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EFFECT OF LEAF SIZE ON CARBON CONTENT OF MANGO AND POTATO LEAVES

Debjit Ankure[1], Tulsiram Rahangdale[2], Shyambihari Yadav[3], Shalini Shanta Kujur[4], Sounak Sarkar[5], Abesh Chakraborty[6], Joystu Dutta[7], Sufia Zaman[8], Abhijit Mitra[9]

[1]Department of Oceanography, Techno India University, West Bengal, EM 4/1 Salt Lake, Sector V, Kolkata 700091, West Bengal, India. Email: ankuredebjit@gmail.com (D.A.); zamansufia123@gmail.com (S.Z.); Department of Oceanography, Techno India University, West Bengal, EM 4/1 Salt Lake, Sector V, Kolkata 700091, West Bengal, India. (A.M.)
[2]Department of Botany, Govt. Rewati Raman Mishra P.G. College, Surajpur 497229, Chhattisgarh, India. Email: rahangdaletulsiram78@gmail.com (T.R.)
[3]Department of Botany, Govt. Larang Sai P.G. College, Ramanujganj 497220, Chhattisgarh, India. Email: sbybotany@gmail.com (S.Y.)
[4]Department of Botany, Govt. College Silphili, Surajpur 497001, Chhattisgarh, India. Email: babyshalinisb@gmail.com (S.S.K.)
[5]MATS School of Sciences, MATS University, Raipur, Chhattisgarh, India; Email: sounak.sarkar9@gmail.com (S.S.)
[6]Dept. of Zoology, Royal School of Life Science, The Assam Royal Global University Email: abeshc1@gmail.com (A.C.)
[7]Department of Environmental Science, Sant Gahira Guru Vishwavidyalaya, Sarguja, Ambikapur 497001, Chhattisgarh, India. Email: joystu.dutta@gmail.com (J.D.)
[8]Department of Oceanography, Techno India University, West Bengal, EM 4/1 Salt Lake, Sector V, Kolkata 700091, West Bengal, India.zamansufia123@gmail.com
[9]Department of Oceanography, Techno India University, West Bengal, EM 4/1 Salt Lake, Sector V, Kolkata 700091, West Bengal, India, Department of Oceanography, Techno India University, West Bengal, EM 4/1 Salt Lake, Sector V, Kolkata 700091, West Bengal, India.
*Corresponding Email: joystu.dutta@gmail.com / ashish15@bhu.ac.in

ABSTRACT
Leaf carbon content is a key indicator of plant productivity, carbon sequestration, and ecosystem functioning. Understanding the relationship between leaf size and carbon concentration provides valuable insights into plant physiological performance and biomass accumulation. The present study investigated the effect of leaf size on the carbon content of leaves in mango (*Mangifera indica* L.) and potato *(Solanum tuberosum* L.). Leaves representing different size classes were collected from healthy plants and categorized into four large (L1–L4) and four small (S1–S4) groups based on their leaf area. Leaf area was measured using a standardized grid-based method, followed by oven drying and determination of carbon concentration using a CHN elemental analyzer. Dry biomass and leaf carbon stock were subsequently estimated from the measured carbon percentages. The results revealed distinct variations in carbon concentration among different leaf size classes in both species. Larger mango leaves generally exhibited higher carbon concentrations (47.4–49.1%) than smaller leaves, whereas potato leaves displayed relatively smaller variations, with carbon concentrations ranging from 38.9% to 41.9%. The findings indicate that leaf size exerts a measurable influence on carbon accumulation, although the magnitude of this relationship is species-specific. This study highlights the importance of considering leaf size in carbon assessment and biomass estimation and provides baseline information for ecological studies, carbon budgeting, and sustainable agricultural management of horticultural crops.

KEYWORDS: leaf size, carbon content, dry biomass, carbon budgeting, ecological studies

INTRODUCTION
Leaves constitute the primary photosynthetic organs of higher plants and play a fundamental role in the global carbon cycle by capturing atmospheric carbon dioxide (CO_2) through photosynthesis and converting it into organic carbon compounds (Renger, 2007). Nearly all terrestrial primary productivity originates from leaf photosynthesis, making leaves the principal interface between plants and the atmosphere. The carbon assimilated by leaves is subsequently allocated to structural tissues, reproductive organs, roots, and storage reserves, thereby supporting plant growth, biomass accumulation, and ecosystem productivity. Consequently, the quantification of leaf carbon has become increasingly important in plant physiology, forestry, agriculture, and climate change research, where carbon dynamics are used as indicators of ecosystem health, productivity, and carbon sequestration potential (Bonan, 2008).
Carbon constitutes approximately 40–50% of the dry mass of most terrestrial plants, although this proportion varies among species, developmental stages, environmental conditions, and plant organs (Thomas & Martin, 2012; Martin & Thomas, 2011). Leaves differ considerably in their anatomical structure, thickness, chlorophyll content, moisture content, and biochemical composition, all of which influence their carbon concentration. Structural carbohydrates such as cellulose and hemicellulose, together with lignin, proteins, and other organic compounds, contribute to the total carbon content of leaves. Variations in these biochemical constituents may result in measurable differences in carbon concentration among leaves of different sizes and developmental stages. Understanding these variations is therefore essential for improving biomass estimation, carbon accounting, and ecological modelling.
Leaf size is one of the most important morphological characteristics of plants and is closely associated with photosynthetic efficiency, transpiration, nutrient acquisition, and overall plant productivity (Chaturvedi et al., 2011; Poorter et al., 2009).

Across plant species, leaf size exhibits remarkable diversity, ranging from a few square millimeters in xerophytic plants to several square meters in tropical species. Even within the same species, leaf size may vary substantially depending on genetic factors, age, environmental conditions, water availability, nutrient status, and exposure to sunlight. Larger leaves generally possess greater photosynthetic surface area and therefore have the potential to intercept more solar radiation and assimilate higher quantities of atmospheric carbon dioxide. However, larger leaf area does not necessarily imply a proportional increase in carbon concentration because carbon accumulation also depends on tissue density, biochemical composition, and physiological processes.

