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WOOD CARBON AND NITROGEN OF 37 WOODY SHRUBS AND TREES IN TAMAULIPAN THORN SCRUB, NORTHEASTERN MEXICO.

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Abstract

The present study was undertaken to determine interspecific variations of carbon and nitrogen contents of 37 species of woody trees sand shrubs at Linares, Northeastern Mexico. Woods were collected, dried and powdered following standard procedure. Ashed sample was digested in a solution containing HCl and HNO_3, using the wet digestion technique. Wood carbon and nitrogen contents (%, dry mass basis) were carried out on 0.020 g of milled dried leaf tissue by using a CHN analyser (Perkin Elemer, model 2400). Wood carbon showed large variations among species (37-51 %) and nitrogen content (0.56-1.97). The five species selected with very high carbon percentage are such as *Bernardia myricifolia* (51.12); *Acacia berlandieri* (51.00); *Leucophyllum frutescens* (50.84); *Berberis chochoco* (50.56); *Havardia pallens* (50.36). Similarly, the species showed variations in nitrogen content (0.56-1.97). The species containing high wood nitrogen are *Acacia greggii* (1.98%), *Ebenopsis ebano* (1.97 %), *Sideroxylon celestrinum* (1.75 %), *Diospyros texana* (1.56 %), and *Guaiacum angustifolia* (1.52 %). The species with high wood carbon are potential sources of bioenergy and carbon sink. These species store high amounts of carbon following carbon fixation by leaves.

Key words: Wood carbon, Nitrogen, Woody trees, Interspecific variability, Bioenergy, Selection, Carbon sink.

Introduction

A knowledge on variation in plant traits and chemical components is necessary for analyze productivity and quality. Ecologists have profound interest to quantify, analyze and interpret the causes and its effects on plant functional traits of co-existing plant species (Westoby & Wright, 2006); and also on analyses of interspecific patterns in leaf, wood, and reproductive traits (Moles *et al*., 2004; Chave *et al*., 2009). Forests help in climate change mitigation through carbon sequestration and storage (Canadell & Raupach, 2008; Shaheen *et al*., 2016).

Forests serve mankind and animal kingdom for food and their necessities for livelihood. Watson *et al*., (2018) mentioned that increasing human activities have caused maximum damage to forests. There are sufficient evidences that the remaining intact forest supports a significant global environmental values to degraded forests. They suggest that intact forests is an essential and necessity for current global attempts on to stop biodiversity crisis, climate change and achieve sustainability (Watson *et al*., 2018).

Wood plays an important role in wood industry for his high economic values. Wood carbon is an important source of renewable bioenergy (solar energy) captured by plants through leaves during the process of photosynthesis and stored in wood for a long time. Various studies have been documented on interspecific variation of wood carbon (Thomas & Malczewski, 2007; Martin *et al*., 2015; Pérez *et al*., 2013). The variation of stored wood-carbon would determine the capacity of a particular tree for supply of bioenergy. Large variations are observed in carbon storage in woods and fixation of carbon called carbon sequestration through leaves (Watson *et al*., 2018).

The carbon fixation is a physico-chemical and physiological process which involves the absorption of CO_2 from the atmosphere and its storage as carbon for a long time and it reverses the accumulation of CO_2 in the atmosphere. Forests store huge amounts of carbon. In the US, forests accumulate 90% of the US carbon sink and capture s approximately 10% of US CO_2 emissions. Trees after capture of CO_2 through the process of storage their carbon in wood for many years.

Community carbon forestry is considered as a mitigation option under climate change agreements. The New Zealand Emissions Trading Scheme (ETS) has started another potential revenue stream for forest owners and investors and earn carbon credits for storing carbon in their forest land as carbon sequestration (Think-Global, Act Local Kyoto). Forests play a vital role in regulating the earth's climate, removing and storing enormous quantities of atmospheric carbon.

Only few studies are undertaken by Thomas and Malczewski (2007) on interspecific variability and volatile wood carbon content of 14 native tree species in Eastern China, revealed that C content showed statistically significant variation among species, ranging from 48.4% to 51.0%. But the volatile C fraction was considerable, averaging 2.2%, and showed high variation among species. In previous studies, wood C content was appreciably higher in conifer than hardwood (angiosperm) species (50.80 vs 49.50%, respectively). Wood carbon density (g/cm^3) showed very high inter-specific variation, due mainly to differences in wood specific gravity. The results on wood C published in North America demonstrated that the global mean value of 47.05% in dried wood, but little study is available on volatile C.

