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Effect of wood density on above-ground biomass while measuring the mango trees

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ABSTRACT

Capital city of Uttar Pradesh Lucknow, comes in the Northern sub-tropical region of India. It comes under the central plain region and contains highly fertile soil for agriculture, but Lucknow and its nearby districts such as Hardoi, Sitapur, and Unnao are known for the finest Mango (*Mangifera indica*) cultivars, 'Dashehari' is one of them. The 'Dashehari' an endemic mango landrace is famous across the country. 'Dashehari' trees are huge and have a wide canopy, which influences mitigating the atmospheric carbon through balancing the carbon cycle. This study has been focused on the estimation of 'Dashehari' tree biomass. In this research, an effort has been done to minimize error and standardize key factors while estimating tree biomass. Although, generalized allometric equations have mainly been used as a forest measuring tool to estimate above-ground biomass, but applying these equations to other commercial trees, either gives uncertain results or which varies too much differently. Therefore, eighty years old seedlings of Dashehari trees were harvested with a legal permit. Above-ground biomass of every mango tree has been calculated by the destructive method as well as non-destructive methods. Subsequently, measurements of the trees and comparative findings were evaluated by statistical analysis. The study showed that by the non-destructive method, wood density influences the estimation of the biomass of the tree. Above-ground biomass was recorded as higher than the destructive method while using standard wood density value (0.60 g cm^{-3}), whereas above-ground biomass was recorded as almost similar to the destructive method while using modified wood density (0.48 g cm^{-3}).

1. Introduction

The terrestrial ecosystem plays an important role in carbon sequestration. According to Houghton (1996), almost 90% of the world's terrestrial carbon is stored in the forest, out of which 50 to 55 % of carbon is stored in the tropical forest which protects from the effect of climate change (Ngo *et al.*, 2013; Aryal *et al.*, 2014; Lewis *et al.,* 2015; Di porcia *et al.*, 2019; Jones *et al.*, 2019). Tree biomass influences biodiversity through its different shapes, sizes, and structures and is also useful for estimating forest productivity and carbon storage in Europe (Kauppi *et al.*, 1992), Central Amazon Forest (Chambers *et al.*, 2001), and the Brazilian Amazon (Brown and Lugo, 1992). As the tree grows, atmospheric CO_2 is stored in tree biomass through the process of photosynthesis. According to the Global Forest Resources Assessment report world forest stores 43.8% carbon in tree biomass, 11% in deadwood and litter, and the remaining 45.2% in the soil (FAO, 2020). Above ground biomass (trees, herbs), below-ground biomass (roots), litter, deadwood and soil organic matter, are the major carbon pools in any ecosystem (FAO, 2005, 2010, 2020; IPCC, 2006). The quality of the world's forests shows the potential of carbon pools and stored carbon in the tree biomass (Chauhan *et al.*, 2019; Panwar *et al.*, 2017; Chauhan *et al.,* 2015; Brown *et al.*, 1999).

Mangifera indica is one of the species of flowering plant belonging to the *Anacardiaceae* family. Although mango cultivation has adopted various climatic conditions but, cool or dry condition is prior to flowering, moist with moderate hot temperature (30–33 °C) is favourable during fruit development (Laxman *et al.*, 2016). Today, mango production is increasing globally. More than 1,000 cultivars

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*Corresponding author: akka0444@gmail.com of mango are grown with a unique flavor. It contains micronutrients such as minerals and vitamins and also have macronutrients such as amino acids, lipids, protein, carbohydrates, and fatty acids (Maldonado-Celis *et al.*, 2019).

In India, Mango is one of the popular tropical fruit and is cultivated almost in every state. Mango plantation covers 22581.3 km^2 areas, out of which Uttar Pradesh covers 2649.30 km^2 in 2017 and 2656.20 km^2 in 2018 (Welfare, F. 2018). After Andhra Pradesh, the second-largest mango-producing state is Uttar Pradesh in India (Paul, 2014). Malihabad, Uttar Pradesh has the largest 14 mango belt covering 300 km^2 of the area under cultivation. Malihabad, Lucknow, Mal, Kakori, and Bakshi ka Talab are the main cultivated areas of mango orchards. ʽDashehari', ʽLangra', ʽChaunsa', ʽLucknow Safeda', ʽBombay Green', and ʽRamkela' are the popular commercial mango cultivars in the Northern sub-tropical region in India. However, the abundance of mango orchards may have stored a huge amount of carbon in their entire biomass but, there is a lack of data on the total contribution of carbon sequestration. It is necessary to calculate accurate biomass and its contribution to sequestrated carbon (Chaturvedi *et al.,* 2012; Chaturvedi and Raghubanshi, 2013). Therefore it is necessary to quantify the contribution of mango trees to carbon sequestration.