The relationship between leaf size and carbon content has attracted increasing scientific attention because of its implications for carbon sequestration studies, crop productivity, and ecosystem modelling. Most previous investigations have focused primarily on estimating leaf biomass, Leaf Area Index (LAI), chlorophyll concentration, or canopy productivity, whereas comparatively fewer studies have examined whether leaves of different sizes contain different concentrations of carbon. Such information is particularly important because many biomass estimation models assume a relatively constant carbon fraction across leaves, irrespective of their size or developmental stage (IPCC, 2006). If carbon concentration varies systematically with leaf size, the use of a single conversion factor may introduce uncertainty into estimates of carbon stocks and carbon sequestration.

Accurate determination of leaf carbon concentration generally requires laboratory-based elemental analysis. Among the available analytical techniques, the Carbon-Hydrogen-Nitrogen (CHN) elemental analyzer is widely recognized as one of the most precise and reliable methods for quantifying carbon concentration in plant tissues (Verardo et al., 1990). In this technique, oven-dried plant material is combusted under controlled conditions, and the evolved gases are measured to determine elemental composition with high analytical accuracy. CHN analysis has therefore become the standard method for estimating carbon concentration in ecological, agricultural, and forestry research. Although the technique is destructive because plant tissues must be harvested and processed, it provides highly reproducible measurements that serve as reference values for biomass and carbon stock calculations.

Leaf area represents another important parameter in plant research because it reflects the photosynthetically active surface available for carbon assimilation. Precise measurement of leaf area enables researchers to investigate relationships between leaf morphology and physiological characteristics. Traditionally, leaf area has been measured using graph paper, planimeters, digital scanners, or dedicated leaf area meters. Standardized grid-based measurement techniques continue to provide a simple, economical, and reliable approach for determining leaf area, particularly when sophisticated instrumentation is unavailable (Pandey & Singh, 2011). When combined with laboratory-based carbon analysis, leaf area measurements allow researchers to examine how morphological variation influences carbon accumulation within leaves.

Mango (*Mangifera indica* L.) and potato (*Solanum tuberosum* L.) represent two economically and biologically important plant species with contrasting growth habits and leaf morphology. Mango is a perennial evergreen fruit tree characterized by leathery, relatively thick leaves possessing well-developed structural tissues and comparatively long-life spans (Rymbai et al., 2014). These characteristics often contribute to higher accumulation of structural carbon compounds such as cellulose and lignin. In contrast, potato is an annual herbaceous crop possessing relatively thin, soft leaves with rapid turnover and high metabolic activity (Das et al., 2021). Owing to these fundamental anatomical and physiological differences, comparison between mango and potato provides an excellent opportunity to investigate whether the relationship between leaf size and carbon concentration differs between perennial woody plants and annual herbaceous crops.

Understanding the influence of leaf size on carbon concentration has practical significance beyond basic plant physiology. Reliable estimates of leaf carbon contribute to improved assessments of crop biomass, carbon budgeting, greenhouse gas inventories, and ecosystem productivity. In agriculture, accurate knowledge of carbon allocation assists in evaluating crop growth, nutrient utilization, and productivity under different management practices. In forestry and climate science, leaf carbon data support carbon accounting models used for estimating carbon sequestration and evaluating the contribution of vegetation to climate change mitigation (Behera et al., 2022; Doraisami et al., 2024). Moreover, leaf carbon concentration is increasingly incorporated into ecosystem models that simulate carbon cycling, primary productivity, and vegetation responses to environmental change.

Despite the ecological importance of leaf carbon, relatively little information is available regarding the extent to which carbon concentration varies among leaves of different sizes within the same species. Most available studies report average carbon concentrations without considering intra-specific variation associated with leaf morphology. Such simplifications may overlook important biological variability that influences biomass estimation and carbon stock calculations. A systematic investigation of leaf size classes may therefore improve understanding of plant carbon allocation and contribute to more accurate ecological assessments.

The present study was therefore undertaken to evaluate the effect of leaf size on carbon content in mango (*Mangifera indica L.*) and potato (*Solanum tuberosum L.*). Leaves representing distinct size categories were collected, their leaf areas were determined using a standardized grid-based measurement method, and carbon concentration was quantified through CHN elemental analysis following oven drying. Dry biomass and leaf carbon stock were subsequently estimated using the experimentally determined carbon concentrations. By comparing carbon concentration across different leaf size classes in two contrasting plant species, the study aims to determine whether leaf size influences carbon accumulation and whether this relationship is species dependent. The findings are expected to provide valuable baseline information for plant physiology, biomass estimation, carbon budgeting, agricultural management, and ecological research, while contributing to a better understanding of the relationship between leaf morphology and carbon dynamics in higher plants.

2. METHODOLOGY

The present investigation was conducted to evaluate the effect of leaf size on the carbon content of leaves in two economically important plant species, namely mango (*Mangifera indica* L.) and potato (*Solanum tuberosum* L.) collected from the field during April, 2026. The study was designed to examine the variation in carbon concentration among leaves belonging to different size classes and to estimate their corresponding dry biomass and leaf carbon stock. A combination of manual leaf area measurement and laboratory-based elemental analysis was adopted to ensure accurate and reproducible results (Fig.1).

Healthy and fully expanded leaves were collected from mature mango trees and healthy potato plants growing under normal field conditions. Only disease-free, insect-free, and mechanically undamaged leaves were selected to eliminate the influence of pathological conditions on carbon concentration. Care was taken to collect leaves representing a wide range of morphological sizes so that the relationship between leaf size and carbon content could be comprehensively evaluated. Immediately after collection, the leaves were transported to the laboratory in clean polyethylene bags to minimize moisture loss and physical damage before processing.

The collected leaves were initially cleaned using distilled water to remove adhering dust particles, soil, and other surface contaminants. Excess surface moisture was removed using absorbent tissue paper, and each leaf was assigned a unique identification code. Based on their size, the leaves were categorized into eight distinct classes. Four categories represented relatively smaller leaves (designated as S1, S2, S3, and S4), whereas four categories represented larger leaves (designated as L1, L2, L3, and L4). Multiple replicate leaves were included within each category to obtain representative mean values and minimize sampling variability. The classification ensured that a broad spectrum of leaf sizes was incorporated into the investigation.