Zeng (2008) suggest that for mitigation of global climate change, there is a necessity of development of strategies to keep the atmospheric CO_2 concentration below danger level. It is calculated that a sustainable long-term carbon sequestration potential for wood burial is 10 GtC y^{-1}, and currently about 65 GtC is on the world's forest floors in the form of coarse woody debris suitable for burial. It was assessed that the potential of sequestration is greatest in tropical forests (4.2 GtC y^{-1}), followed by temperate (3.7 GtC y^{-1}) and boreal forests (2.1 GtC y^{-1}). Therefore, burying wood has other benefits such as minimizing CO_2 source from deforestation, extention of the lifetime of reforestation carbon sink, and reduction of fire danger.

It is of great concern that with continued expansion of the terrestrial human footprint continues, the amount of native forest, which is free from human activities is declining. There exist sufficient evidences that the remaining intact forest supports an exceptional influence of global environmental values relative to degraded forests. This is very important for maintaining biodiversity, carbon sequestration and storage, water provision, indigenous culture and the maintenance of human health. Therefore, it is suggested that maintaining and, where possible, restoring the integrity of dwindling intact forests is an urgent priority for current global efforts to halt the ongoing biodiversity crisis, slow rapid climate change and achieve sustainability goals (Watson *et al*., 2018).

Studies have been undertaken on carbon fixation and nitrogen content in leaves of more than 40 woody species of Tamaulipan thornscrub, northeastern Mexico (González-Rodríguez *et al*., 2015). In this study, are selected few woody trees and shrubs species with high carbon and nitrogen content such as *Eugenia caryophyllata* (51.66%), *Litsea glauscensens* (51.54%), *Rhus virens* (50.35%), *Gochnatia hypoleuca* (49.86%), *Pinus arizonica* (49.32%), *Eriobotrya japonica* (47.98%), *Tecoma stans* (47.79%), and *Rosmarinus officinalis* (47.77%). These species could be recommended for plantation in carbon polluted areas CO_2 to reduce carbon load. They selected a few species with high nitrogen content, such as *Mimosa malacophylla* (8.44%), *Capscicum annuum* (6.84%), *Moringa oleifera* (6.25%), *Azadirachta indica* (5.85%), *Eruca sativa* (5.46%), *Rosmarinus officinalis* (5.40%), *Mentha piperita* (5.40%). These species could serve as good sources of nitrogen for health care. They also selected few species with high C/N ratio such *Arbutus xalapensis* (26.94%), *Eryngium heterophyllum* (24.29%), *Rhus virens* (22.52%), and *Croton suaveolens* (20.16%). This may be related to high production of secondary metabolites and antioxidants (González-Rodríguez *et al*., 2015; Maiti *et al*., 2015).

Specific strategies have been adopted for mitigation of carbon emissions through forestry activities there are four major strategies available to mitigate carbon emissions through forest management activities: 1). To increase the amount of forest land through reforestation; 2). To increase the carbon density of existing forests at a stand and landscape scale; 3). To increase the use of forest products to replace fossil fuel emissions; 4). To reduce carbon emissions derived from deforestation and degradation (Canadell & Raupach, 2008).

It is suggested that increasing the carbon density of existing stands or a land scape requires the selection and planting of trees with faster growth and efficient carbon fixation capacities. It well known that planting of any kind of tree can lead to more forest cover, thereby, these trees can absorb more carbon dioxide from the atmosphere. On the other hand, a genetically modified tree specimen might grow much faster than any other regular tree (Canadell & Raupach, 2008).

In respect to the rate of deforestation, 13 billion meters squares of tropical regions are deforested every year. It is expected this means, these regions have potential to reduce rates of deforestation by 50% by 2050, for stabilizing the global climate (Canadell & Raupach, 2008). There is an increase in abandoned farmland increasing in the recent years and this increase in intensive agriculture and urbanization.

A study was undertaken by Ovington (1957) on the volatile matter, organic carbon and nitrogen contents in woods of tree species grown in close stands, collected from trees in a number of different forest plantations. The results revealed considerable variation of these components. The maximum ranges for volatile matter was from 97.66 to 99.90%, for carbon from 52.82 to 70.26% and nitrogen from 0.042 to 0.576%. It is concluded that although considerable variation was found in each group of softwoods and hardwoods for the tree species of the experimental plots, in general, the rate of nitrogen and carbon build-up in the ecosystem is much greater under a coniferous crop than under a hardwood crop.

