

INTRODUCTION

It tropical regions, the very basic fundamental behind development of agroforestry in tropical regions, is that tree provides the soil fertility enhancement benefits to the associated crops. Fine roots are the basic pathways through which the trees used to take up water and nutrients. In these connections, the studies of fine roots and litter dynamics under agroforestry system are the need of the hour. The roots of trees play an important role as source and sink for nutrients in agroforestry systems. Generally, the top soil layers have higher proportion of fine roots that compete with crop roots for resources in agroforestry system [1, 2]. On the other hand, roots of trees in general and the fine roots in particular enrich the soil with organic matter and nutrients by rapid turnover, intercept the leached nutrients from sub surface soil layers and recycle them to surface playing their safety net role in these systems [3, 4]. The distribution of fine roots is one of the important determinants under agroforestry system that dictates the availability of nutrients to associated crops and to the trees itself. The production and turnover of fine roots are important for overall cycling of nutrients. The concentration of nutrients in fine roots dictates the nutrient return potential of the roots. The decomposing roots that release the nutrients is a pathway of significant nutrient flux in agroforestry systems. Nutrient concentration in fine roots may be higher than those in tree foliage [5]. The information on tree root biomass and its distribution is there, but the finest part of the root-system (i.e. fine roots) which is most dynamic and most actively involved in water and nutrient uptake, is meagre, hence of great interest in agroforestry system. Apart from sole cropping or annual cropping system, agroforestry land use systems are relatively complex where environmental resources are shared, hence the species may interfere with one another. If we have the knowledge of root distribution of tree species then, we can design nutrient management options, based on its availability. Considering the above facts, the present investigation was undertaken.

MATERIAL AND METHODS

The present investigation was undertaken in the experimental farm of ICAR-Central Agroforestry Research Institute, Jhansi in the year 2016. The aonla plantations were planted at spacing of 10x10 m and of the age of 20 years when the soil samples were collected during *kharif* 2017. The experiment was conducted in randomized block design with 3 replications. Six vertical soil depths for sampling of fine roots (0-15, 15-30, 30-45, 45-60, 60-75 and 75-90 cm) and six horizontal distances from tree base (0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 m) were selected.

The experimental site is located at 25°30' N latitude and 78°33' E longitude at an elevation of 271 m from mean sea level in the semi arid tract of the central plateau region of India. The area receives average rainfall of around 900 mm of which 80% received during July to September. The climate is hot dry summers and cold winters. The soil of the study site is typically red soil with very low water holding capacity. The soil pH and electrical conductivity (EC) in soil: distilled water (1:2) suspension was measured [6], soil organic carbon [7], available N [8], available phosphorus [9] and available potassium [10]. The initial soil pH were 7.9, EC was 0.16 m mhos cm^{-1}, organic carbon 0.32%, available N 161.7 kg ha^{-1}, available P 13.2 kg ha^{-1} and available K 120.6 kg ha^{-1} respectively.

The soil samples were collected after harvest of mustard crop during 2016-17. Greengram-mustard rotation is followed in this experiment. It was collected with the help of soil power auger at the depth upto 90 cm. The undisturbed cores were then brought to laboratory and then cut into cores of specific lengths and soaked in tray containing water for overnight. Then the root were very carefully washed from muddy water and through serial sieving through (<2mm sieves) fine roots were obtained and then it was separated into dead and live roots. The live roots were then put on soaking paper for removing any extra water content. Further, by following the modified line intersection method of [11], the fine root length and fine root length density were computed.

RESULTS AND DISCUSSION

In *Phyllanthus emblica* based agroforestry system, 21 years old having a density of 100 trees/ha, it was found that during summer season the fine root length varies from 43.83 cm in 0-15 cm soil depth at a distance of 0.5 m from tree base to 2.47 cm in 75-90 cm soil depth at a distance of 1 m from tree base (Figure 1). The root length varied from 43.83 cm to 17.29 cm at 0-15 cm and 5.56 cm to 4.32 cm at 75-90 cm soil depth respectively.

