

## Leaf Functional Traits Study of Native Trees in Different City Environment

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**Abstract:** To reveal the effects of the different city environment (clean area and polluted area) on native trees, leaf functional traits of six native trees in Zhanjiang were studied. The relationship between leaf mass per area (LMA) and leaf functional traits were analyzed. The results showed that different leaf functional traits of the six native trees show difference in different environment. The fresh weight (FW) of *Ficus microcarpa* L.f., *Hibiscus rosa-sinensis* Linn, *Ixora chinensis* Lam. and *Lagerstroemia speciosa* (L.) Pers. in the two environments is different among each other significantly ( $p < 0.05$ ). The specific leaf area (SLA) of *Ficus virens* Aiton, *Hibiscus rosa-sinensis* Linn., *Ixora chinensis* Lam., *Dracontomelon duperreanum* Pierre and *Lagerstroemia speciosa* (L.) Pers. which growing in clean area was significantly higher than in polluted area ( $P < 0.01$ ), no significant SLA difference was found on *Ficus microcarpa* L.f. in the two environments ( $P > 0.05$ ). LMA shows extremely significantly positive correlation with fresh weight and dry weight ( $p < 0.01$ ,  $r^2 = 0.186$ ;  $p < 0.01$ ,  $r^2 = 0.0806$ ), and shows a weak significantly positive correlation to leaf area ( $p < 0.05$ ,  $r^2 = 0.0048$ ), and it also shows a weak significantly negative correlation with width-length ratio ( $p < 0.01$ ,  $r^2 = 0.0173$ ), and a significant moderate-intensity negative correlation with water content ( $p < 0.01$ ,  $r^2 = 0.4604$ ), but no difference is found with average width.

### Introduction

Plant functional traits (PFT) is an important property influencing the colonization, subsistence and adaptation and that is involved with the capability of obtaining, utilizing and preserving resources[1,2]. In recent years, the relationship between PFT and environmental factors has been attracting more and more attention[3,4,5]. The relationship between PFT and environmental factors is the screening result of climate, interference and biological conditions[6]. PFT have been used to describe the response of native vegetation to environmental factors[7]. As an important plant organ, the functional traits of leaf can effectively reflect the habitat conditions, incarnating plant survival strategy under specific environment and the response to environmental changes[8,9]. The functional traits of leaf include specific leaf area(SLA), thickness(TH), fresh weight(FW), dry weight(DW) and dry matter content(DMC), etc[10,11], which were formed gradually by means of heritable variation and natural selection in the long-term effects of the external environment condition (especially the climate conditions) on plant, and can reflect a series of survival strategies including gas exchange, energy absorption, carbon fixation etc on plants better in different environmental conditions, such as environment with sufficient or insufficient factors. The text studied on leaf functional traits of six native trees in Zhanjiang, analyzed the traits of the differences between

different environment, and discussed the response of native plant to environmental characteristics.

## Sampling

We selected six native greening trees which were widely applied in landscape architecture (Table 1) in different environment (polluted area and clean area). The study in polluted area was conduct along the main road in Zhanjiang, and clean area including Cunjinqiao Park and Forest park. For every tree, we chose ten growing well individuals for repeated sampling in July 2015; all individuals kept a consistent diameter at breast height to avoid the influence of tree age. Then selected four current-growth branches with consistent light environment in different direction in the central canopy for every individual, and then chose a slice of mature, complete and healthy typical leaf between 5<sup>th</sup> leaf from the top and 5<sup>th</sup> leaf from the bottom. Wipe clean the leaf with filter paper, and kept it in a sealed bag for laboratory determination.

Table 1 General characteristics of native trees

Species	Family	Genus	Growth form
<i>Ficus virens</i> Aiton.	Moraceae	Ficus	Deciduous or semi-deciduous trees
<i>Dracontomelon duperreanum</i> Pierre.	Anacardiaceae	Dracontomelon	Evergreen trees
<i>Ficus microcarpa</i> L.f.	Moraceae	Ficus	Evergreen trees
<i>Lagerstroemia speciosa</i> (L.) Pers.	Lythraceae	Lagerstroemia	Deciduous or semi-deciduous trees
<i>Hibiscus rosa-sinensis</i> Linn.	Malvaceae	Hibiscus	Evergreen shrubs
<i>Ixora chinensis</i> Lam.	Rubiaceae	Ixora	Evergreen shrubs