Subsequently, a study was undertaken on prediction of wood density and carbon-nitrogen content in tropical agrofortry in Western Kenya using infrared spectroscopy (IR). He suggested that infrared Spectroscopy coupled with chemometrics multivariate techniques offers a fast and non-destructive cheap technique for obtaining reliable results. It was assessed that measured carbon range was 40% to 52% (mean 48%), while IR predicted 44% to 51% (mean 48%) in NIR region and 46% to 51% (mean 48%) in MIR region. Measured nitrogen range was 0.09 to 0.48% (mean 0.28%), while IR predicted 0.18% to 0.47% (mean 0.24%) in NIR region and 0.18% to 0.38% (mean 0.24%) in MIR region. Interactions between densities with tree species and tree parts showed significant effect (p>0.5) for all the parameters. This suggests large variations within species that cannot be predicted using IR. NIR region gave better predictions than MIR, although the prediction performance was insufficient to recommend Infrared Spectroscopy as a practical method for direct determination of wood density and carbon content across species when different percentages were used (Kennedy, 2012).

A study has been undertaken by Martin *et al*., (2015) on variation in carbon and nitrogen contents among major woody tissue types in temperate trees. It is mentioned that the quantification of variation in the wood chemical traits of trees is necessary for determining forest biogeochemical budgets and models. They worked on wood carbon (C) and nitrogen (N) concentrations in 17 temperate tree species across five woody tissue types: sapwood, heartwood, small branches, coarse roots, and bark and also; analyses were corrected for losses of volatile C. Their results revealed that both C and N showed significant variation among tissue types, but differences were observed mainly by high C and N in bark, a pattern observed for nearly all species. Among non-bark tissue types, bivariate correlations among sapwood, heartwood, small branches, and coarse roots were highly significant and positive for wood C (*r* =0.88-0.98) and N (*r* =0.66-0.95) concentrations. They suggest that intraspecific variation in C across tissue types is less important than interspecific variation for assessment and modeling of forest-level C dynamics. On the contrary, it was observed differences in N among tissue types were greater and seemed to be more important for incorporation into forest-level nutrient assessments and models. They suggest that, with the exception of bark, wood chemical trait values derived from stemwood can be utilized to accurately represent whole-tree trait values in models of forest C and N stocks and fluxes, at least for temperate species (Martin *et al*., 2015).

Recently, a study was undertaken on isotope composition of carbon and nitrogen in tissues and organs of *Betula pendula*. Ratios of $^{13}C/^{12}C$ and $^{15}N/^{14}N$ isotopes were identified in different parts and organs of drooping birch (*Betula pendula* Roth) in preforest-steppe and pine-birch forests of the Middle Urals by mass spectrometry. The data were analyzed and interpreted from the perspective of biochemical processes of carbon and nitrogen metabolism in the leaf, cambial tissue, trunk wood, branches, roots, and in the soil. It is concluded that the lighter isotopic composition of carbon is characteristic for the leaves, trunk cambium as well as fine (Voronin *et al*., 2017).

Gilson *et al*., (2014) undertook a very interesting study on seasonal changes in carbon and nitrogen compound concentrations in a *Quercus petraea* chronosequence It is mentioned that forest productivity declines with tree age. This decline may be attributed to changes in metabolic functions, resource availability and/or changes in resource allocation (between growth, reproduction and storage) with tree age in situ. The results reflects a general pattern of carbon and nitrogen function at all tree ages, showing carbon reserve remobilization at budburst for growth, followed by carbon reserve formation during the leafy season and carbon reserve use during winter for maintenance. The variation in concentrations of nitrogen compounds shows less amplitude than that of carbon compounds. Storage as proteins occurs later which mainly depends on leaf nitrogen remobilization and root uptake in autumn. There are differences between tree age groups, particularly the loss of carbon storage function of fine and medium-sized roots with tree ageing. Moreover, the pattern of carbon compound accumulation in branches supports the hypothesis of a preferential allocation of carbon towards growth until the end of wood formation in juvenile trees, at the expense of the replenishment of carbon stores, while mature trees start allocating carbon to storage right after budburst. At key phenological stages, physiological and developmental functions differ with tree age, and together with environmental conditions, influence the carbon and nitrogen concentration variations in sessile oaks.