Biomass can be measured by destructive (clear-cut harvesting and weighing) and non-destructive methods (based on field measurement without cutting the tree). Since tree cutting is banned in most of the countries, therefore allometric equations have been widely using for non-destructive measurements while estimating of above-ground biomass (Brown, 1997). AGB of the tree and sequestrated carbon within the tree are directly quantified by the allometric equations which includes diameter of tree trunk at the breast height and total height of the tree. The quality of the allometric model represents one of the most important limitations in assessing AGB stocks (Skole *et al.,* 2011; Clark and Kellner, 2012; Ganeshamurthy *et al.,* 2016; Saral *et al.,* 2017). Total 279 allometric equations were compiled for the estimation of tree biomass, of which 169 equations were developed in the USA (Ter-Mikaelian and Korzukhin, 1997). Most of the developed equations were aimed to be calculating the carbon budget at a large scale by forestry (Chave *et al.,* 2005, 2014; Paul *et al.,* 2013). These equations were widely used as a draft for biomass estimation in particular tree species. However, generalized allometric equations have primarily been used as a forest measuring tool to estimate AGB, but applying these equations to other commercial trees gives uncertain results (Daba and Soromessa, 2019). If we only consider the density of wood as an important factor, then there may be a huge difference in the entire result. Wood density (WD) is a key parameter for non-destructive measurement, which shows the compactness of woody tissue in a tree. Wood density is acknowledged as an important factor of differences in above-ground biomass over succession gradients (Ketterings *et al.,* 2001). Usually, the standard value of WD 0.60 g cm^{-3} is considered in the non-destructive method (Brown *et al.,* 1997; Zanne *et al.,* 2009; Pandya *et al.,* 2013; Saral *et al.,* 2017). The principal objective of conducting this study was to evaluate if the standard value of WD (0.6 g cm^{-3}) will give better results while calculating the biomass of the ʽDashehari' tree. The study also aimed to minimize error while measuring biomass through the non-destructive method by finding essential parameters and finding out the wood density of a seedling ʽDashehari' tree. Apart from this, purpose of the study was also to figure out the relationship between the tree biomass and their wood density. The findings on the biomass of Dashehari will be helpful for further study in course of assessing carbon storage.

2. Material and methods

2.1 Experimental site

The study was conducted at two sites. Sampling site was located at Kakori (Figure. 1), Lucknow (U.P, whereas the laboratory analysis was done 9 km away from sampling site, at ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Kakori, Lucknow (U.P.) between 80°80′ E 26°88′ N at 128 m above sea level. In the winter season temperature may fall to 3 – 4 °C and in summer maximum temperature rises to 47- 48 °C. The annual average rainfall is 850 - 900 mm with maximum rainfall take place between June to September. Soil is saline and sodic in nature which contains alluvial- sandy, alluvial clayed soil (Dept of horticulture 2016).

2.2 Field measurements

Eighty years of 9 "Dashehari" mango trees were selected with almost the same and free from damage and disease. Selected every 9 trees were harvested from 9 different plots with 50 × 50 m in size and covered with 25 mango trees (Figure 2). Destructive and non-destructive methodologies were conducted to estimate the total tree biomass. All trees were harvested to standardize non-destructive parameters such as height of the tree (h), length and volume of all primary and secondary branches, and wood density (ρ) while estimating accurate biomass of the trees (Figure. 3) with the legal permission from the Forest and Wildlife Department, Government of Uttar Pradesh. during developmental work of road widening.

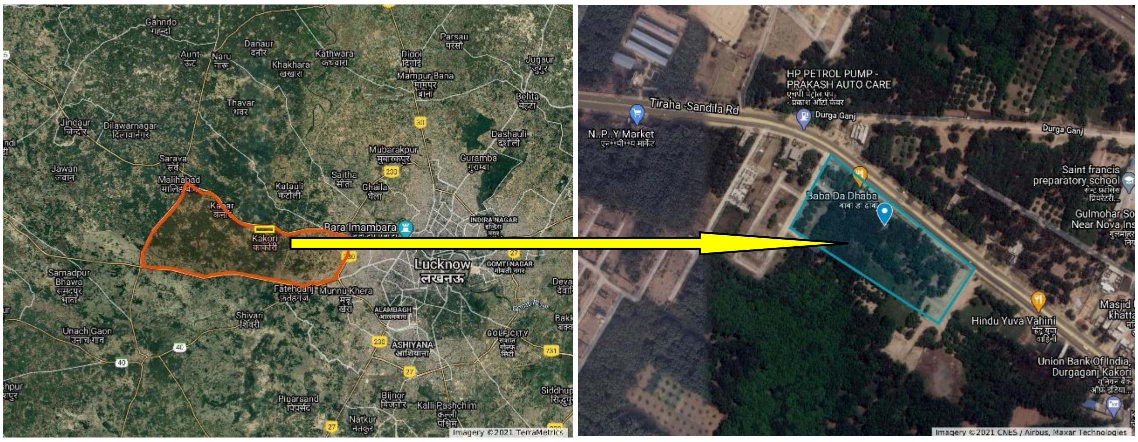

Figure 1. Google map imagery of sampling site Kakori, (Uttar Pradesh), INDIA, Jan 2022

