Study on Carbon concentration in various components of tree in *Grevillea robusta*, *Tectona grandis* and *Prosopis juliflora* plantations

[1]Dr. Krishan Pal and [2]Pratibha Yadav

[1]Associate Professor, Department of Botany, OPJS University, Churu, Rajasthan (India)
[2]Research Scholar, Department of Botanu, OPJS University, Churu, Rajasthan (India)
Email: ajayindorakuk@yahoo.com, Phone no. +91-9990016693

Abstract: The carbon concentration in different components was Bole= 49.50% Grevillea robusta; 45.92% Tectona grandis; 45.46% Prosopis juliflora; Branches= 48.46% Grevillea robusta; 43.25% Tectona grandis; and 43.63% Prosopis juliflora; Leaves= 45.57% Grevillea robusta; 40.91% Tectona grandis; and 36.52% Prosopis juliflora; roots (coarse)= 42.18% Grevillea robusta; 41.36% Tectona grandis; 39.68% Prosopis juliflora; and fine roots= 43.52% Grevillea robusta; 42.16% Tectona grandis; 39.71% Prosopis juliflora. There were no significant differences in carbon concentration of tree components among Grevillea robusta, Tectona grandis, and Prosopis juliflora. But in case of Prosopis juliflora carbon content was higher in branches. Aboveground carbon pool in the three plantations was 128485.4kg ha^{-1} Grevillea robusta; 27465.09kg ha^{-1} Tectona grandis; 10026.68kg ha^{-1}Prosopis juliflora. This formed 64.95 to 84.16% of the total carbon of the vegetation. The carbon pool varied from 1620.96 to 19595.75kg C ha^{-1} in the first year and from 1720.06 to 20308.58kg C ha^{-1} in the second year in coarse roots and 2516.02 to 3275.31kg C ha^{-1} and from 3052.90 to 3636.53kg C ha^{-1} in fine roots of the three plantation.

[Krishan, P. and Yadav, P. **Study on Carbon concentration in various components of tree in *Grevillea robusta*, *Tectona grandis* and *Prosopis juliflora* plantations.** *Academ Arena* 2019;11(10):47-51]. ISSN 1553-992X (print); ISSN 2158-771X (online). http://www.sciencepub.net/academia. 6. doi:10.7537/marsaaj111019.06.

Keywords: Carbon concentration, Plantation, Soil, Grassland**.**

Introduction:

Carbon and nitrogen are the main constituents of plant and soil organic matter. The plants fix atmospheric CO_2 through the process of photosynthesis in the form of organic compounds and stored in different aboveground and belowground plant components. The carbon fixed by the plants is the primary source of organic matter inputs into the soil both from aboveground and belowground parts of the plants. The organic matter inputs into the soil provide substrate for microbial processes and accumulation of soil organic matter. The various pools of carbon in the tree plantations include aboveground woody biomass, belowground biomass, litter fall, ground floor litter and soil carbon. Aboveground woody biomass represents the largest pools of carbon in tree plantations. Several workers have emphasized the importance of this pool in capture of the majority of new carbon sequestered by tree plantations (Dixon et al 1994; Schoreder 1994). The belowground biomass carbon plays an important role in tree plantations and grassland systems. The carbon flux in litterfall accounts for the annual return of carbon to the soil. The soil carbon pool has a potential for carbon storage in soil.

Productive plantations, primarily established for wood and fiber production, account for 78 percent of the plantation forests, and protective plantations, primarily established for conservation of soil and water, for 22 percent (FAO 2017). Tree based systems accumulate large amount of biomass and sequester substantial amount of carbon in perennial tree components. Tree plantations have been found to increase the organic matter and nutrient status of the surface soil (Young 1989; Singh et al 1989), the repeated fine root turnover, and long term accumulation and decomposition of larger roots and stems (Pregitzer and Friend 1996; Coleman et al 2000). Tree based land-use systems could sequester carbon in soil and vegetation and improve nutrient cycling within the systems (Kaur et al 2002a). Forestry plantations have the potential for sequestering carbon, primarily carbon accumulated within the vegetation. In the context of managing the terrestrial biosphere to maximize carbon sequestration (Schulze et al 2000) it is necessary to understand the consequences of reforestation on ecosystem carbon storage.