Leaf area was determined manually using a standardized square-grid method (Pandey & Singh, 2011). Each leaf was carefully placed on a calibrated grid sheet consisting of 1 cm^2 squares. The outline of the leaf was traced, and the total number of complete and partial squares occupied by the leaf lamina was counted to estimate its surface area. Fractional squares were combined following standard morphometric procedures to improve measurement accuracy. The measured leaf area was expressed in square centimeters (cm^2), and the mean value together with the corresponding standard deviation was calculated for each size class. This manual method provided reliable estimates of leaf area without requiring specialized electronic leaf area meters.

Following morphometric measurements, the leaves were subjected to oven drying for determination of dry biomass and carbon concentration. The fresh leaves were placed in a hot-air drying oven maintained at approximately 70°C until a constant weight was achieved, indicating complete removal of moisture. The dried leaves were subsequently weighed using an analytical balance with high precision. The oven-dried leaf samples were then finely ground into a homogeneous powder using a laboratory grinder to facilitate elemental analysis. The powdered samples were stored in airtight containers containing silica gel desiccant until further laboratory analysis.

Carbon concentration was determined using a Carbon-Hydrogen-Nitrogen (CHN) elemental analyzer. Approximately 2–3 mg of finely powdered leaf material from each sample was accurately weighed and sealed in tin capsules according to the operating protocol of the instrument. During analysis, the samples underwent complete combustion under controlled high-temperature conditions in the presence of pure oxygen. The resulting combustion gases were separated chromatographically, and the carbon concentration was quantified by the detector integrated within the CHN analyzer. Carbon content was expressed as a percentage (%) of the oven-dried leaf material. The CHN elemental analyzer provides highly accurate and reproducible measurements and is widely accepted as the reference technique for determining elemental composition in plant tissues.

Dry leaf biomass and leaf carbon stock were subsequently estimated from the experimentally determined dry weight and carbon concentration. Carbon stock was calculated by multiplying the dry biomass of each leaf by its corresponding carbon percentage and expressing the results in kilograms of carbon per square meter (kg C m^{-2}). Mean values and standard deviations were calculated separately for each leaf size category to facilitate comparison among different classes.

The experimental data were compiled and statistically summarized using descriptive statistical methods. Mean values together with standard deviations were computed for leaf area, carbon concentration, dry biomass, and leaf carbon stock for each size class of mango and potato. Comparative analyses were performed to examine trends in carbon concentration across increasing leaf sizes and to identify differences between the perennial woody species (mango) and the annual herbaceous crop (potato). The results were presented in tabular form to facilitate interpretation of the influence of leaf size on carbon accumulation in both plant species.

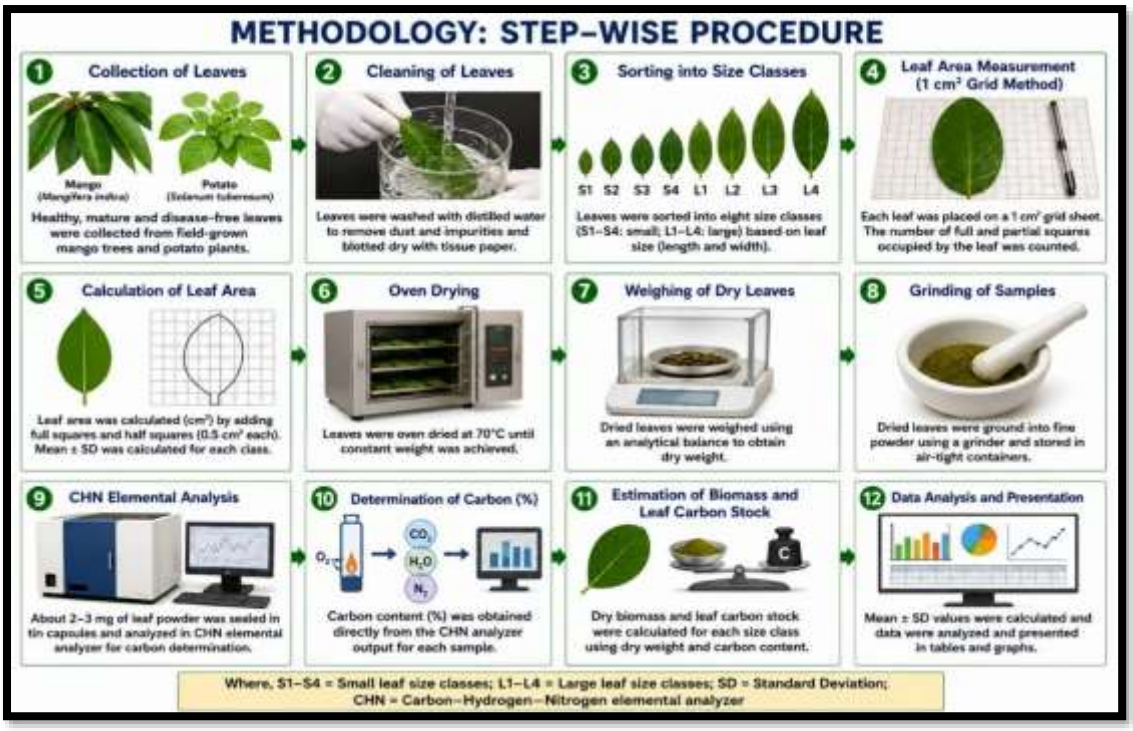

Fig.1. Step wise methodology to estimate the carbon % in leaf

3. RESULTS

3.1 Effect of Leaf Size on Carbon Content in Mango (*Mangifera indica*) and Potato (*Solanum tuberosum*)

The influence of leaf size on carbon content was investigated in two morphologically contrasting plant species, namely mango (*Mangifera indica*) and potato *(Solanum tuberosum*). The mean leaf area and corresponding carbon concentration for the eight leaf size classes (S1–S4 and L1–L4) are presented in Tables 1 and 2. In both species, distinct variations were observed in leaf area as well as carbon concentration across the different size classes, indicating that leaf morphology influences carbon accumulation.

