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Potentiality of Carbon Sequestration in Six Year Ages Young Plant from University Campus of Aurangabad

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Abstract - Carbon sequestration in urban sectors and forest areas is of great attention due to its concerns about global climate change. In the present investigation aboveground carbon sequestration potential of six year young age Emblica officinalis, Mangifera indica, Tamarindus indica, Achras sapota, Annona retiaculata and Annona squamosa species from the university campus of Aurangabad is measured. The aboveground biomass rate of carbon sequestered was estimated using ash method. The percentage of carbon content in the aboveground and below ground biomass i.e. leaves, stem, branches, bark and root of Emblica officinalis were 43.67%, 52.89%, 53.91%, 53.59% and 55.68% respectively, in Mangifera indica were 49.28%, 50.65%, 50.43%, 52.11 and 53.88% carbon respectively, in Tamarindus indica were 53.47%, 57.53%, 56.84%, 55.85% and 54.63% carbon respectively, in Achras sapota were 53.63%, 52.4%, 53.72%, 48.42% and 49.52% carbon respectively, Annona retiaculata were 53.67, 57.24%, 55.24 53.08% and 51.62% respectively, Annona squamosa there were 52.08%, 55.09%, 55.33%, 56.01% and 52.04 respectively. The total above ground biomass carbon stalk per hectare as estimated for Emblica officinalis was 33.07 Kg C ha-1, in Mangifera indica it was 30.6 Kg C ha-1 and in Tamarindus indica it was 36.96 Kg C ha-1 and in Achras sapota were 12.86 Kg C ha-1 in Annona retiaculata was 83.1 Kg Cha-1 and for Annona squamosa it was 73.5 Kg C ha-1 in University campus.

Keywords : Aboveground biomass, belowground biomass, carbon sequestration potential, climate change, carbon stock.

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Abstract - Carbon sequestration in urban sectors and forest areas is of great attention due to its concerns about global climate change. In the present investigation aboveground carbon sequestration potential of six year young age *Emblica officinalis, Mangifera indica*, *Tamarindus indica*, *Achras sapota, Annona retiaculata* and *Annona squamosa* species from the university campus of Aurangabad is measured. The aboveground biomass rate of carbon sequestered was estimated using ash method. The percentage of carbon content in the aboveground and below ground biomass i.e. leaves, stem, branches, bark and root of *Emblica officinalis* were 43.67%, 52.89%, 53.91%, 53.59% and 55.68% respectively, in *Mangifera indica* were 49.28%, 50.65%, 50.43%, 52.11 and 53.88% carbon respectively, in *Tamarindus indica* were 53.47%, 57.53%, 56.84%, 55.85% and 54.63% carbon respectively, in *Achras sapota* were 53.63%, 52.4%, 53.72%, 48.42% and 49.52% carbon respectively, *Annona retiaculata* were 53.67, 57.24%, 55.24 53.08% and 51.62% respectively, *Annona squamosa* there were 52.08%, 55.09%, 55.33%, 56.01% and 52.04 respectively. The total above ground biomass carbon stalk per hectare as estimated for *Emblica officinalis* was 33.07 Kg C ha^{-1}, in *Mangifera indica* it was 30.6 Kg C ha^{-1} and in *Tamarindus indica* it was 36.96 Kg C ha^{-1} and in *Achras sapota* were 12.86 Kg C ha^{-1} in *Annona retiaculata* was 83.1 Kg Cha^{-1} and for *Annona squamosa* it was 73.5 Kg C ha^{-1} in University campus.

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I. Introduction

Carbon dioxide (CO_2) is a major contributing gas to the green house effect. It is one of the dominant greenhouse gases among them. The Kyoto Protocol prepared by the United Nations in the Framework of Convention on Climate Change stipulates Clean Development Mechanisms (CDM) and its Joint Implementation whereby storage of carbon in various terrestrial sinks may be acceptable for insertion in national greenhouse gas inventories of each nation. The increasing carbon emission is of major concerns all over the world and it has been well addressed in Kyoto protocol (Ravindranath et al., 1997; Chavan and Rasal, 2010). The rate of carbon storage increases in young tree species, while it declines after full growth as the stand ages (Jana, et al., 2009). Carbon sequestration is a natural method for the removal of carbon from the atmosphere by storing it in the biosphere (Dhruba, 2008; Chavan and Rasal, 2010). Biomass is defined as the total amount of aboveground living organic matter in trees expressed as oven-dry tons per unit area that reduces the concentration from atmospheric concentration of carbon dioxide (Brown, 1997; FORDA and JICA, 2005; Ravindranath and Ostwald, 2008). The atmospheric carbon dioxide is captured and stored in plants, soils, oceans, or atmosphere in the forms of biomass by photosynthesis process.