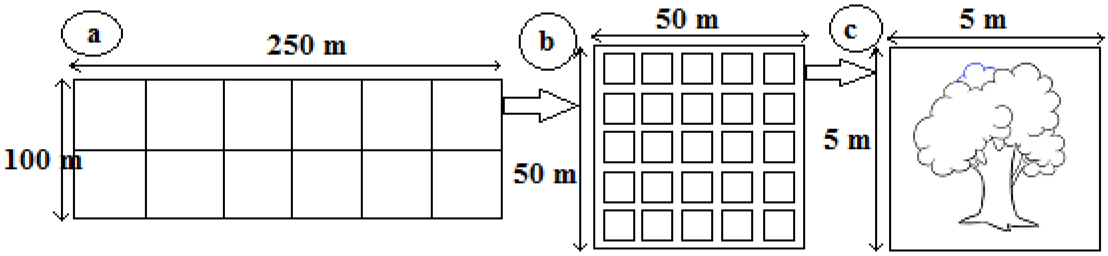

Figure 2. Cluster sampling (a), 50 × 50 m site with 25 mango orchard (b), 5 × 5 m sample of the tree (c)

Figure 3. Wood logs of Dashehari tree for destructive measurements

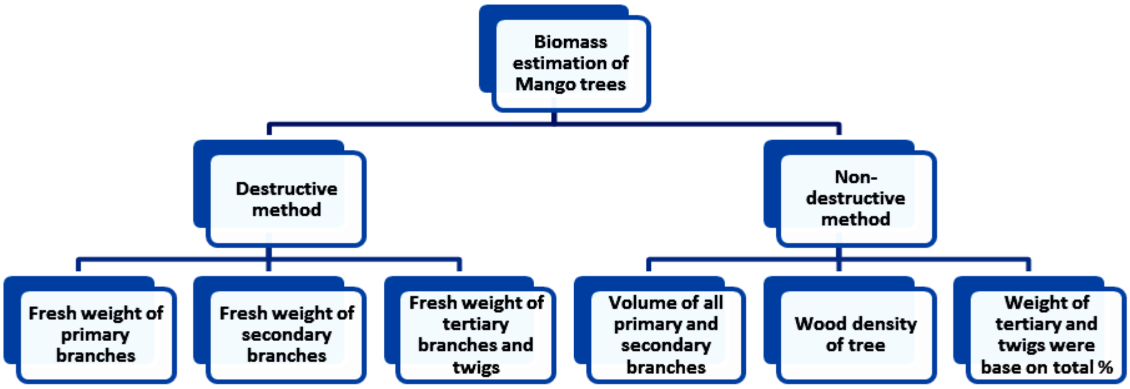

Figure 4. Flow diagram of both destructive and non-destructive methods for the estimation of tree biomass

2.3 Data analysis

Tree height and Diameter at breast height

The height of the trees was recorded with the help of a Haga, analog altimeter, and measuring tape. Although, the diameter at breast height was measured at 1.3 m (Brown, 1997) above the ground level but, the length of the tree trunks was found less than 1.3 m so; the basal diameter was recorded.

Volume

Volumes of all major parts such as; the trunk, primary branches, and secondary branches were calculated by non-destructive methods. To calculate the volume of all branches, diameters were noted with the help of a tree caliper at 3 positions, bottom and top which were at 10 cm below and 10 cm above the bifurcation points and also at maximum thickness. The lengths of each primary and secondary branch were recorded. Mean variables of diameters and height were obtained directly from field measurements. Further, their volumes were calculated according to Kushwaha *et al.*, 2021.

$$\text{Volume of cylinder} = \pi r^2 H$$

Where, π = 3.14, r = radius (maximum thickness) and H = total height/length of the tree.

Wood density

Usually, the mean value of wood density of 0.6 g cm^{-3} was considered as the standard value for the non-destructive method (Brown, 1997; Zanne *et al.,* 2009; Pandya *et al.,* 2013; Laxman *et al.,* 2016), but in the present study, wood density was obtained by the destructive method for which 90 wood samples were collected from the trunk and primary branches, 10 samples were from each tree, five from the leading primary branch moving from the bottom to the top and five from the bottom of the trunk (Figure 5, 6, 7). Samples from primary branches were collected between 10 cm below the bifurcation point of the secondary branch and 10 cm above the tree bole. Samples from tree trunks were collected from pith to cork cambium named; A1, A2, A3, A4, and A5 (Figure 8). The fresh weight of all samples was taken and kept for oven drying in Digital hot air of Decibel. The weight of samples was recorded at the interval of every 24 hours until its constant weight is obtained which were kept under oven-dry conditions at 100 ± 5 °C for 48 to 72 hours and further calculated by:

$$\text{Wood density (g cm}^{-3}\text{)} = \frac{\text{Oven dry weight of the sample (g)}}{\text{Volume of sample (cm}^3\text{)}}$$