## Determination of leaf functional traits

Numbered all the leaves sequentially, weighed fresh weight (FW) of each leaf with a 1/100 balance, and scanned leaf by Epson Perfection V700 Photo scanner, then calculate indexes including leaf area, leaf length, leaf width and length-width ratio using WinFolia 7.0. Leaf width is the width at the widest point, and average width refers to the width of average from the blade tip to petiole. Put the leaf into the oven at 105 °C for 15 minutes after scanning, dried to a constant weight at 80 °C, and weighed leaf dry weight (DW). Leaf thickness (TH) were measured by vernier calipers (precision 0.02 mm) at the top, middle and bottom of each leaf, measuring position were about 0.25 cm on both sides of the main vein of leaves. Specific leaf area (SLA), leaf mass per area (LMA) and moisture content are calculated by the following formula:

$$\text{SLA (cm}^2 \text{ g}^{-1}\text{)} = \text{leaf area (cm}^2\text{)} / \text{DW (g)}$$

$$\text{Moisture content (\%)} = (\text{FW (g)} - \text{DW (g)}) / \text{FW (g)}$$

$$\text{LMA (mg cm}^{-2}\text{)} = \text{DW (g)} / \text{leaf area (cm}^2\text{)}$$

## Data analysis

The structural traits data were used for statistical analysis, difference of the characters between different environments was analyzed by independent samples T test using SPSS17.0. Correlation analysis between leaf mass per area and structural characters Kruskal-Wallis test used SASTISTICA 8.0. Significance level P is 0.05; data keep two decimal fractions; standard errors are rounding errors.

## Result and Analysis

### Comparison of fresh weight and leaf morphology

The different leaf structural indexes of six native trees show difference in clean area and polluted area (Table 2). The fresh weight of *Ficus virens* Aiton. and *Dracontomelon duperreanum*

Pierre. in the two different habitats is non-significant difference ( $p > 0.05$ ), while *Ficus microcarpa* L.f., *Hibiscus rosa-sinensis* Linn., *Ixora chinensis* Lam. and *Lagerstroemia speciosa* (L.) Pers. showed significant differences ( $p < 0.05$ ). The length and the width of leaf, the average width of leaf of *Ficus virens* Aiton. in clean area were significantly greater than in polluted area. But the non-significant difference is found in the Width to length ratio. the length of leaf, the width to length ratio of *Ficus concinna* all shows important difference in different habitats, while the width of leaf and the average width of leaf is non-significant difference; and the width of leaf, the average width of leaf and the width to length ratio of *Hibiscus rosa-sinensis* Linn. In polluted area were significantly greater than in clean area, but the length of leaf in clean area is greater than polluted area; all indicators of *Ixora chinensis* Lam. Show significant difference in two different environment and the leaf length, the leaf width, and the average width of leaf in polluted area were greater than in clean area, but the width to length ratio in clean area is greater than in polluted area; the leaf length, the leaf width and the average width of leaf of *Dracontomelon duperreanum* Pierre. in clean area were significantly greater than in polluted area, but their width to length ratio shows non-significant difference; the leaf length of *Lagerstroemia speciosa* (L.) Pers. in clean area is greater than in polluted area, while its width of leaf in polluted area is greater than in clean area, while its other indicators were non-significant difference in different environment. Results show that the fresh weight and structural indexes of leaf of six native trees had no significant regularity from clean area and polluted area, what may be due to the change created by the difference of tree species.