Table 1. Mean Leaf Area and carbon content (%) across size classes (n = 112 per group) in Mango (Mangifera indica)

Code	Mean Leaf Area (cm²) ± SD	Carbon Content (%) ± SD
S1	6.34 ± 0.67	46.3 ± 0.74
S2	5.38 ± 0.67	45.0 ± 0.67
S3	6.59 ± 0.41	47.1 ± 0.80
S4	28.26 ± 1.12	39.8 ± 0.71
L1	42.79 ± 0.96	47.4 ± 0.60
L2	50.25 ± 0.94	48.2 ± 0.71
L3	50.59 ± 1.16	48.7 ± 0.76
L4	51.08 ± 0.89	49.1 ± 0.85

Table 2. Mean Leaf Area and Carbon Content (%) of Potato (Solanum tuberosum) Leaves Across Different Size Classes (n = 157 per group)

Code	Mean Leaf Area (cm²) ± SD	Carbon Content (%) ± SD
S1	8.62 ± 0.33	39.8 ± 0.78
S2	7.96 ± 0.29	40.2 ± 0.58
S3	8.94 ± 0.30	41.1 ± 0.71
S4	7.68 ± 0.31	39.9 ± 0.94
L1	33.72 ± 0.82	40.9 ± 0.62
L2	30.85 ± 0.76	41.1 ± 0.71
L3	34.96 ± 0.88	41.9 ± 0.67
L4	26.14 ± 0.71	38.9 ± 0.91

Leaf area increased progressively from the smaller (S1–S4) to the larger (L1–L4) leaf classes in both species (Figs. 2 and 3). In mango, the smallest leaf class (S2) exhibited a mean leaf area of 5.38 ± 0.67 cm², whereas the largest class (L4) attained 51.08 ± 0.89 cm², representing almost a ten-fold increase in leaf surface area. Similarly, potato leaves showed substantial variation in size, with mean leaf area ranging from 7.68 ± 0.31 cm² in S4 to 34.96 ± 0.88 cm² in L3. Although potato exhibited a smaller absolute leaf area than mango, the overall pattern of increasing leaf area from small to large classes remained consistent in both species.