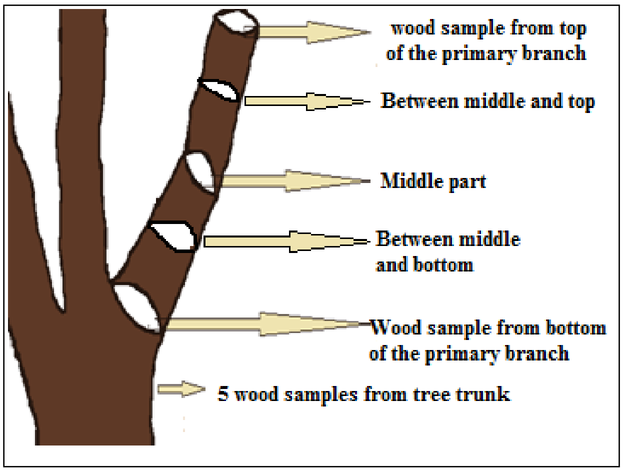

Figure 5. Position of wood samples taken from primary branches

Figure 6. Cross section of wood from the primary branch

Figure 7. Wood sample from a cross-section

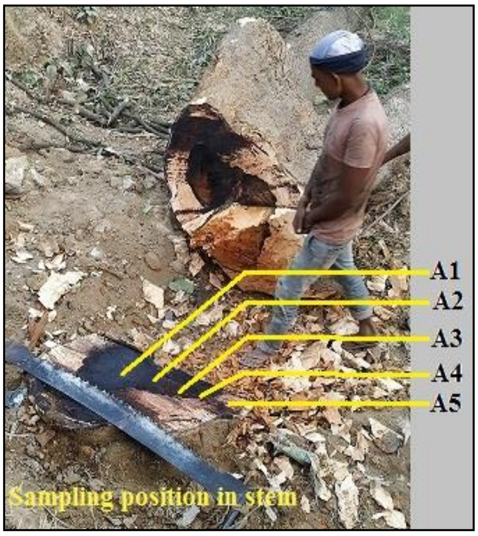

Figure 8. Wood samples taken from trunk (pith to cambium)

Above-ground biomass (AGB)

Above-ground biomass was obtained by destructive as well as non-destructive method also. In the destructive method, entire trees were harvested, and fresh above-ground biomass (tree trunk, all primary, secondary and tertiary branches, twigs leaves) was taken separately. In the non-destructive method, above-ground biomass has been calculated by multiplying the volume of all major branches and the wood density (Ravindranath and Ostwald, 2008).

AGB (kg) = volume of tree (m^3) × wood density (kg m^{-3}).

Where the volume of the tree includes all primary and secondary branches and trunk. Tertiary and twigs were calculated based on the contribution percentage obtained by the destructive method and further above-ground biomass was obtained by the sum of all major parts.

In this experiment, two values of wood density have been taken; wood density obtained by the destructive method as well as the standard value of wood density 0.06 gcm^{-3} (Brown,1997).

Below-ground biomass (BGB)

Below-ground biomass has been calculated by multiplying above-ground biomass and 0.26 for mango in destructive as well as non-destructive methods according to the works of Cairns *et al.,* (1997), Ravindranath and Ostwald (2008), and Chavan and Rasal (2012).

Total biomass

Estimation of above-ground biomass was based on the volume of the branches and wood density of a tree and below-ground biomass was obtained by multiplying 0.26 in above-ground biomass. So, the total biomass of the tree was calculated by adding above and below-ground biomass.

Total biomass(Kg) = Above ground biomass(Kg) + Below ground biomass(Kg)

Statistical design and analysis

The present experiment was carried out by a cluster sampling technique. The cluster was randomly selected and each major element was followed by three treatments, T1 (Destructive method), T2 (Non-destructive method with WD 0.48 g cm^{-3}), and T3 (Non-destructive method with WD 0.60 g cm^{-3}) including three replication per treatment. Data were summarized on an MS Excel sheet and further Analysis of variance (ANOVA) was carried out to evaluate the variation in wood density. The correlation between T1, T2, and T3 was checked by the statistical PAST software (version 3).