Table 2 Leaf functional traits of 6 native trees in different environment

Specie	Site	Fresh weigh ( g )	Length ( cm )	Width ( cm )	Avewidth ( cm )	Width / Length
<i>Ficus virens</i> Aiton	clean area	1.34±0.06 a	14.63±0.23 a	6.67±0.16 a	4.87±0.13 a	0.46±0.01 a
<i>Ficus virens</i> Aiton	polluted area	1.29±0.05 a	13.53±0.24 b	6.12±0.1 b	4.46±0.08 b	0.46±0.01 a
<i>Ficus microcarpa</i> L.f.	clean area	0.41±0.01 a	7.27±0.12 a	3.7±0.06 a	2.49±0.04 a	0.51±0.01 a
<i>Ficus microcarpa</i> L.f.	polluted area	0.49±0.01 b	7.84±0.11 b	3.62±0.05 a	2.4±0.03 a	0.46±0.01 b
<i>Hibiscus rosa-sinensis</i> Linn.	clean area	0.4±0.01 a	7.52±0.09 a	4.29±0.07 a	2.85±0.05 a	0.57±0.01 a
<i>Hibiscus rosa-sinensis</i> Linn.	polluted area	0.85±0.03 b	7.11±0.11 b	5.55±0.09 b	3.87±0.07 b	0.78±0.01 b
<i>Ixora chinensis</i> Lam.	clean area	0.3±0.01 a	5.74±0.1 a	2.69±0.04 a	1.88±0.03 a	0.47±0.01 a
<i>Ixora chinensis</i> Lam.	polluted area	0.49±0.01 b	8.34±0.12 b	2.95±0.04 b	2.1±0.03 b	0.36±0 b
<i>Dracontomelon duperreanum</i> Pierre	clean area	0.76±0.03 a	14.74±0.21 a	4.2±0.08 a	2.85±0.06 a	0.29±0.01 a
<i>Dracontomelon duperreanum</i> Pierre	polluted area	0.72±0.02 a	13.8±0.21 b	3.97±0.06 b	2.66±0.04 b	0.29±0 a
<i>Lagerstroemia speciosa</i> (L.) Pers.	clean area	3.05±0.12 a	22.49±0.31 a	8.89±0.14 a	6.12±0.11 a	0.4±0.01 a
<i>Lagerstroemia speciosa</i> (L.) Pers.	polluted area	3.86±0.12 b	20.77±0.27 b	8.75±0.11 a	5.99±0.08 a	0.42±0.01 b

Data followed different letters within column of the same tree indicate significant differences at 0.05 level.

### The difference of leaf area, dry weight and leaf water content

There was different performance in leaf area, dry weight and leaf water content of six different species in different environment (Figure 1). We found that the leaf area of *Ficus virens* Aiton., *Dracontomelon duperreanum* Pierre. and *Lagerstroemia speciosa* (L.) Pers. in clean area was significantly higher than in polluted area, while *Hibiscus rosa-sinensis* Linn. and *Ixora chinensis* Lam. in clean area was significantly less than that in polluted areas. No significant difference was found about the leaf area of *Ficus microcarpa* L.f. in two environments. Dry weight of *Hibiscus rosa-sinensis* Linn., *Ixora chinensis* Lam. and *Lagerstroemia speciosa* (L.) Pers. in polluted areas was significantly higher than that in clean area, but there was no significant difference among *Ficus virens* Aiton., *Ficus microcarpa* L.f. and *Dracontomelon duperreanum* Pierre. The leaf water

content of *Ficus microcarpa* L.f. and *Hibiscus rosa-sinensis* Linn. in polluted area showed significantly larger than that in clean area, while the leaf water content of *Ixora chinensis* Lam., *Dracontomelon duperreanum* Pierre. and *Lagerstroemia speciosa* (L.) Pers. in clean area was significantly greater than that in polluted area, and *Ficus virens* Aiton. was no significant difference in different environment.

### Performance of specific leaf area of habitat heterogeneity

Specific leaf area (SLA) is the light capture area of per unit dry mass, related to plant assimilation rate, reflects the ability of plants to acquire resources, is closely related to the survival and growth of plants. We can conclude from that the SLA of *Ficus virens* Aiton., *Hibiscus rosa-sinensis* Linn., *Ixora chinensis* Lam., *Dracontomelon duperreanum* Pierre., *Lagerstroemia speciosa* (L.) Pers. which growing in clean area was significantly higher than in polluted areas ( $P < 0.01$ ), *Ficus microcarpa* L.f. in two environments without significant difference ( $P > 0.05$ ) (Figure 2). The results show that the responses of five native trees in different environment are consistency, showed the SLA of plants in clean area is greater than in polluted area .

### Correlativity between leaf mass per area and different leaf structure factors

Leaf mass per area(LMA) is dry mass per unit leaf area, representing carbon sequestration capacity and assimilation efficiency of leaf more intuitively. As seen in the Figure 3, LMA shows positive correlation and extremely significant difference to fresh weight and dry weight of leaf ( $p < 0.01$ ,  $r^2 = 0.186$ ;  $p < 0.01$ ,  $r^2 = 0.0806$ ), meanwhile a weak positive correlation to leaf area ( $p < 0.05$ ,  $r^2 = 0.0048$ ) , and it also shows a weak negative correlation and extremely significant difference to width to length ratio ( $p < 0.01$ ,  $r^2 = 0.0173$ ) , a moderate-intensity negative correlation and extremely significant difference to water content ( $p < 0.01$ ,  $r^2 = 0.4604$ ) , but it shows non-significant difference to average width.