The amount of carbon sequestered continuously by a tree increases substantially over the time and age of tree till it matures. The process of carbon capture in photosynthesis is influenced by different factors including the tree age, leaf area and photosynthetic efficiency. The increasing carbon emission is of major concerns all over the world; it has been well addressed in Kyoto protocol (Ravindranath et al., 1997; Chavan and Rasal, 2010). The rate of carbon storage increases in young tree species, while it declines after full growth as the stand ages (Jana, et al., 2009). Above Ground Biomass (AGB) of tree includes all living biomass of all its parts above the soil, while Below Ground Biomass (BGB) includes all the plant biomass of live roots excluding the fine roots of sizes <2mm diameter (Ravindranath and Ostwald, 2008). Carbon sequestration in growing forests is known to be a cost-effective option for mitigation of global warming and global climatic change. The objective of this study is to measure carbon sequestered from selective tree species of *Emblica officinalis, Mangifera indica*, *Tamarindus indica*, *Achras sapota, Annona retiaculata* and *Annona squamosa* grown in the University campus in Aurangabad city, Maharashtra in India.

II. Methodology

a) Site and study area

The study area selected in present investigation for the estimation of above ground biomass and below ground biomass and carbon sequestration was the University campus of Aurangabad, which is located at

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the latitude 19^{O}53'47"N and longitude 75^{O}23'54"E. The university campus is lousy green and covers about 140 hectares area under the plantation program for selected tree species. The tree species *Emblica officinalis, Mangifera indica*, *Tamarindus indica*, *Achras sapota, Annona retiaculata* and *Annona squamosa* selected for present investigation are from the plots grown on the university campus. The weather of Aurangabad is dry and moderately extreme. The average day temperature ranges from 27.7^{0} C to 38.0^{0} C. It falls from 26.9^{0}C to 20.0^{0}C during night. Relative humidity is extremely low for major part of the year and ranges between 30% and 50%, while it is highest 85% during monsoon. The average rainfall is about 90 cm. It is rather variable from year to year (ESRAM, 2009).

b) Estimation of carbon sequestered in different parts of six year tree species

The tree biomass includes the total of Above Ground Biomass (AGB) and Below Ground Biomass (BGB). The above ground biomass studied includes all above ground materials covering stem, braches, leaves, bark and below ground biomass consist coarse roots and stumps. The estimation of biomass in the plant was performed by measuring the tree height and diameter of plant species. Weight of the wood biomass has been calculated by multiplying the volume of biomass and specific gravity (SG) of the plant. The specific gravity (SG) considered is the ratio of oven dry weight and green volume of plant.

The organic carbon storage in selected tree species of *Emblica officinalis, Mangifera indica*, *Tamarindus indica*, *Achras sapota, Annona retiaculata* and *Annona squamosa* was estimated by Ash Method as described elsewhere (Allen, et al., 1986; Negi, et al., 2003; Jana, et al., 2009). The leaves, stem, sub branches, bark and root of each species were separated to estimate carbon by Ash method. The fresh weight of each part of all species washed with distilled water and dried with tissue paper immediately was taken then oven dried for moisture removal at 80^{0}C for 24 hrs. Oven dried sample were taken in pre-weighed crucible. The crucibles were placed in the Muffle furnace adjusted at 400^{0} C, ignition was carried out for 2.30 hrs. The crucible was cooled slowly inside the desiccators. After cooling the crucible with ash were weighed and percentage of organic carbon were calculated as formulae given by Allen et al, (1986).

$$\boldsymbol{C}\% = (100 - Ash\%) \times 0.58 \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, *C* is the organic carbon; W1is weight of crucibles, W2 is weight of oven-dried grind samples with Crucibles, and W3 the weight of ash with Crucibles.