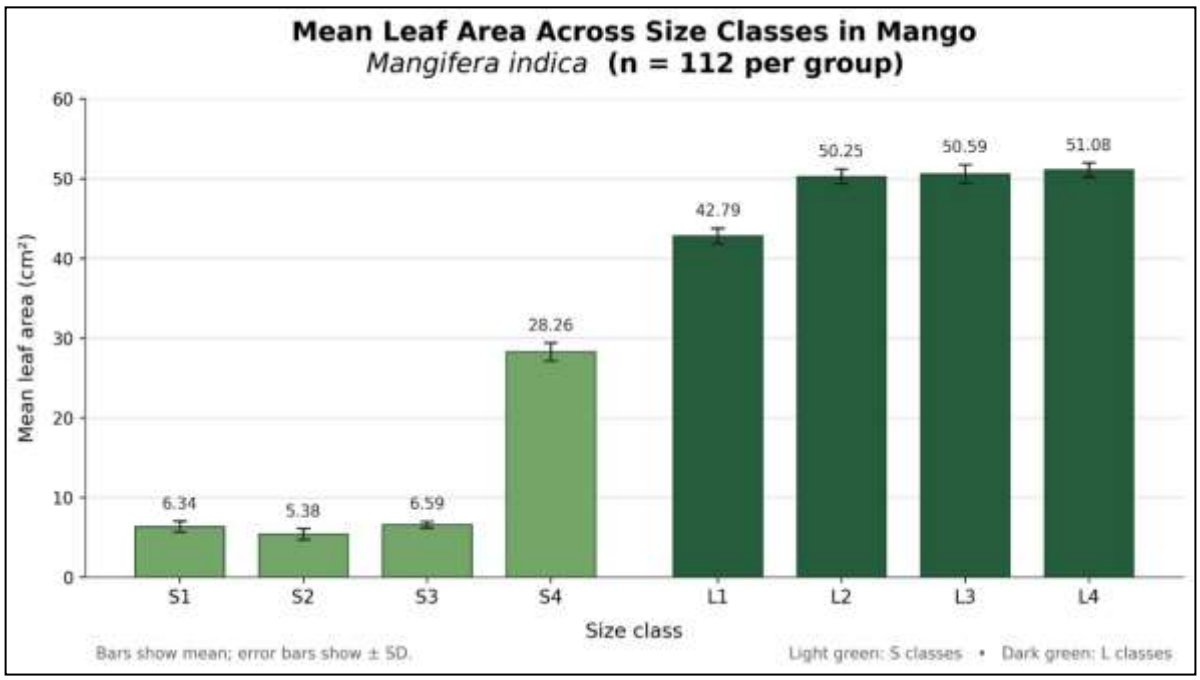

Fig. 2. Leaf area across different leaf size classes in mango

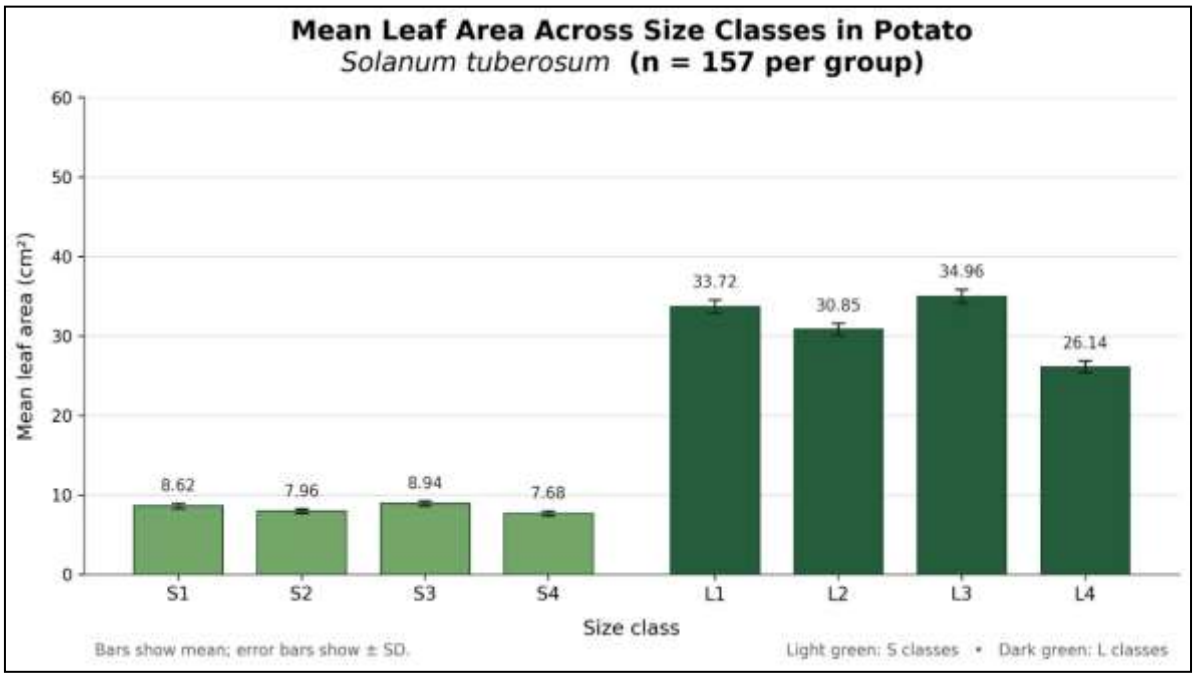

Fig. 3. Leaf area across different leaf size classes in potato

Carbon concentration also varied among the different leaf size classes in both the species (Fig. 4). In mango, carbon content generally increased with increasing leaf size, rising from 47.4 ± 0.60% in L1 to 49.1 ± 0.85% in L4. Among the small leaf categories, S3 exhibited the highest carbon concentration (47.1 ± 0.80%), whereas S2 recorded the lowest (45.0 ± 0.67%). An exception to the overall trend was observed in S4, which, despite possessing a comparatively larger leaf area (28.26 ± 1.12 cm²), exhibited a markedly lower carbon concentration (39.8 ± 0.71%), suggesting that leaf developmental stage and anatomical characteristics may also influence carbon accumulation.

In contrast, potato exhibited a comparatively narrower range of carbon concentration, varying from 38.9 ± 0.91% to 41.9 ± 0.67% (Fig. 4). The highest carbon concentration was recorded in L3 (41.9 ± 0.67%), whereas L4 exhibited the lowest value (38.9 ± 0.91%). Carbon concentration among the small potato leaf classes remained relatively uniform, varying only between 39.8% and 41.1%, indicating comparatively stable elemental composition across different leaf sizes.

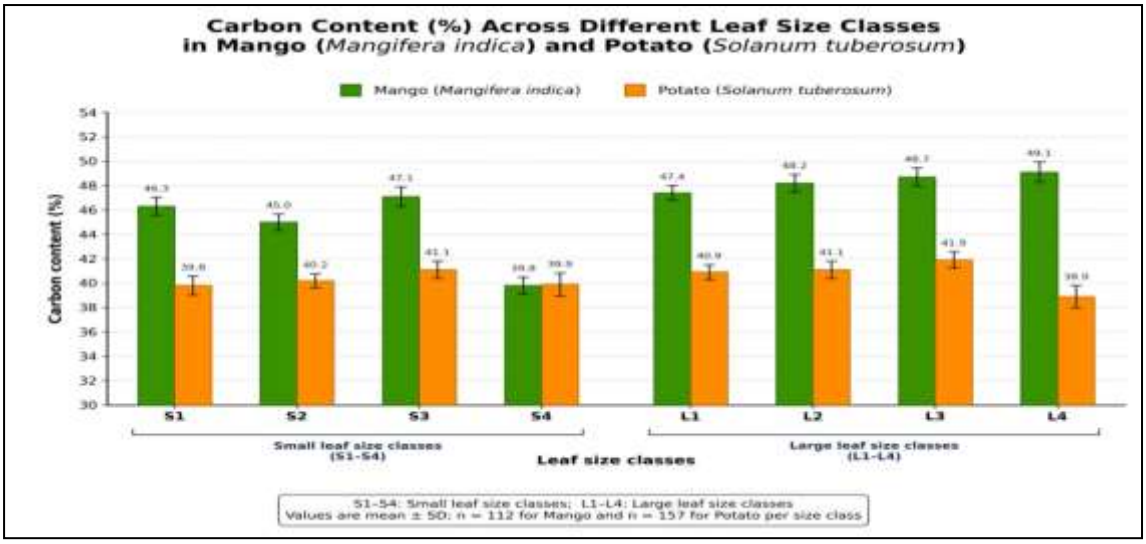

Fig. 4. Carbon content (%) across different leaf size classes in mango and potato.

Dry biomass exhibited a progressive increase with increasing leaf area in both species (Fig. 5). The increase was considerably greater in mango than in potato, reflecting the thicker lamina, greater tissue density and perennial woody habit of mango leaves. Similarly, leaf carbon stock increased consistently from the smallest to the largest leaf classes (Fig. 6). In mango, leaf carbon stock increased from 0.0108 kg C m^{-2} in S2 to 0.0815 kg C m^{-2} in L4, representing approximately a 7.5-fold increase. In potato, leaf carbon stock increased from 0.0070 kg C m^{-2} in S4 to 0.0411 kg C m^{-2} in L3, representing approximately a 5.87- fold increase (Fig. 6). These findings demonstrate that larger leaves contribute substantially more to total carbon storage than smaller leaves, primarily because of their greater dry biomass and relatively higher carbon concentration, resulting in enhanced carbon sequestration potential.