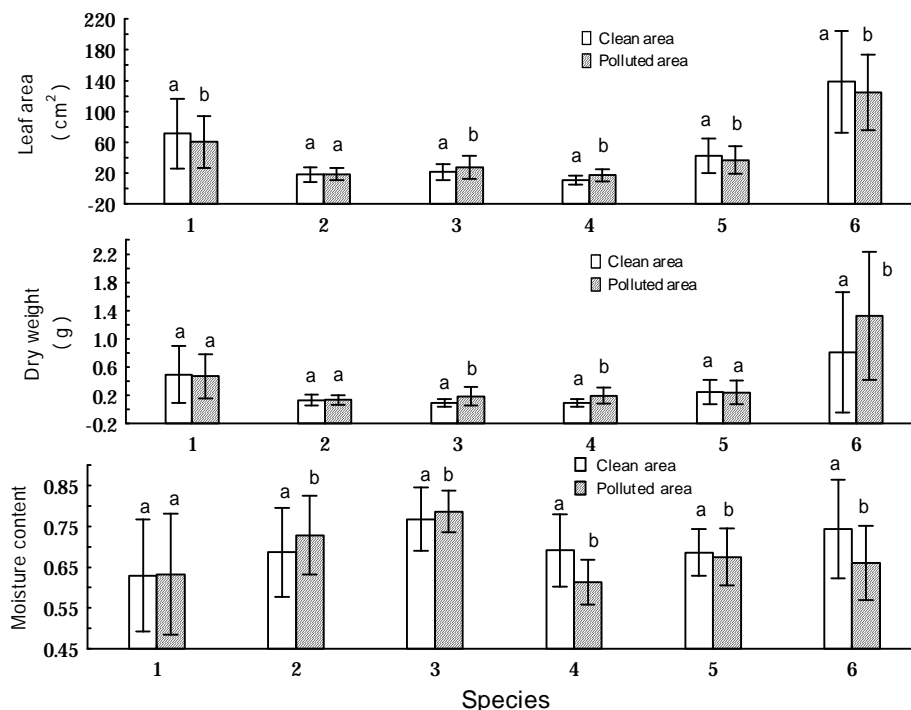


Fig. 1 Differences in dry weight, leaf area and moisture content of leaves of 6 native trees between different environment.

( Different letters above column of the same species indicate significant difference at 0.05 level).

1. *Ficus virens* Aiton. 2. *Ficus microcarpa* L.f. 3. *Hibiscus rosa-sinensis* Linn.;

4.*Ixora chinensis* Lam. 5.*Dracontomelon duperreanum* Pierre 6.*Lagerstroemia speciosa* (L.) Pers.

# Conclusion and discussion

Leaf functional traits reflecting plant adaptation to environment and resource utilization rate, are sensitive to environmental changes and vary with habitat changes[12]. During the adaptation to habitat, leaf functional traits will show functional correlation with habitat and trade-off[13]. We tested difference in leaf functional traits of six native trees under various environment and detected differences in fresh weight, leaf length, leaf width, mean width, leaf area, dry weight and leaf water content among six trees. However, no consistent trend was observed. *Ficus microcarpa* L.f. did not change with habitat, which indicated that leaf functional traits changed with habitat and responses to environment were uncertain.