Forests and tree plantations play an important role in sequestering carbon from the atmosphere (Wang et al 2004; Scholes and Noble 2001). Carbon management in forests and forestry plantations is gaining attention in India to mitigate and reduce the concentration of green house gases in the atmosphere (Ramachandran et al 2018). Trees through the turnover of leaves and roots into the system substantially increase the organic matter (Jose et al

2000). Tree plantations on sodic soils ameliorate soil by decreasing soil pH, electrical conductivity and improve organic matter and soil fertility status (Singh et al 1998). The tree species of *Prosopis, Acacia* and *Casuarina* have been found to be highly promising for the rehabilitation of salt lands (Singh et al 1993).

The organic carbon status of alkali soils is improved when planted with trees (Singh and Gill 1992; Singh et al 1993). According to Singh (1995), growing of *Prosopis* plus *Leptochloa fusca* improved soil organic carbon and available nitrogen during their 52 months growth. The organic carbon accretion was much higher when trees were associated with crops on alkali soils (Singh and Singh 1997).

The aim of this study was to analyze plant carbon pools and fluxes in tree plantations and grassland systems of reclaimed sodic soils, and to analyze distribution of organic and inorganic carbon stocks in soils.

Materials and methods

Sample Collection and Analysis of Plant Carbon

Samples of different tree components (bole, branch, and leaf) were collected from individuals of various diameter classes. The samples from stump and lateral roots were collected from felled trees in the field. The samples of litterfall were obtained at monthly intervals. The samples of fine roots were obtained through sampling of soil cores seasonally.

The plant samples of wheat, rice, *Grevillea*, *Tectona*, *Prosopis* and *Eucalyptus* species were oven-dried at 65º C and powdered in a Willey mill equipped with 2mm sieve. Organic carbon in plant samples was analyzed following the method of Kalembasa and Jenkinson (1973).

Carbon Pool in Tree Plantations and Grassland Systems

Carbon pool in tree components was calculated using the average dry weight of biomass during 2017 and 2018 and their mean carbon concentrations. Root weight was multiplied by its carbon concentration to obtain carbon pool. Carbon pool in the grassland systems and rice-wheat cropping system were calculated by multiplying the dry matter weight of plant biomass with average carbon concentration.

Analysis of Nitrogen in Plant Samples

Total nitrogen concentration in roots, straw and grains of rice and wheat was analyzed by the semi-microkjeldahl method (Bremner 1965b). Powdered plant material (100mg) was digested with 3ml conc. H_2SO_4 and 500mg catalyst (8 K_2SO_4: 1 $CuSO_4$). The ammonia evolved from the diluted digest was distilled using Markham's distillation unit. The ammonia evolved was absorbed in 2% boric acid with mixed indicator (0.1% methyl red in 95% ethanol and 1% bromocresolgreen in 95% ethanol) and titrated with standardized N/85 hydrochloric acid.

Soil Carbon Pool

Sub-samples of air dried soil were analyzed for organic carbon by dichromate oxidation method (Kalembasa and Jenkinson 1973). Soil inorganic N was analyzed following Bremner (1965b).

The amount of organic and inorganic carbon in soil was estimated from the bulk density, soil depth, and organic and inorganic carbon concentration in soil of the respective soil depth.

Results

Plant carbon pools in systems

Carbon Concentration in Tree Components

In general, the bole and branches had the higher concentration of carbon followed by leaves and roots in *Grevillea robusta* (Table 1). But in *Tectona grandis* and *Prosopis juliflora*, roots had higher concentration of carbon than leaves. The carbon concentration in different components was Bole= 49.50% *Grevillea robusta*; 45.92% *Tectona grandis;* 45.46% *Prosopis juliflora*; Branches= 48.46% *Grevillea robusta*; 43.25% *Tectona grandis;* and 43.63% *Prosopis juliflora*; Leaves= 45.57% *Grevillea robusta*; 40.91% *Tectona grandis;* and 36.52% *Prosopis juliflora;* roots (coarse)= 42.18% *Grevillea robusta*; 41.36% *Tectona grandis;* 39.68% *Prosopis juliflora;* and fine roots= 43.52% *Grevillea robusta*; 42.16% *Tectona grandis;* 39.71% *Prosopis juliflora*. There were no significant differences in carbon concentration of tree components among *Grevillea robusta*, *Tectona grandis*, and *Prosopis juliflora.*

Carbon Pool in Tree Plantations

The carbon content of trees differed considerably due to variation in biomass of tree components and the plant species. The relative contribution of different plant components to total aboveground carbon accumulation was in the order: bole> branches> leaves. But in case of *Prosopis juliflora* carbon content was higher in branches. Aboveground carbon pool in the three plantations was 128485.4kg ha^{-1} *Grevillea robusta*; 27465.09kg ha^{-1} *Tectona grandis*; 10026.68kg ha^{-1} *Prosopis juliflora.* This formed 64.95 to 84.16% of the total carbon of the vegetation. The carbon pool varied from 1620.96 to 19595.75kg C ha^{-1} in the first year and from 1720.06 to 20308.58kg C ha^{-1} in the second year in coarse roots and 2516.02 to 3275.31kg C ha^{-1} and from 3052.90 to 3636.53kg C ha^{-1} in fine roots of the three plantations (Table 2).