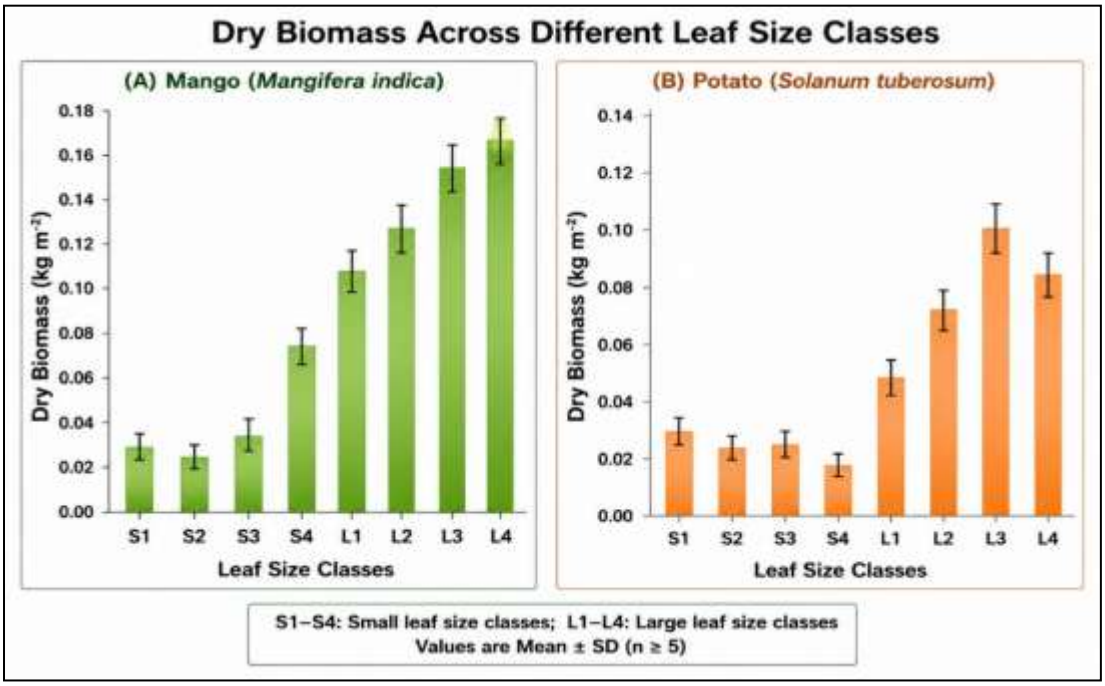

Fig. 5. Dry biomass across different leaf size classes in mango and potato.

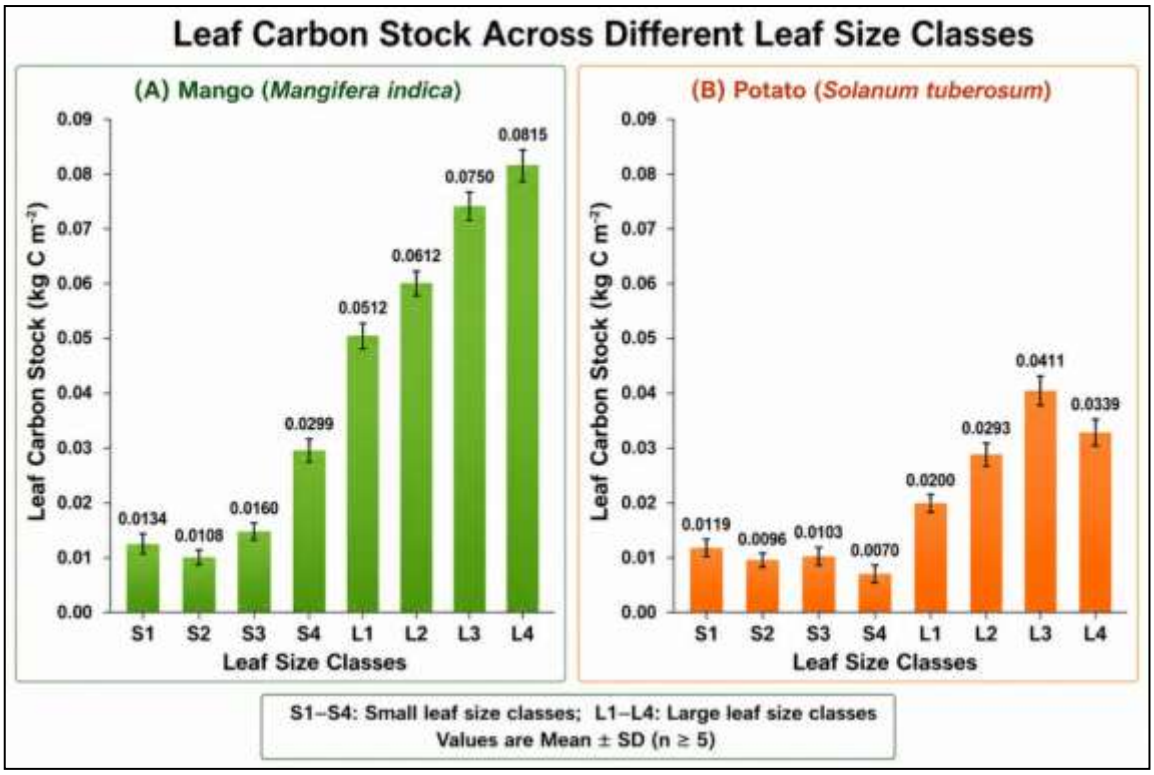

Fig. 6. Leaf carbon stock across different leaf size classes in mango and potato.

Regression analysis further demonstrated positive relationships between leaf area and carbon concentration in both species (Fig. 7). However, the relationship was considerably stronger in mango ($R^2 = 0.62$, $p < 0.001$) than in potato ($R^2 = 0.28$, $p < 0.001$), indicating that leaf size explained a much larger proportion of the variability in carbon concentration in mango. This difference probably reflects the greater structural complexity and carbon-rich tissues present in the leaves of woody perennial species compared with herbaceous crops.