In the present study we have estimated the aboveground biomass stocks, belowground biomass and carbon stocks taking volume of biomass and specific gravity (SG) of the tree, as described by many researchers (Rajput et al., 1996; Jana et al., 2009; Negi et al., 2003).

$$\boldsymbol{SG} = \frac{Oven\ dry\ weight}{Green\ volume} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Biomass = Volume of Biomass X Specific Gravity... (3)

$$\boldsymbol{Carbon} = Biomass\ X\ Carbon\% \ldots\ldots\ldots\ldots (4)$$

III. Results and Discussion

The estimation of the above biomass in the selected tree species was performed by estimating carbon percentage and by knowing the tree height, diameter, and girth size.

Biomass carbon content: The Aboveground biomass (AGB) and Belowground biomass (BGB) of the tree such as leaves, stems, branches (including sub-branches), bark and root have been collected and dried at laboratory. The results of biomass analysis by ash method are presented in Figures. Total carbon stalk of a tree has been evaluated by the sum of all the carbon contents of leaves, stem, sub-branches and bark of the tree. The carbon concentration of different tree parts was rarely measured directly, but generally assumed to be 50% of the dry weight (Losi et al., 2003; Jana et al.,2009). The content of carbon in woody biomass any component of forest on average is around 50% of dry matter (Paladinic et al., 2009). The percentage of carbon in fresh biomass and in each component of the tree, as well as in the whole tree were calculated based on percentage of carbon in the dry biomass of the aboveground and belowground of all components of the leaves, stem, branches, bark, and root. Based on these results, the capacity to stored carbon in individual parts of the tree, in the whole tree and in fresh and dry biomass was compared.

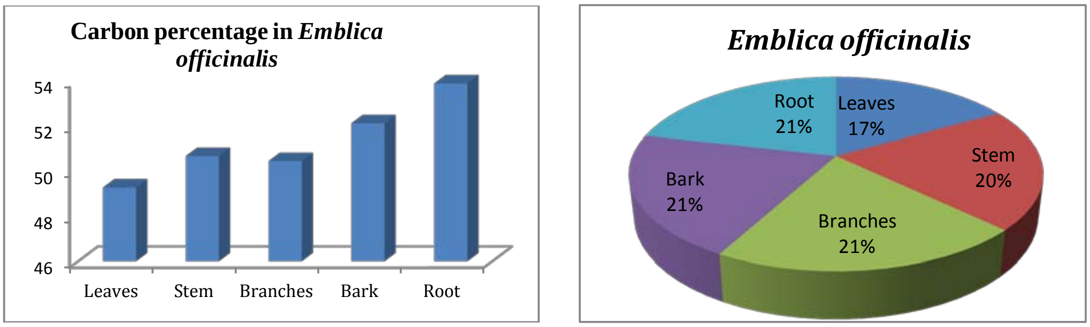

Fig. 1: Carbon percentage in components of young *Emblica officinalis* tree parts (Bar chart) and proportion of whole tree components (Pie diagram).

It is observed for the percentage of carbon content in the aboveground and below ground biomass i.e. leaves, stem, branches, bark and root of *Emblica officinalis* were 43.67%, 52.89%, 53.91%, 53.59% and 55.68% respectively. The highest carbon percentage was shown in branches, bark and root it was 21% belowground biomass than the aboveground. The carbon percentages in the components of six year young *Emblica officinalis* tree parts (Bar chart) and proportion of whole tree components (Pie diagram) (Fig.1).

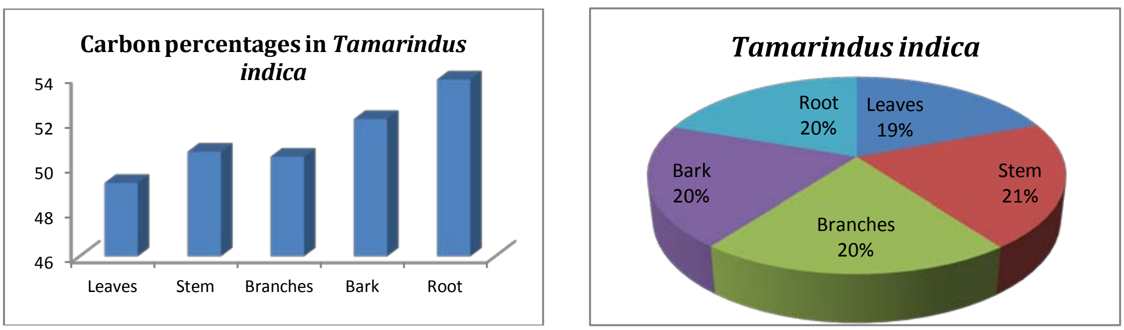

Fig.2 : Carbon percentage in components of young *Tamarindus indica* tree parts (Bar chart) and proportion of whole tree components (Pie diagram).