3. Results and discussion

3.1 Tree height and DBH

The height of the trees was ranging from 16.3 to 19.9 m in the non-destructive method but the actual heights of the trees were recorded between 18.13 to 20.22 m by the destructive method. Variation was shown between the actual height of the tree and by non-destructive measurements (Figure 9). The mean height of the tree was 19.26 m by the destructive method and 18.30 m by the non-destructive method. The heights of the trees by the non-destructive method were 4.98% less than the actual height. It may be due to the standing position and angle of the altimeter while taking measurements. There may be an error in height measurement by the traditional method and non-destructive methods earlier reported by Tackenberg (2007). The height of the tree was not considered while estimating AGB, because if all the branches lengths were taken separately, then there is no need to include tree height while estimating AGB. Such a finding was earlier reported by Lewis *et al.,* (2009). The length of tree trunks was varying between 0.99 and 1.11 m among treatments. The basal diameters of the trunk were between 0.626 and 0.69 m. Some of the sampled trees had observed the same diameter and others were found to be different in tree trunks but, the height of all trees was different. Earlier reports (King, 1996; Litton and Boone Kauffman, 2008) show that trees at the same DBH may vary significantly among species.

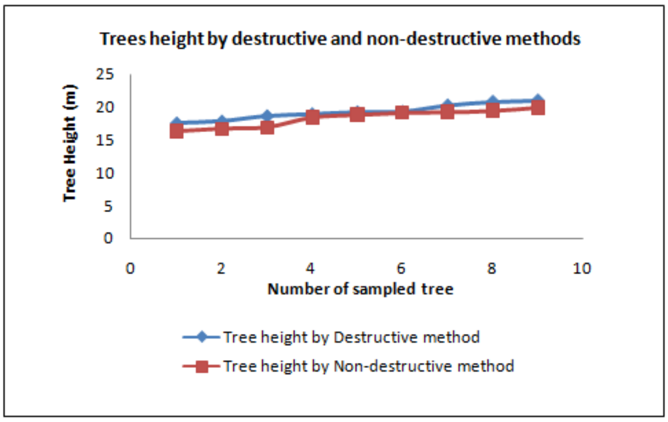

Figure 9. Variation in trees height by destructive and non-destructive methods

3.2 The volume of the branches

The total average numbers of primary and secondary branches varied between 4 and 8. The radius of primary branches was between 0.211 and 0.12 m and the length was from 7.03 to 11.39 m. The radius of secondary branches was found between 0.061 and 0.189 m and the length was from 2.4 to 8.3 m. The radius of the average tree trunk was 0.331m, and the length was 1.06 m. The diameter of all primary and secondary branches was found to be higher at the bottom and less at the top with increasing length but the diameter of the tree trunk was not the same. The diameter of the trunk was found less at the bottom part and more at the upper part. The lengths of all branches were different from one another. The average volume of primary branches was found between 0.515 and 0.983 m^3 (Figure 10). Average volumes of secondary branches were ranging from 0.087 to 0.316 m^3 and the trunk was 0.364 m^3 (Figure 11). As result, the volume of all branches exhibited a decreasing trend with an increase in length, but volume was increasing with the increasing diameter. It shows that the diameter and volume were directly proportional to each other. Earlier findings were reported by Kushwaha *et al.,* (2021) where the volume of primary and secondary branches were increasing with the radius of the branches in the 'Dashehari' mango tree. On the other hand, volume and length were inversely proportional to each other. A decreasing trend with an increase in length from bottom to top was reported earlier by Devi & Yadava (2009) in the tropical forest of India and Ravindranath and Ostwald (2008) globally.

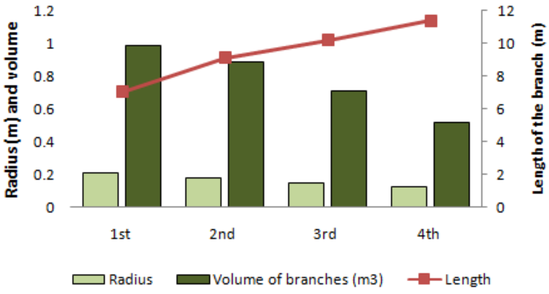

Figure 10. Volume of the average number of primary branches by radius and length

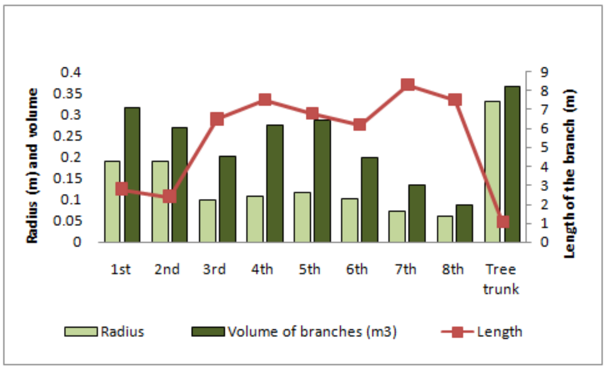

Figure 11. Volume of the average number of secondary branches by radius and length