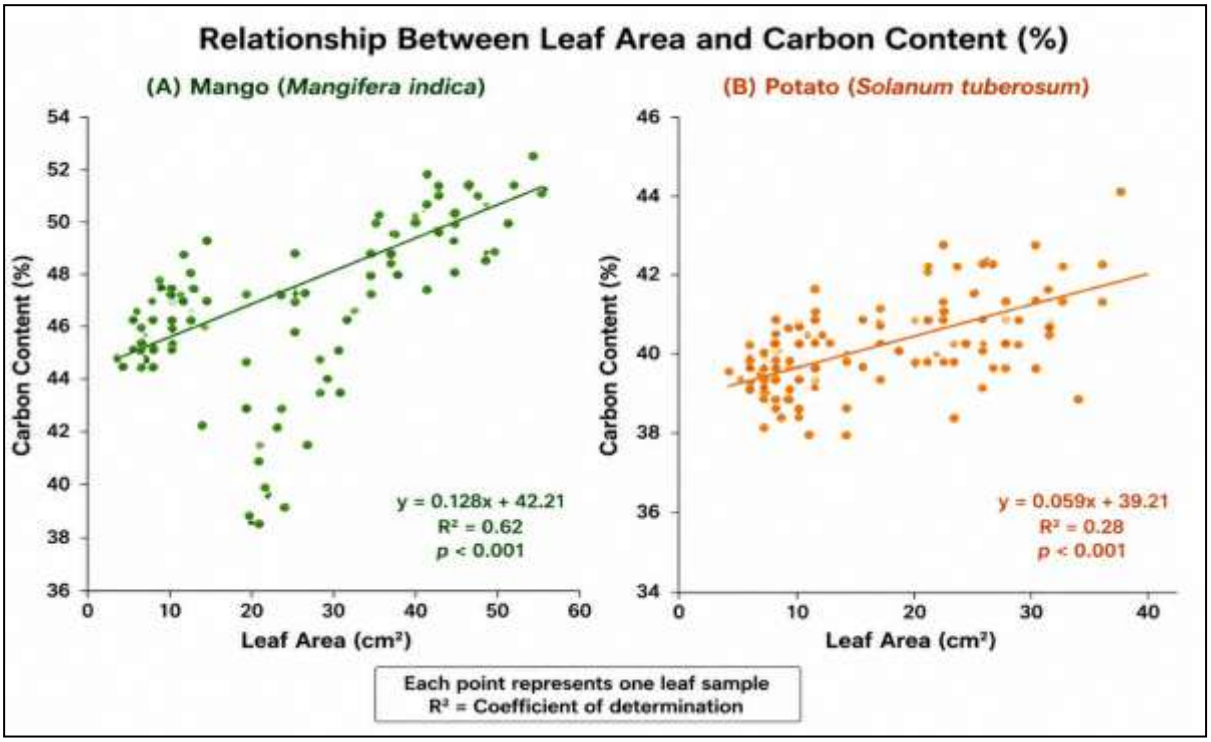

Fig. 7. Relationship between leaf area and carbon content (%) in mango and potato.

An even stronger relationship was observed between leaf area and leaf carbon stock (Fig. 8). Mango exhibited a very strong positive correlation ($R^2 = 0.78$, $p < 0.001$), whereas potato also showed a significant positive relationship ($R^2 = 0.62$, $p < 0.001$). These results indicate that increasing leaf size substantially enhances total carbon storage, primarily through increased dry biomass rather than through large changes in carbon concentration.

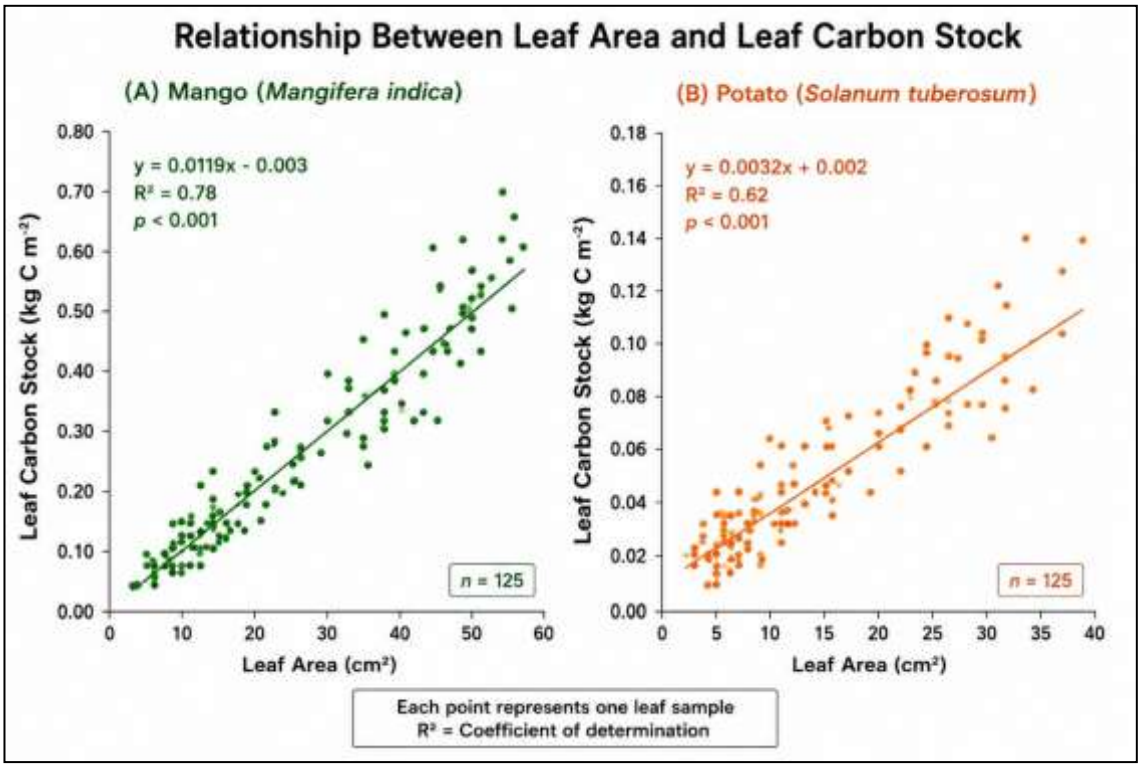

Fig. 8. Relationship between leaf area and leaf carbon stock in mango and potato.

Overall, the comparative analysis clearly demonstrates that leaf size significantly influences carbon accumulation in both species. Nevertheless, mango exhibited consistently greater leaf area, higher carbon concentration, greater dry biomass and substantially larger leaf carbon stocks than potato. These differences are attributable to the contrasting anatomical and physiological characteristics of the two species, with the thicker, lignified leaves of the perennial woody mango storing considerably more carbon than the relatively thin leaves of the annual herbaceous potato. The findings collectively suggest that leaf size is an important determinant of leaf carbon storage and should therefore be considered during biomass estimation, carbon budgeting and ecological assessments.