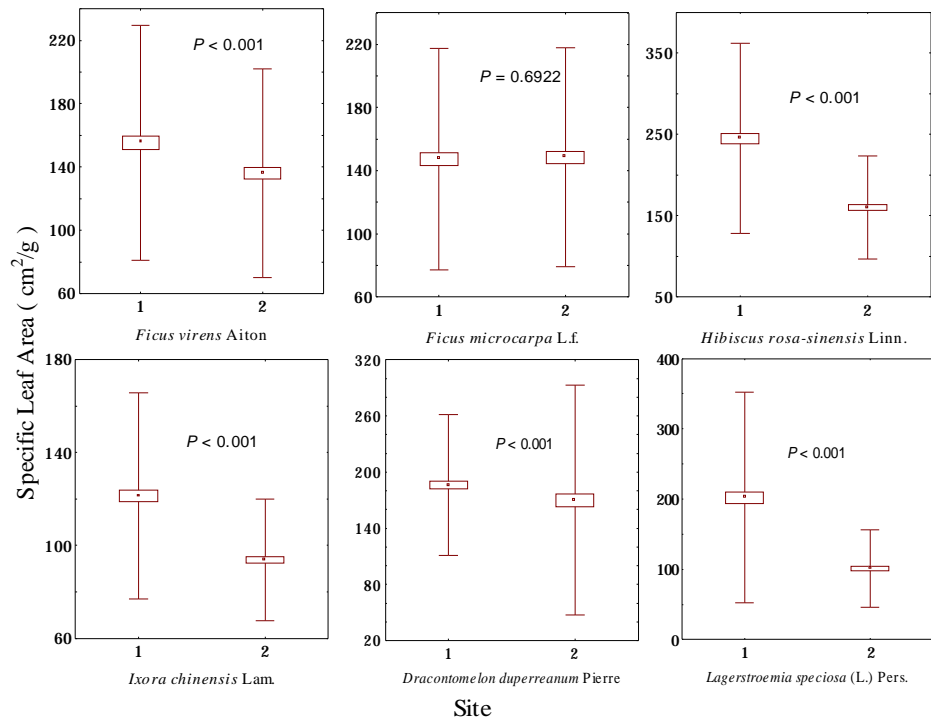


Fig. 2 Differences in SLA ( Specific Leaf Area ) of 6 native trees between different environment ( □: 25% – 75%; I: Non-outlier range).1. Clean area 2. Polluted area

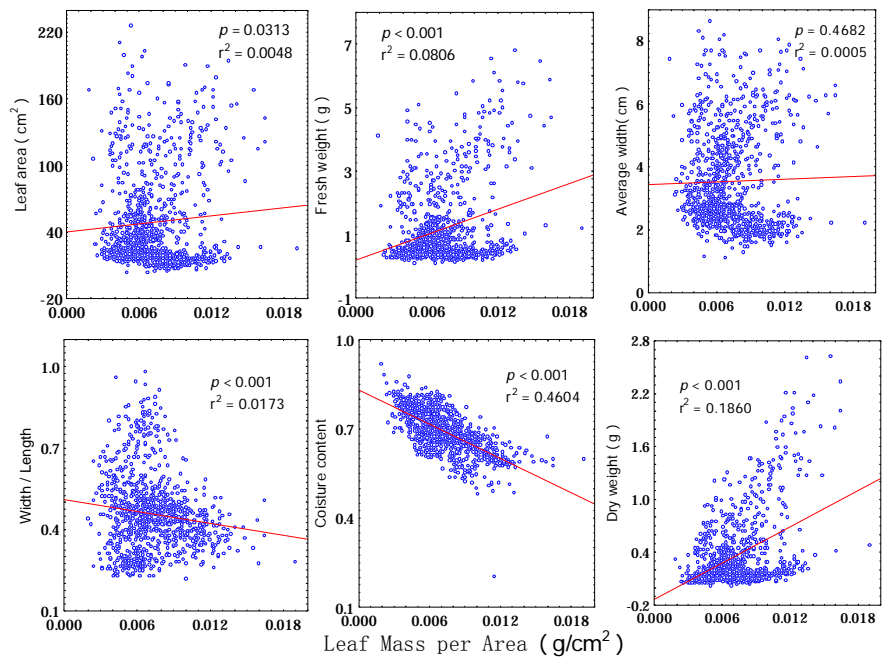


Fig. 3 Correlation between LMA and other leaf functional traits

Special leaf area (SLA) indicative of resource acquisition and water utilization capacity of plant is correlated with adaptability of plant to environment[14]. For example, plants with small SLA are more resistant against drought, while those with large SLA are better to conserve nutrition[15]. SLA of *Ficus virens* Aiton, *Dracontomelon duperreanum* Pierre., *Lagerstroemia speciosa* (L.) Pers., *Hibiscus rosa-sinensis* Linn. and *Ixora chinensis* Lam. in clean area were larger than in polluted area, which indicated that polluted area were more suitable for plant to survive and grow than clean area. Leaf shape of five species in streets varied with environmental stress due to pollution, which led to larger SLA.

Leaf mass per area (LMA), characterizing carbon sequestration capacity of plants, reflects correlations of per unit leaf area with resource utilization. LMA of plants is large under drought and barrenness [16]. Wright et al[17]found negative correlations of LMA with water and precipitation after investigating 75 species of plant in the eastern Australia, which was consistent with our findings. We also found that LMA was correlated most significantly with water content among all tested factors, which suggested water was the requisite for resource utilization in plants.

This paper tested the adaptability of native trees under different environment. Results suggest that LMA and SLA can be used to distinguish polluted and clean area efficiently, which is significant for native trees selection in Zhanjiang. As for clean area and polluted area construction, responses of leaf functional traits to different environment are of significance in promotion and application of garden cultural construction.

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