The percentage of carbon content in the ABG and BGB i.e. leaves, stem, branches, bark and root of *Tamarindus indica* carbon percentage were 53.47%, 57.53%, 56.84%, 55.85% and 54.63% respectively. The highest carbon percentage was noticed in the leaves in aboveground than the belowground plant parts. The carbon percentages in the components of six year young *Tamarindus indica* tree parts (Bar chart) and proportion of whole tree components (Pie diagram) (Fig.2).

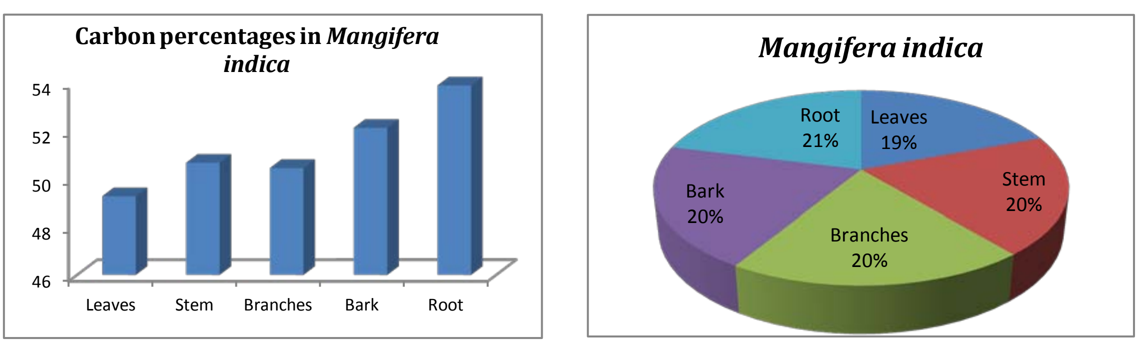

Fig.3 : Carbon percentage in components of young *Mangifera indica* tree parts (Bar chart) and proportion in whole tree components (Pie diagram).

The percentage of carbon content in the ABG and BGB i.e. leaves, stem, branches, bark and root of *Mangifera indica* in its different parts were 49.28%, 50.65%, 50.43%, 52.11 and 53.88% carbon respectively. The highest carbon percentage was observed in belowground plant part in root than the aboveground plant parts. The carbon percentages in the components of six year young *Mangifera indica* tree parts (Bar chart) and proportion of whole tree components (Pie diagram) (Fig.3).

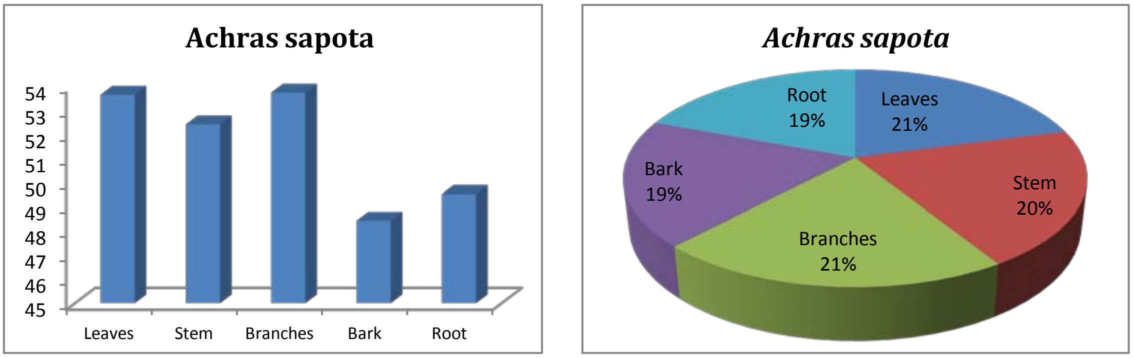

Fig.4 : Carbon percentage in components of young *Achras sapota* tree parts (Bar chart) and proportion of whole tree components (Pie diagram).

The percentage of carbon content in the ABG and BGB i.e. leaves, stem, branches, bark and root of *Achras sapota* were 53.63%, 52.4%, 53.72%, 48.42% and 49.52% carbon respectively. The highest carbon percentage was observed in stem in ABG than BGB plant parts. The carbon percentages in the components of six year young *Achras sapota* tree parts (Bar chart) and proportion of whole tree components (Pie diagram) (Fig.4).