3.3 WD of mango trees

In the primary branch, the wood density of 0.46 g cm^{-3} in the upper, 0.482 g cm^{-3} in the middle, and 0.5 g cm^{-3} at the bottom portion was obtained by the destructive method (Figure 12). Wood density of the tree's trunk was obtained between 0.43 to 0.57 g cm^{-3} from pith to cambium (Figure 13). In the primary branch, the highest wood density was found at the bifurcation point of the trunk and primary branch, while moving upward, wood density was lowest. Wood density shows a decreasing trend from bottom to top. Gupta *et al.,* (2017) reported that wood specific gravity (WSG) of the stem was higher than both the primary and secondary branches and the primary branch was also higher than the WSG of the secondary branch. However, in the trunk, WD was obtained higher than the primary branch but, values were decreased from the pith (medulla) to the cambium (outer layer of the trunk below the bark). The inner part of the tree trunk contains the highest wood density throughout the entire tree. WD of trunk from pith to cambium (bark) was decreasing which is similar to the earlier finding by Henry *et al.,* (2010). Similar findings were reported in tropical trees by King *et al.,* (2006) where the growth rate increases with a decreasing rate of WD. The mean WD of the 'Dashehari' mango tree, increased significantly (0.07 g cm^{-3}) between the tree trunk (0.4788 ± 0.0036 g cm^{-3}) and primary branch (0.5488 ± 0.0232 g cm^{-3}), likewise, the WD of seedling 'Dashehari' mango tree (n = 90) averaged 0.480 ± 0.2267 g cm^{-3} from the trunk and the primary branch was obtained (two tail sample t-test, $p < 0.05$). Here, we have found that both paired variables were statistically not significant which shows a weak relationship. The value of WD was not only varied from tree to tree but also found to be different in each part of the tree. In earlier reports, WD not only varies from tree to tree but also varies between branches of each tree, even within the tree trunk (Henry *et al.,* 2010). The mean WD value of the mango tree was found 0.48 g cm^{-3} or 480 kg m^{-3} by the destructive method (Figure 12, 13) which was less than the earlier findings. In general, the earlier findings for WD of *Mangifera indica* from Karnataka, India 0.59 g cm^{-3} (Prabha *et al.,* 2017), and 0.66 g cm^{-3} from Anantapur, India (Vasubsbu *et al.,* 2015) respectively. As result, the value of WD was varying due to some major factors such as the effect of the location of the tree, variation in climatic conditions, and varietal differences of mango. Similar findings were earlier reported by Resquin *et al.,* (2019) who showed that differences in WD respond according to location and density of stock but, an increase in WD with the age of the crop, it only happened in the tropical forest; in Costa Rica, Panama, Puerto Rica and Ecuador was reported by Stegen *et al.,* (2009). In this study, WD was found to be an essential parameter while estimating AGB. The value of WD is an essential parameter for calculating biomass and sequestrated carbon by the forests (Brown and Lugo, 1984, 1992).

3.4 Above and below-ground biomass

In T1, the fresh weight of tree trunks varied between 168 and 215 kg; primary branches were between 1359 and 1563 kg; secondary branches were between 807 and 920 kg, and tertiary branches were between 811 and 996 kg by harvesting the entire mango tree (Figure 14). In T2, the weight of tree trunk, primary and secondary branches were calculated by the volume of all branches and the result of WD varied between 150.8 and 201.15 kg; 1416 to 1606.3 kg and 792.9 to 909.4 kg, respectively (Figure 16). In T3, AGB was calculated in the same as the T2 but, the standard value of WD (0.60 g cm^{-3}) was considered. In T3, the Weight of the tree trunk, primary and secondary branches were ranging between 177.51 and 261.414 kg; 1713.37 to 2005.99 kg; 916.83 to 1223.64 kg, respectively (Figure 17). In T2, AGB of the trees was found to be 5.96% less than the T1 (destructive method) whereas, T3 exhibited 14.95 % higher AGB estimation biomass than the T1.

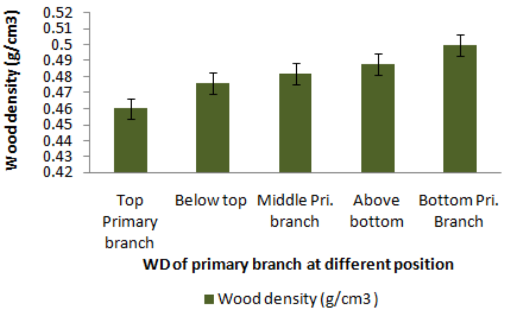

Figure 12. Wood density of primary branch

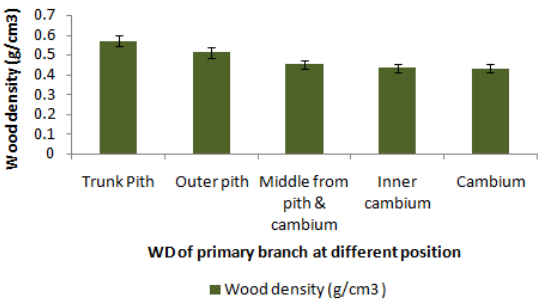

Figure 13. Wood density of tree trunk

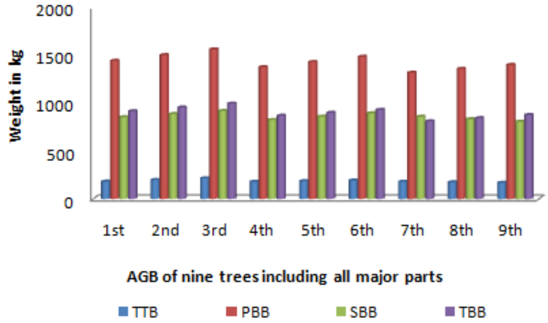

Figure 14. Fresh AGB (kg) of all major parts by T1 (Destructive method)