Sakai *et al*., (2012) estimated wood density and carbon and nitrogen concentrations in deadwood of *Chamaecyparis obtusa* and *Cryptomeria japonica.* They commented that estimation of carbon (C) and nitrogen (N) stocks in deadwood in forests nationwide is needed to understand large-scale C and N cycling. To do so, requires estimated values of wood density and C and N concentrations. Data were collected from 73 *Chamaecyparis obtusa* (Sieb. et Zucc.) Endl. It was assessd that wood densities decreased from 386 to 188 kg m^{-3} for *C. obtusa* and from 334 to 188 kg m^{-3} for *C. japonica* in decay classes. The variation in wood density increased with decay class, and the coefficient of variance increased from 13.9% to 46.4% for *C. obtusa* and from 15.2% to 48.1% for *C. japonica*. The N concentrations increased from 1.04 to 4.40 g kg^{-1} for *C. obtusa* and from 1.11 to 2.97 g kg^{-1} for *C. japonica* in decay classes 1-4. The variation in N concentration increased with decay class, and the coefficient of variance increased from 51.9% to 76.7% for *C. obtusa* and from 50.3% to 70.4% for *C. japonica*. Log diameter and region contributed to variations in wood density and N concentration in decay classes 1 and 2 for *C. obtusa* and *C. japonica*. However, no relationship was detected between regional climates and the two parameters. In contrast, C concentrations ranged from 507 to 535 g kg^{-1} and were stable with much lower coefficients of variance throughout the decay classes for both tree species. Thus, they recommend that the same C concentration can be adapted for all decay classes of both tree species.

In the context of above literature, the present study is dedicated to study carbon and nitrogen contents in woods of 37 tree species at Linares, northeastern Mexico.

Materials and Methods

Study area**:** This research was carried out at the Experimental Research Station of Universidad Autónoma de Nuevo León (24°47’ N; 99°32’ W; 350 m amsl) in Linares County, Nuevo León, México. The climate is subtropical or semiarid with warm summer, monthly mean air temperature vary from 14.7ºC in January to 23ºC in August, although during summer temperature goes up to 45ºC. Average annual precipitation is around 805 mm with a bimodal distribution (González-Rodríguez *et al.,* 2004). The dominant type of vegetation is the Tamaulipan thornscrub or subtropical thornscrub wood land. The dominant soil is deep, dark grey, lime-grey, vertisol with montmorrillonite, which shrink and swell remarkably in response to change in moisture content (González-Rodríguez *et al.,* 2004).

Plant material and methods: Wood samples were collected during summer, 2017. Woods of 37 woody shrubs and trees were collected and then dried in incubator at 60ºC for 7 to 10 days until fully dried. Then, each sample of wood of each species are powdered in mill. A 2.0 mg of the sample was weighed in a AD 6000 Perkin-Elmer balance in a vial of tin, bent perfectly. This was placed in CHONS analyzer Perkin Elmer (Model 2400) for determining carbon and nitrogen. For estimating the carbon and nitrogen contents, the samples were incinerated in a muffle oven at 550°C for 5 hours. Ashed sample was digested in a solution containing HCl and HNO_3, using the wet digestion technique (Cherney, 2000). We took data from five samples and taken average with standard deviation. The list of plant species included in this study are mentioned in Table 1.

Results

During summer, 2017, we collected woods of 37 trees and shrubs and following standard protocols for analysis of wood carbon and nitrogen content (%) of five replicated ashed samples and the results are given in Table 2. It is observed there was a large variation in both carbon and nitrogen percentage among the woody species studied. It is observed that carbon content varied from 37% to 51%. Similarly, the species showed variations in nitrogen content (0.56% to 1.97%). The species containing high wood nitrogen were *Acacia greggii* (1.98%), *Ebenopsis ebano* (1.97%), *Sideroxylon celestrinum* (1.75%), *Diospyros texana* (1.56%), and *Guaiacum angustifolia* (1.52%).

On the basis of the data mentioned, we selected woody trees and shrubs with high wood carbon content mentioned below.

Table 1. List of plants used for determining the carbon and nitrogen content in 37 woody species.