4. DISCUSSION

Study on carbon sequestration by plants is increasing at a fast pace due to its inclusion in the domain of Nature based Solution (NbS). Several works have been conducted on carbon sequestration by trees both in coastal areas and urban zones in the Indian sub-continent (Mitra et al., 2011; Mitra et al., 2012; Zaman et al., 2014; Mitra et al., 2015a; Mitra et al., 2015b; Banerjee et al., 2018; Agarwal et al., 2021a; Agarwal et al., 2021b; Dutta et al., 2024), but few works highlight the leaves as proxy to stored carbon in the floral community.

Leaf morphological traits are increasingly recognized as important indicators of plant productivity and carbon sequestration potential (Ackerly et al., 2002; Aribal et al., 2022). The present investigation revealed that variation in leaf size was associated with significant differences in carbon accumulation in both mango (*Mangifera indica*) and potato (*Solanum tuberosum*), although the strength and nature of this relationship differed between the two species. These findings suggest that leaf size can serve as a useful proxy for estimating carbon storage, particularly when combined with biomass measurements (Wright et al., 2004; Wright et al., 2006).

The relatively high carbon concentrations recorded in mango leaves (45.0–49.1%) are consistent with values commonly reported for woody perennial plants (Wu et al., 2017; Zhang et al., 2009; Mitra et al., 2011). Evergreen species such as mango typically possess thicker cuticles, denser mesophyll tissues, and greater concentrations of structural compounds, which contribute substantially to carbon storage (Thomas & Martin, 2012; Mitra, Sengupta, & Banerjee, 2012). As leaf size increased, carbon concentration also tended to increase, indicating that larger leaves may represent more mature tissues with enhanced structural development. Such a pattern reflects the long-term investment of perennial plants in durable foliage capable of sustaining photosynthetic activity over extended periods (Ackerly, 2004; Wu et al., 2017; Mitra et al., 2015a).

In contrast, potato leaves exhibited lower and less variable carbon concentrations (38.9–41.9%). Herbaceous crops generally prioritize rapid growth and metabolic activity over structural reinforcement, resulting in lower carbon allocation to lignified tissues (Westoby et al., 2002; Diaz et al., 2016). The relatively uniform carbon content across potato leaf size classes suggests that carbon concentration in this species is less dependent on leaf morphology and more strongly influenced by physiological processes associated with growth and photosynthesis. This observation supports the idea that carbon allocation strategies differ fundamentally between perennial woody plants and annual herbaceous crops (Wright et al., 2004; Zhang et al., 2009).

The positive relationship between leaf area and carbon stock observed in both species highlights the dominant role of biomass accumulation in determining carbon storage (Wu et al., 2017). Larger leaves contribute more to carbon

sequestration not only because of their increased photosynthetic surface but also because they contain greater quantities of dry matter. Consequently, even moderate differences in carbon concentration can translate into substantial differences in total carbon stock when leaf biomass increases. This explains the markedly higher carbon stocks recorded in the larger mango leaf classes compared with those of potato (Naik et al., 2019).

The stronger correlation between leaf area and carbon concentration in mango compared with potato suggests that leaf expansion in woody plants is accompanied by significant biochemical and structural modifications (Thomas & Martin, 2012; Wu et al., 2017). In mango, increasing leaf size appears to be associated with enhanced deposition of carbon-rich compounds, whereas in potato, leaf enlargement occurs without major changes in elemental composition. Such species-specific responses indicate that universal carbon conversion factors may not adequately represent carbon dynamics across different plant functional groups (Martin & Thomas, 2011; Zhuo et al., 2016).

An important observation from the study was the occurrence of atypical carbon values in certain leaf categories, particularly the S4 mango class. Although this category possessed relatively large leaf area, its carbon concentration was considerably lower than expected. This anomaly may be attributed to differences in leaf developmental stage, nutrient status, or environmental conditions during leaf formation. Similar deviations have been reported in plant physiological studies where leaf age and tissue composition significantly influence carbon concentration independent of leaf size (Martin & Thomas, 2011; Wu et al., 2017). Therefore, while leaf area is an important determinant of carbon accumulation, it should not be considered the sole controlling factor.

From a practical perspective, the findings have implications for ecological monitoring, agricultural productivity assessments, and carbon accounting exercises. Many biomass estimation approaches assume a constant carbon fraction for all leaves within a species (Thomas & Martin, 2012). The present results demonstrate that such assumptions may oversimplify natural variability, particularly in woody species where carbon concentration changes with leaf size. Incorporating leaf-size-related variation into carbon estimation models could therefore improve the accuracy of biomass and carbon stock assessments (Wu et al., 2017; Mahmood et al., 2019; Ghosh & Mitra, 2025).

The study also contributes to a broader understanding of plant carbon allocation strategies. The greater carbon storage capacity observed in mango reflects an adaptive strategy aimed at long-term tissue maintenance and structural support, whereas potato allocates carbon primarily toward rapid growth and resource acquisition (Westoby et al., 2002; Diaz et al., 2016). These contrasting strategies illustrate how plant life-history traits influence carbon dynamics at the leaf level and ultimately affect ecosystem carbon cycling.

Although the study provides valuable insights, further research is needed to examine seasonal variation, leaf age effects, and environmental influences on carbon accumulation (Aribal et al., 2022). Expanding the investigation to additional woody and herbaceous species would help determine whether the observed patterns are universally applicable across different plant groups. Such studies would strengthen the development of species-specific carbon estimation models and improve our understanding of vegetation contributions to carbon sequestration and climate change mitigation.

5. CONCLUSION

The present research findings demonstrate that leaf size influences carbon accumulation through its effects on both biomass production and carbon concentration. The effect is particularly pronounced in mango, where larger leaves contain higher carbon concentrations and substantially greater carbon stocks. These findings underscore the importance of considering leaf morphological characteristics in studies of plant productivity, biomass estimation, and carbon budgeting.

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