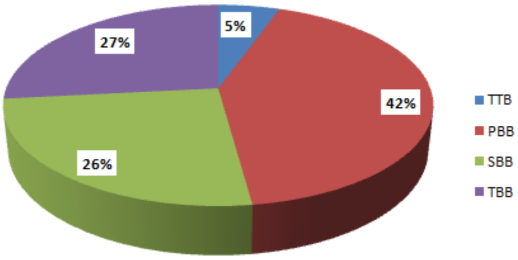

Figure 15. Contribution in AGB (kg) of all major parts in the mango tree

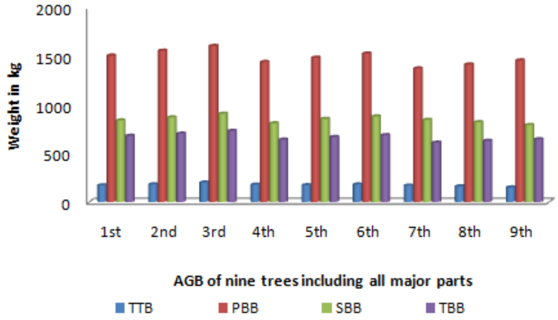

Figure 16. Calculated AGB (kg) of all major parts by T2 (non-destructive method)

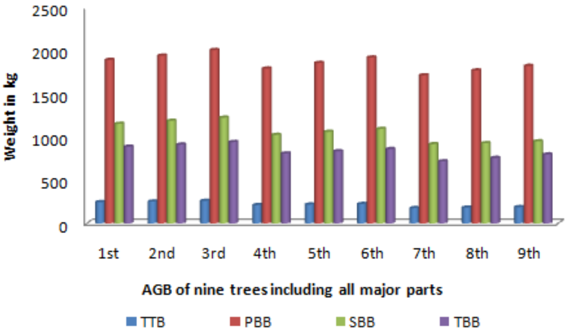

Figure 17. Calculated AGB (kg) of all major parts by T2 (non-destructive method)

TTB: Tree trunk biomass; PBB: Primary branch biomass; SBB: Secondary branch biomass; TBB: Tertiary branch biomass

T1: destructive method; T2: non-destructive method (WD 0.48 g/cm^3); T3: non-destructive method (Standard WD 0.60 g/cm^3)

The contribution of the primary branch was found to be the highest weight in the whole tree while the trunk was found to be the lowest. The biomass of secondary and tertiary branches was found similar. The tree trunk was found to have the least contribution to the biomass of the entire tree (Figure 15). In AGB, primary branches and trunk were contributing almost half of the total weight of the mango tree which was 47%. Secondary branches and tertiary branches were contributing 53% of AGB (Figure 15). In this finding, the biomass of primary branches was accounted highest in AGB (42%) which was almost similar to those reported earlier in mango trees cultivated on the Réunion Island (Normand and Lauri, 2012); the tropical forest of Nigeria (Eneji *et al.,* 2013) and grafted mango trees in India (Ganeshamurthy *et al.,* 2016). From the present investigation, it was found that the WD of the mango tree is directly proportional to the AGB of trees. Similar findings were reported earlier by Phillips *et al.,* (2019) in the Tambopata region forest, south-eastern Peru.

They found that the relationship between WD and AGB is directly proportional to each other. Other studies showed that the variability of biomass could be a variation of the wood density (Patino *et al.,* 2009; Stegen *et al.,* 2009; Henry *et al.,* 2010). Utilization of tree height and DBH relationship is an accessible measurement in allometric equations while estimating AGB, but the value may differ with wood-specific gravity. Average BGB was 878.02 kg by T1, 825.69 kg by T2, and 1031.406 kg by T3. The total biomass of the mango tree was 4255.02 kg in T1 treatment, 4001.426 kg in and 5002.2075 kg in T3, respectively.