Family	Growth type	Scientific name
Fabaceae	Tree	*Acacia berlandieri* Benth.
Leguminoseae	Shrub	*Acacia farnesiana* (L.) Willd.
Leguminoseae	Shrub	*Acacia rigidula* Benth.
Mimosaceae	Tree	*Acacia schaffneri* (S.Watson) F.J.Herm.
Fabaceae	Tree	*Acacia wrightii* Benth.
Rutaceae	Shrub	*Amyris madrensis* S.Watson.
Rutaceae	Shrub	*Amyris texana* P.Wilson
Berberidaceae	Shrub	*Berberis chochoco* Schlecht.
Euphrobiaceae	Shrub	*Bernardia myricifolia* (Scheele) S.Watson.
Leguminoseae	Tree	*Caesalpinia mexicana* A.Gray
Ulmaceae	Tree	*Celtis laevigata* Willd.
Ulmaceae	Shrub	*Celtis pallida* Torr.
Leguminosae	Tree	*Cercidium macrum* I.M.Johnst.
Rhamnaceae	Shrub	*Condalia hookeri* M.C.Johnst.
Boraginaceae	Shrub	*Cordia boissieri* A.DC.
Euphrobiaceae	Shrub	*Croton suaveolens* Torr.
Ebenaceae	Shrub	*Diospyros palmeri* Eastw.
Ebenaceae	Shrub	*Diospyros texana* Scheele
Fabaceae	Tree	*Ebenopsis ebano* (Berland.) Barneby & J.W.Grimes
Boraginaceae	Shrub	*Ehretia anacua* I.M.Johnst.
Fabaceae	Shrub	*Eysenhardtia polystachya* (Ortega) Sarg.
Oleaceae	Shrub	*Forestiera angustifolia* Torr.
Zygophyllaceae	Shrub	*Guaiacum angustifolium* Engelm.
Asteraceae	Shrub	*Gymnosperma glutinosum* Less.
Fabaceae	Tree	*Harvadia pallens* Britton & Rose
Rutacea	Shrub	*Helietta parvifolia* (A.Gray ex Hemsl.) Benth.
Rhamnaceae	Shrub	*Karwinskia humboldtiana* (Schult.) Zucc.
Verbenaceae	Shrub	*Lantana macropoda* Torr.
Fabaceae	Shrub	*Leucaena leucocephala* (Lam.) de Wit
Scrophulariaceae	Shrub	*Leucophyllum frutescens* (Berland.) I.M.Johnst.
Caesalpiniaceae	Tree	*Parkinsonia aculeata* L.
Fabaceae	Tree	*Prosopis laevigata* (Humb. & Bonpl. ex Willd.) M.C.Johnst.
Fagaceae	Tree	*Quercus virginiana* Mill.
Salicaceae	Tree	*Salix lasiolepis* Benth.
Rutaceae	Tree	*Sargentia greggii* S.Watson
Sapotacee	Tree	*Sideroxylon celastrinum* (Kunth) T.D.Penn.
Rutaceae	Shrub	*Zanthoxylum fagara* Sarg.

Table 2. Carbon and nitrogen contents (%; mean and standard deviation) in woods of 37 woody trees and shrubs.