Carbon Flux in Net Primary Productivity in Tree Plantations

Carbon flux is the input of carbon through net primary productivity into the system and its subsequent transfer to the soil through litter and root turnover. The carbon input through net primary productivity in tree plantations was (kg C ha^{-1} yr^{-1}): 11373.90 *Grevillea robusta*; 7265.52 *Tectona grandis*; 5650.06 *Prosopis juliflora* (Table 3). The aboveground carbon input through net primary production varied form 63.94 to 73.28% and roots contributed 3.28 to 6.27% carbon input in the studied tree plantation systems.

Table 1: Carbon concentration in various components of tree in *Grevillea robusta*, *Tectona grandis* and *Prosopis juliflora* plantation.

Components	Carbon concentration (%)		
	Grevillea robusta	*Tectona grandis*	*Prosopis juliflora*
Bole	49.50±1.98	45.92±2.35	45.46±0.55
Branch	48.46±0.50	43.25±1.62	43.63±0.54
Roots (Coarse)	42.18±0.81	41.36±1.34	39.68±0.55
Fine roots	43.52±0.77	42.16±1.12	39.71±0.65
Leaves	45.57±1.77	40.91±1.78	36.52±0.90

Table 2: Carbon content in different tree components of *Grevillea robusta*, *Tectona grandis* and *Prosopis juliflora* plantations.

Tree components	Carbon content (kg ha^{-1})	
	I year	II year
Grevillea robusta		
Bole	105529.46±2880.91	109244.91±2831.40
Branches	19497.16±847.32	20608.45±849.43
Foliage	3458.76	3458.76
Total Aboveground	128485.38	133312.12
Roots	19595.75±552.13	20308.58±543.22
Fine roots	3275.31	3636.53
Total Belowground	22871.06	23945.11
Total	151356.44	157257.23
Tectona grandis		
Bole	17520.26±138.47	19009.79±124.76
Branches	7510.69±66.74	8232.36±60.76
Foliage	2434.14	2434.14
Total Aboveground	27465.09	29676.29
Roots	4772.14±32.20	5116.37±23.39
Fine roots	2588.20	3050.27
Total Belowground	7360.34	8166.64
Total	34825.43	37842.93
Prosopis juliflora		
Bole	3247.67±27.68	3417.02±22.02
Branches	4411.78±48.62	4712.58±39.21
Foliage	2367.23	2367.23
Total Aboveground	10026.68	10496.83
Roots	1620.96±16.07	1720.06±12.88
Fine roots	2516.02	3052.90
Total Belowground	4136.98	4772.96
Total	14163.66	15269.79

Table 3: Carbon accumulation in various components of tree in *Grevillea robusta*, *Tectona grandis* and *Prosopis juliflora* plantations.

Components	Carbon accumulation (kg C ha^{-1} yr^{-1})		
	Grevillea robusta	*Tectona grandis*	*Prosopis juliflora*
Bole	3764.97	1489.64	352.31
Branch	1111.19	721.84	610.82
Leaves	3458.76	2434.14	2367.23
Roots (Coarse)	712.84	344.11	208.32
Fine roots	2326.14	2275.79	2111.38
Aboveground	8334.92	4645.62	3330.36
Belowground	3038.98	2619.9	2319.7
Total	11373.90	7265.52	5650.06

Table 4: Carbon content in different primary producer compartments of the grassland system.