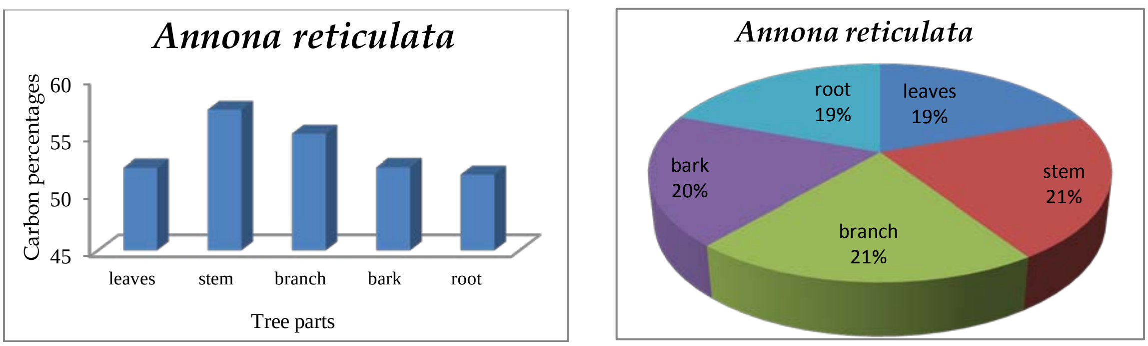

Fig.5 : Carbon percentage in components of young *Annona reticulata* tree parts (Bar chart) and proportion of whole tree components (Pie diagram).

It is observed for the percentage of carbon content in the aboveground and below ground biomass i.e. leaves, stem, branches, bark and root of *Annona retiaculata* were 53.67, 57.24%, 55.24 53.08% and 51.62% respectively. The highest carbon percentage was observed in stem in AGB than BGB plant parts (Fig.4). The carbon percentages in the components of six year young *Annona retiaculata* tree parts (Bar chart) and proportion of whole tree components (Pie diagram) (Fig.5).

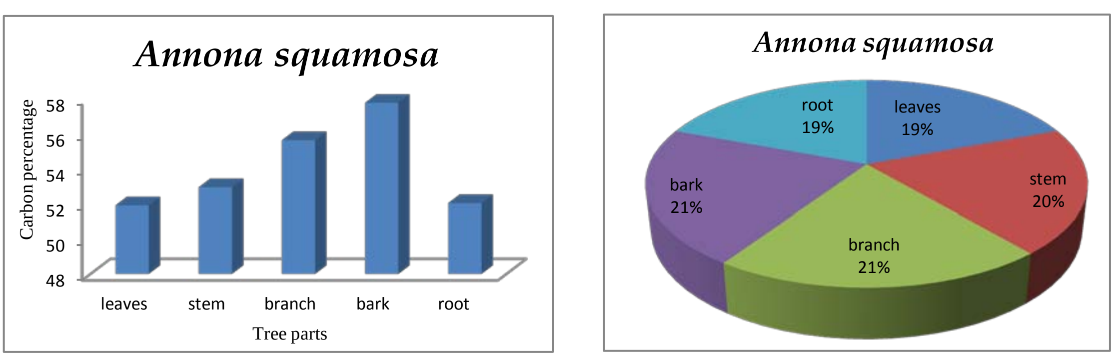

Fig.6: Carbon percentage in components of young *Emblica officinalis* tree parts (Bar chart) and proportion of whole tree components (Pie diagram).

The carbon percentage in components of ABG and BGB i.e. leaves, stem, branches, bark and root of *Annona squamosa* there were 52.08%, 55.09%, 55.33%, 56.01% and 52.04 respectively. The highest carbon percentage was observed in bark in AGB than BGB plant parts. The carbon percentages in the components of six year young *Annona retiaculata* tree parts (Bar chart) and proportion of whole tree components (Pie diagram) (Fig.6).