Scientific name	Carbon (%) mean	SD	Nitrogen (%) mean	SD
Acacia berlandieri Benth.	51.00	1.69	1.07	0.03
Acacia farnesiana (L.) Willd.	37.14	0.41	1.36	0.04
Acacia wrightii Benth.	48.60	1.98	0.97	0.04
Acacia rigidula Benth.	48.23	0.01	0.85	0.00
Acacia schaffneri (S.Watson) F.J.Herm.	40.22	0.31	0.96	0.02
Amyris madrensis S.Watson.	42.00	0.03	0.99	0.15
Amyris texana P.Wilson	49.70	1.18	1.18	0.07
Berberis chochoco Schlecht.	50.58	2.02	1.20	0.03
Bernardia myricifolia (Scheele) S.Watson.	51.12	0.28	1.27	0.04
Caesalpina mexicana A.Gray.	45.73	2.12	0.99	0.06
Celtis laevigata Willd.	44.79	2.35	0.87	0.00
Celtis pallida Torr.	46.39	1.83	1.15	0.03
Cercidium macrum I.M. Johnst.	43.44	1.40	1.36	0.15
Condalia hookeri M.C. Johnst.	43.26	2.67	0.71	0.04
Cordia boissieri A.DC.	38.55	0.38	1.26	0.02
Croton suaveolens Torr.	44.08	0.45	1.23	0.02
Diospyros palmeri Eastw.	43.86	0.78	1.01	0.00
Diospyros texana Scheele	39.87	1.39	1.64	0.02
Ebenopsis ebano (Berland.) Barneby & J.W. Grimes.	45.90	1.82	1.97	0.01
Ehretia anacua I.M.Johnst.	46.02	1.23	1.44	0.05
Eysenhardtia polystachya (Ortega) Sarg.	48.17	1.58	1.31	0.06
Forestiera angustifolia Torr.	41.81	0.06	0.49	0.06
Guaiacum angustifolium Engelm.	47.53	1.03	1.52	0.03
Gymnosperma glutinosum Less.	47.22	2.83	0.49	0.07
Havardia pallens Britton & Rose	50.36	0.74	0.77	0.01
Helietta parvifolia (A.Gray ex Hemsl.) Benth.	41.24	0.83	1.03	0.04
Karwinskia humboldtiana (Schult.) Zucc.	39.33	0.67	1.28	0.12
Lantana macropoda Torr.	36.38	0.01	0.55	0.02
Leucaena leucocephala (Lam.) de Wit	48.86	0.74	1.06	0.00
Leucophyllum frutescens (Berland.) I.M. Johnst.	50.84	0.17	0.66	0.02
Parkinsonia aculeata L.	36.50	0.18	1.29	0.06
Prosopis laevigata (Humb. & Bonpl. ex Willd.) M.C. Johnst.	47.63	0.45	1.29	0.13
Quercus virginiana Mill.	47.99	2.79	0.71	0.02
Salix lasiolepis Benth.	42.42	1.03	0.56	0.00
Sargentia greggii S.Watson	48.14	2.14	1.23	0.02
Sideroxylon celastrinum (Kunth) T.D. Penn.	46.92	2.33	1.75	0.02
Zanthoxylum fagara Sarg.	38.09	0.79	1.37	0.03

Discussion

In the context of above results, different authors mention the effect of global warming on forests and role of plants in capture of carbon dioxide (Peters, 1990). Wood carbon is a very important sink of atmospheric carbon which help in mitigation of climate change. It may be observed from Table 2 that many species contained more than 40% in wood carbon up to 50%, which could be an important source of bioenergy and carbon sink. We selected the five species with very high value of wood C (%); such as *Bernardia myricifolia* (51.12); *Acacia berlandieri* (51.00); *Leucophyllum frutescens* (50.84); *Berberis chochoco* (50.56); and *Havardia pallens* (50.36).

Our results show large interspecific variation in wood carbon content (37-51%) which coincides with the results of various authors mentioned before (Thomas & Malczewski, 2007; Rodríguez Laguna *et al.,* 2008, Pérez *et al.,* 2013; Martin *et al.,* 2015; Maiti *et al.,* 2015; Sakai *et al.,* 2012) and seasonal variation reported by Gilson *et al.,* (2014). The interspecific variations in C and N reflects variation in carbon cycle, nitrogen cycle and metabolism among species. These informations are usefull for ecologists and environmental specialists for interpretation on effects of climates (Westoby *et al.,* 2002; Westoby & Wright, 2006). The results of present study showed variation in wood carbon from 37 to 51% which coincide with the report of some authors (Thomas and

Malewiski, 2007), who reported variation from 46 to 51%. Wood carbon in conifers varied from 46 to 55%. It is suggested by Zeng (2008) it is necessary to keep atmospheric carbon dioxide to minimum level. Burying wood could minimize atmospheric carbon dioxide. The species having high wood carbon could have important fuction in this respect. We selected more than ten species for high carbon content (50%).

Conclusions

Thirty seven trees and shrubs of the Tamaulipan thornscrub, Northeatern Mexico, show large variations in both wood crbon and nitrogen which gives an opportunity of selection of species for different purposes such as sources of high bioenergy and high nitrogen. Species having high wood carbon have great potential of bioenergy and wood charcoal. These species having high wood carbon could help in storage of carbon for long time, for mitigation of climate change. Wood is a sink of atmospheric carbon for long time. It is highly recommended the five selected species having 50% or more. Wood C metioned above may be potential in cities, factories, sport areas, parks polluted with high carbon to reduce carbon from atmosphere. Besides, these could be recommended for incorporation in agroforestry for higher productivity of crops and timber. The leguminous woody species such as *Acacia* spp. and *Leucaena leucocephala* could improve soil fertility by their nitrogen fixation capacity. Similar to C content, variations were observed in N content (0.56-1.97) which coincides with findings of other authors (Lamlom & Savidge, 2003; Martin *et al.*, 2015).

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