Plant Component	Carbon content (kg ha^{-1})
Live shoots	1628.2
Standing dead	1793.6
Litter	977.3
Roots	4163.6
Total	8562.7
Soil	13911

Corresponding Author Address:
Mrs. Pratibha Yadav
Research Scholar, Department of Botany,
OPJS University, Churu, Rajasthan (India)
Email: ajayindorakuk@yahoo.com
Phone no. +91-9990016693

References:

1. Anderson, J. M. 1992. Response of soils to climate change. *Advances in Ecological Research* 22: 163-210.
2. Anderson, J. P. E. and Domsch, K. H. 1978. A physiological method for the quantitative measurement of microbial biomass in soils. *Soil Biology and Biochemistry* 10: 215-221.
3. Anderson, J. P. E. and Domsch, K. H. 1980. Quantities of plant nutrients in the microbial biomass of selected soils. *Soil Science* 130: 211-216.
4. Anderson, T. H. and Domsch, K. H. 1986. Carbon link between microbial biomass and soil organic matter. In: Megusar, F. and Gantar, M. (Editors), Pages 467-471. Perspectives in Microbial Ecology. Proceedings of the Fourth International Symposium on Microbial Ecology, Slovene Society for Microbiology, Ljubljana, Yugoslavia.
5. Anderson, T. H. and Domsch, K. H. 1989. Ratio of microbial biomass carbon to total organic carbon in arable soils. *Soil Biology and Biochemistry* 21: 471-479.
6. Anderson, T. H. and Domsch, K. H. 1990. Application of eco-physiological quotients (q CO_2 and q D) on microbial biomasses from soils of different cropping histories. *Soil Biology and Biochemistry* 22: 251-255.
7. Anderson, T. H. and Domsch, K. H. 1993. The metabolic quotient for CO_2 (qCO_2) as a specific activity parameter to access the effect of environmental conditions, such as pH, on the microbial biomass of forest soils. *Soil Biology and Biochemistry* 25: 393-395.
8. Angers, D. A., Recous, S. and Aita, C. 1997. Fate of carbon and nitrogen in water-stable aggregates during decomposition of ^{13}C ^{15}N-labelled wheat straw in situ. *European Journal of Soil Science* 48: 295-300.
9. Balesdent, J., Chenu, C. and Balabane, M. 2000. Relationship of soil organic matter dynamics to physical protection and tillage. *Soil and Tillage Research* 53: 215-230.
10. Bargali, S. S. and Singh, S. P. 1995. Dry matter dynamics, storage and flux of nutrients in an aged *Eucalyptus* plantation. *Oecologia Montana* 4: 9-14.
11. Batra, L., Kumar, A., Manna, M. C. and Chhabra, R. 1997. Microbiological and chemical amelioration of alkaline soil by growing Karnal-grass and gypsum application. *Experimental Agriculture* 33: 389-397.
12. Bazilevich, N. I. and Titlyanova, A. A. 1980. Comparative studies on ecosystem function. In: Breymeyer, A. I. and van Dyne, G. M. (Editors), Pages 713-758. Grasslands, System Analysis and Man. International Biological Programme 19: Cambridge University Press, London.
13. Bazilevich, N. I., Drozdov, A. V. and Rodin, L. E. 1971. World forest productivity, its basic regularities and relationship with climate factors. In: Duvigneaud, P. (Editor), Pages 345-353,

Productivity of Forest Ecosystems. Proceedings of Brussels Symposium: UNESCO.
14. Beare, M. H., Cabrera, M. L., Hendrix, P. F. and Coleman, D. C. 1994. Water- stable aggregates and organic matter fractions in conventional and no- tillage soils. *Soil Science Society of America Journal* 58: 777-786.
15. Beare, M. H., Coleman, D. C., Crossley, Jr., D. A., Hedrix, P. F. and Odum, E. P. 1995. A hierarchical approach to evaluating the significance of soil biodiversity to biogeochemical cycling. *Plant and Soil* 170: 5-22.
16. Besnard, E., Chenu, C., Balesdent, J., Puget, P. and Arrouays, D. 1996. Fate of particulate organic matter in soil aggregates during cultivation. *European Journal of Soil Science* 47: 495-503.
17. Bhardwaj, B. and Gupta, S. R. 1993. Organic matter dynamics in a *Populus deltoides* agroforestry system. *International Journal of Ecology and Environmental Sciences* 19: 187-195.
18. Bhattacharyya, T., Chandran, P., Ray, S. K., Pal, D. K., Venugopalan, M. V., Mandal, C. and Wani, S. P. 2018. Changes in levels of carbon in soils over years of two important food production zones of India. *Current Science* 93: 1854-1863.
19. Bhattacharyya, T., Pal, D. K., Chandran, P., Ray, S. K., Gupta, R. K. and Gajbhiye, K. S. 2004. Managing soil carbon stocks in the Indo-Gangetic plains, India. Rice-Wheat Consortium for the Indo-Gangetic plains, New Delhi. 44 pages.

10/17/2019