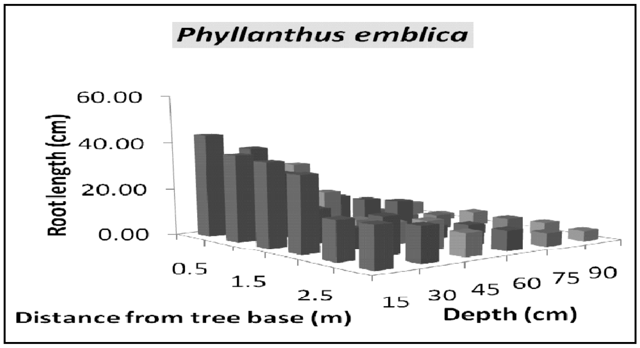

Figure 1: Distribution of fine root length of aonla as varied from distance from tree base and soil depth

The fine root length density (FRLD) varied from 0.046 cm cm^{-3} in 0-15 cm depth to 0.003 cm cm^{-3} in 75-90 cm depth (Figure 2). The fine root length density varied from 0.046 cm cm^{-3} to 0.018 cm cm^{-3} at a depth of 0.15 cm to 0.006 cm cm^{-3} to 0.005 cm cm^{-3} at 75.90 cm soil depth. Thus the general trend is fine root length as well as fine root length density decreases with depth and also as we go far from tree base, there is sharp decline in fine root parameters. This might be due to the fact that, due to competition for nutrients and water among tree roots and crop roots, the fine roots of trees were more confined to surface layers. The distribution of roots through space and time is usually influenced by both genetic characters of plant and localized soil conditions [12]. Although for understanding the fine root dynamics and its behavior, there is need of assessing the seasonal pattern of root dynamics.

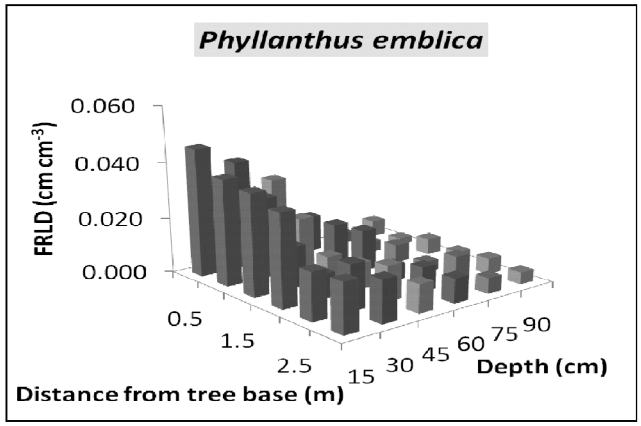

Figure 2: Distribution of fine root length density of aonla as varied from distance from tree base and soil depth

CONCLUSIONS

We have observed a general decrease in both the root parameter studied with vertical soil depth and horizontal distance from tree base. This also clarifies that most of the fine roots are confined to the surface layers and may compete with the annual crops for nutrients and water. Although, the study was confined to summer season sampling of fine roots, thus in order to ascertain the overall effect of the fine root distribution, seasonal pattern of root architecture should be studied.

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REFERENCES

Dhyani, SK and Tripathi, RS (2000). Biomass and production of fine and coarse roots of trees under agrisilvicultural practices in north-east India. *Agroforestry Systems* **50**: 107-121.

Smith, DM., Jackson, NA., Roberts, JM and Ong CK (1999). Root distributions in a *Grevillea robusta*-maize agroforestry system in semi-arid Kenya. *Plant & Soil* **211**: 191-205.

Allen, SC., Jose, S., Nair, PKR., Brecke, BJ., Nkedi-Kizza, P and Ramsey CL (2004). Safety-net role of tree roots: evidence from a pecan (*Caryaillinoensis* K. Koch)-cotton (*Gossypium hirsutum* L.) alley cropping system in the southern United States. *Forest Ecology & Management* **192**: 395-407.

Valverde-Barrantes, OJ., Raich, JW and Russell AE (2007). Fine-root mass, growth and nitrogen content for six tropical tree species. *Plant & Soil* **290**: 357-370.

Gordon, WS and Jackson, RB (2000). Nutrient concentrations in fine roots. *Ecology* **81**: 275-280.

Jackson ML (1973). Soil chemical analysis. Prentice-Hall of India, Pvt Ltd, New Delhi, India, 498 pp

Walkley, A and Black, IA (1934). An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic soil titration method. *Soil Science* **37**: 29-38.

Subbiah, BV and Asija, GL (1956). A rapid procedure for the estimation of available nitrogen in soils. *Current Science* **25**: 259-260.

Olsen, SR., Cole, CW., Watanabe, FS and Dean, LA (1954). Estimation of available phosphorus in soils by extraction with $NaHCO_3$. US Department of Agriculture, Circular 939.

Hanwey, JJ and Heidel, H (1952). Soil analysis methods as used in Lowa State College Soil Testing Laboratory. Lowa Agriculture **57**: 1-31.

Tennant, D (1975). A Test of Modified Line Intersect Method of Estimating Root Length. *Journal of Ecology* **63**: 995-1001.

Huck MG (1983). Root distribution, growth and activity with reference to agroforestry. *In*: Huxley PA (ed) Plant research and agroforestry. ICRAF, Nairobi, pp 527–542.