3.5 Total biomass of ’Dashehari‘ mango tree

Tree trunk, primary branches, secondary branches, tertiary branches, twigs, and roots were contributing to the total biomass of mango trees. The mean of the total biomass of all the sampled trees by T1, T2, and T3 was 4255.02 kg, 4001.42 kg, and 5002.21 kg, respectively. T3 was representing the highest biomass of the mango tree which was 14.95% higher than T1 (actual biomass estimate by destructive method), whereas, total biomass by T2 was showing the lowest which was 5.96% less than the T1. In total biomass by all the methods, primary branches were contributing the largest share while the trunk was contributing the least in entire tree biomass (Figure 18). In T2, the biomass of tree trunk, primary branches, secondary branches, and below-ground biomass was observed equal to T1, but tertiary branches were found lower than the T1. The main reason for the difference between the biomass of tertiary branches in T1 and T2 may be that where the weight of all major branches, trunk primary, and secondary branches was calculated from primary data such as the length and diameter of each branch, but the weight of tertiary branches was calculated based on the contribution of tertiary branches weight from AGB, obtained by T1 whereas, by T3, the biomass of each part of the trees were found to be much higher than T1. With this experiment, if it was possible to measure tertiary branches, then the difference between T1 and T2 could be reduced and the total biomass of trees would be equal by both methods. As the value of WD increases, the total biomass of the trees is also increasing in T3. The result showed that volume and WD were major parameters for estimating the biomass of standing trees but, it is not possible to find the exact weight of standing trees without data on the WD of each tree.

3.6 Correlation among the three treatments

The genetic relationships among the phenotypic traits were calculated (Table 1). The correlation of T1 was found significant and positive with T2 (7.522) and T3 (7.282). T2 had only a positive correlation with T1 (0.975) and T3 (0.001), likewise, T3 showed also a positive correlation with T1 (0.953) and T2 (0.901). The result was showing that the AGB calculated by modified WD (0.48 g cm^{-3}) was close to the destructive method but the standard value of WD (0.60 gcm^{-3}) was found a weak relationship to the destructive method.

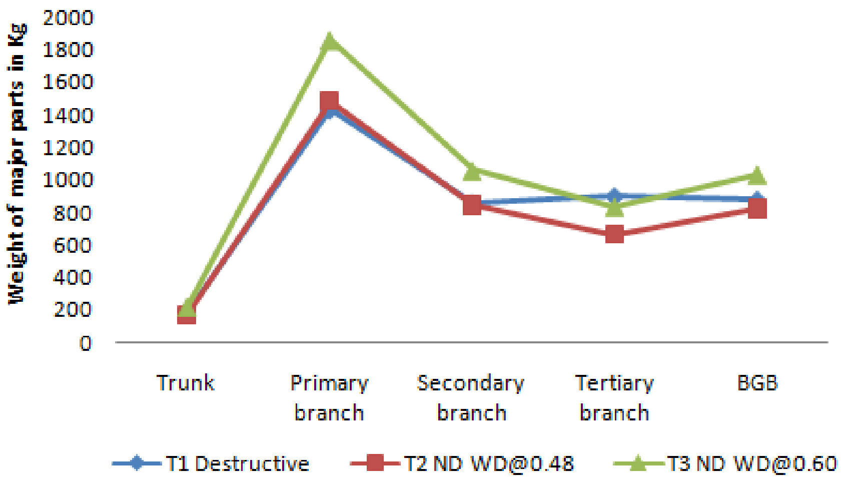

Figure 18. Mean value of total biomass with their major parts by three different methods

T1: Destructive method; T2: Non-destructive method by modified WD, T3: Non-destructive method by standard WD

Table 1. Correlation between the treatments

Replicate samples	**T1 (Destructive method)**	**T2 (Non-destructive method by modified WD 0.48 g cm^{-3})**	**T3 (Non-destructive method by standard WD 0.60 g cm^{-3})**
A	0	7.52E-06	&.2821E-05
B	0.97538	0	0.00093399
C	0.95261	0.90028	0

4. Conclusions

A value of wood density for the mango (Dashehari) tree was recorded and confirmed by a destructive method. The present study showed that the wood density influences the estimation of the biomass of the mango tree. While estimating above-ground biomass by using a standard value of wood density (0.60 g/cm^3) T3, results in higher above-ground biomass, whereas the finding value of wood density (0.48 g/cm^3) T2, results in lower above-ground biomass which was similar to the destructive finding T1. Although above-ground biomass by T2 is still 5.96% lower than the T1, but T3 is 14.94% higher than T1. Above-ground biomass was increasing with an increase in wood density. Although other factors make the difference while calculating above-ground biomass, however, wood density was found as most essential parameter in this study. This study aimed to assess the biomass of standing Dashehari seedling trees by non-destructive method and generate a baseline for the future assessment of total sequestrated carbon by mango orchards in Lucknow and nearby areas. This method will minimize error while estimating tree biomass by using the allometric equation. This method can be one of the cost-effective methods toward a non-destructive approach to developing green sustainable management of forest resources instead of deforestation. This data provides information for further research in regional and climatic variation in the study of wood science, forestry research, air quality, climate change, and engineering and will help in many environmental services such as alternative renewable energy as well as improvement in the economy of farmers.

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