Table 1: Total biomass and carbon in trees of six year age

Tree species	Specific gravity	Biomass (Kg/tree)	Biomass (Kg ha^{-1})	Carbon (Kg C ha^{-1})
Emblica officinalis	0.63	0.067	63.31	33.07
Mangifera indica	0.56	0.038	58.14	30.6
Tamarindus indica	0.50	0.051	67.32	36.96
Achras sapota	0.54	0.057	23.65	12.86
Annona reticulata	0.43	0.102	153	83.1
Annona squamosa	0.50	0.090	135	73.5

The estimation of total amount of stored carbon in a tree should be based on biomass of components of whole tree. Using data collected from a typical tree, the fresh biomass of the tree components were determined, while the dry biomass of the component was estimated using sample analysis. The specific gravity, total biomass and total carbon content after six years of age in *Emblica officinalis, Mangifera indica*, *Tamarindus indica*, *Achras sapota*, *Annona reticulata* and *Annona squamosa* is shown in Table 1.

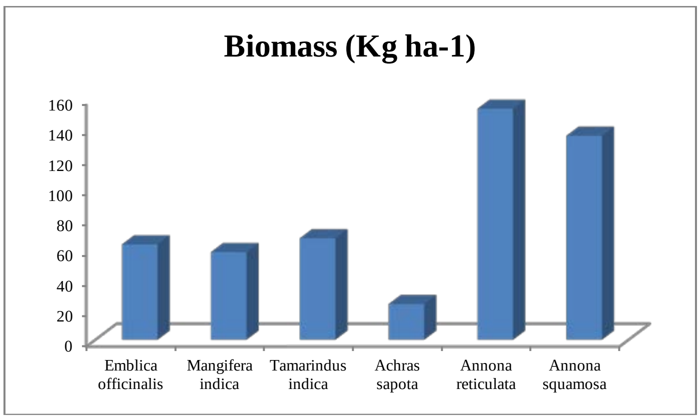

Fig.7: Total biomass in young tree species (Kg ha^{-1})

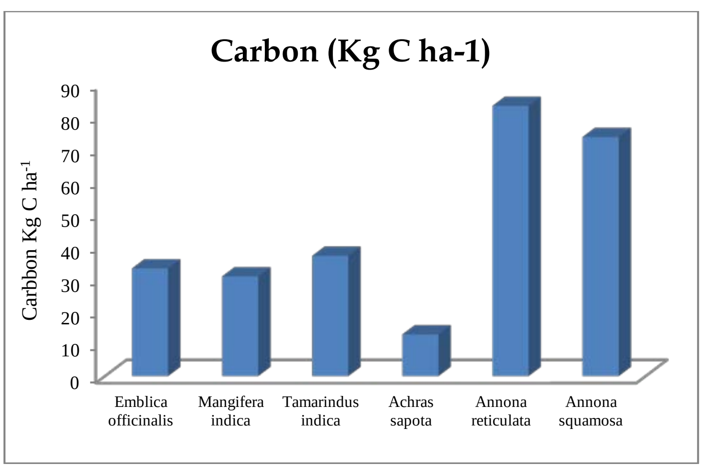

Fig.8 : Total carbon content in young tree species (Kg C ha^{-1})

It is evident that the total of aboveground biomass and Belowground biomass content together as in *Emblica officinalis, Mangifera indica*, *Tamarindus indica*, *Achras sapota*, *Annona reticulata* and *Annona squamosa* for per hectare observed were 63.31 Kg ha^{-1}, 58.14 Kg ha^{-1} , 67.32 Kg ha^{-1}, 23.65 Kg ha^{-1}, 153 Kg ha^{-1} and 135 Kg ha^{-1} respectively (Table 1 & Fig.7).

As per Table 1 & fig. 8 the total of aboveground biomass and belowground biomass together as sequestered carbon stalk per hectare as estimated for *Emblica officinalis* was 33.07 Kg C ha^{-1}, in *Mangifera indica* it was 30.6 Kg C ha^{-1}, in *Tamarindus indica* it was 36.96 Kg C ha^{-1}, in *Achras sapota* it was 12.86 Kg C ha^{-1}, in *Annona retiaculata* it was 83.1 Kg C ha^{-1} and in *Annona squamosa*, it was 73.5 Kg C ha^{-1}.

IV. Conclusion

The total carbon content of from Dr. B. A. M. University area were The total of AGB and BGB together as carbon stalk per hectare as estimated for *Emblica officinalis* was 33.07 Kg C ha^{-1}, in *Mangifera indica* it was 30.6 Kg C ha^{-1}, in *Tamarindus indica* it was 36.96 Kg C ha^{-1}, in *Achras sapota* it was 12.86 Kg C ha^{-1}, in *Annona retiaculata* it was 83.1 Kg C ha^{-1} and in *Annona squamosa*, it was 73.5 Kg C ha^{-1} respectively.

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