Research name

Leaf surface characteristics and the amount of dust covering he leaf surface of perennial trees growing along the perimeters of Kasetsart University Laboratory School, Bangkok, Thailand

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Abstract:

The purposes of this research study are to 1. evaluate leaf surface characteristics of perennial plants growing along the perimeters of Kasetsart University Laboratory School, Bangkok, Thailand, and 2. determine the amount of dust covering the leaf surface of these plants. We collected 3 fallen leaf samples found on the ground below the trees in 3 different areas adjacent to the streets around the school, in the morning and in the evening. There are 10 species and 12 trees in total. Next, we measured the amount of dust covering the leaf surface and calculated the percentage of dust covered area.

We found that the leaves can be divided into 3 groups based on their surface characteristics. The first group which has a smooth, and glossy leaf surface, includes False Mahogany (Swietenia macrophylla King), Golden Shower (*Cassia fistula* L.), Malay rose apple(*Syzygium malaccense*), Orange Jasmine ( *Murraya paniculata*), Golden Fig(*Ficus benjamina*), Rosy trumpet tree (*Tabebuia rosea* )and Purple Orchid Tree(*Bauhinia purpurea*) The second group which has an insignificantly smooth leaf with a slightly hairy surface includes Krapeechan (*Millettia brandisiana* Kurz.)and Rain Tree (*Samanea saman* Merr.) The third group which has a rough leaf surface and a clear mid-rib includes Yellow Poinciana **(*Peltophorum pterocarpum*)** 3. As a result, Yellow Poinciana-1 has the highest amount of dust covering the leaf surface (adaxial 99.29%, abaxial 79.90%). Golden Fig (adaxial 65.87%, abaxial 23.67%) and Malay rose apple (adaxial 85.89%, abaxial 5.43%), with smaller dust covered areas appeared to be less effective in helping reducing air pollutants. In the evening, Yellow Poinciana-2 has the highest amount of dust on the leaf surface (adaxial 98.13%, abaxial 91.40%). Krapeechan (adaxial 81.68%%, abaxial 28.14%), Malay rose apple (adaxial 87.84%, abaxial 0.00%) and Orange Jasmine (adaxial 94.44%, abaxial 0.00%) seemed less effective in helping reducing air pollutants.

We recommend growing trees with stingy leaves and a clear mid-rib, which are more capable of catching airborne dust.

Introduction:

Exposure to atmospheric particles and dust lead to negative consequences on quality of life in urban areas. Dust residues cause damages and leave dirt inside buildings. Hazardous dust particles can lead to annoyance, reduce visibility, and affect human health. Small dust particles can penetrate into the respiratory system, causing irritation, bronchitis, and asthma (Pollution Control Department, 2006). Sources of atmospheric dusts include the following: mobile sources (50% from vehicles), the existing surface (40%), and the living areas (10%). (Patcharawadee, 2005 referred to in Pasinee Sunakorn-On-Tarthaphonphat and Patchareeya Boonkorkaew, 2016).

There are a lot of dust particles in areas surrounding our school.

We observed a lot of dust on leaf surface of trees growing along the streets. The same type of trees inside our school were found to have less dust particles, compared to those growing on the roadside. The researchers think that the leaves should to be able to retain dust. The study of Pasin Sunanakorn (2010) showed that some plants can filter the dust effectively from the buildings that are located near the road. Growing shrubs can collect dust up to 75 percent of all bushes, and the research of Kulshreshtha et al. (2009) has measured the efficiency of roadside plants in reducing dust and the impact on plant leaves. By collecting the samples of plant leaves with dust, and find the effects on the stomata of the plants, the results showed that the dust which accumulated on the plant leaves is harmful, but some plants can tolerate them.

Based on the researchers’ observations and literature reviews, previous studies have shown that leaves can help to trap the dust. However, there are many groups of plants grown around the school perimeters, for example, perennials, shrubs, ornamental plants. We found that the perennial plants have the largest number of trees, and were commonly planted next to the road, in contrast to other groups of plants.

The researchers think that a majority of dust particles around the school were released from personal and public vehicles.

As the particles spread up to higher level, perennials should be able to capture the particles from the air. Therefore, the researchers were interested in studying the surface characteristics of the leaves and the resulting dust covered area on the leaves of perennials growing along the streets around the school. The objectives of this research study are to 1. evaluate leaf surface characteristics of perennial plants growing along the perimeters of Kasetsart University Laboratory School, Bangkok, Thailand, and 2. determine the amount of dust covering the leaf surface of these plants.

Research questions:

1. What kind of perennial trees are grown in the perimeters of Kasetsart University Laboratory School?

2. What are surface characteristics of leaves of these perennials?

3. What is the amount of dust covered area on the leaf surface of these perennials?

Research hypothesis:

1. If the types of perennials growing along the streets around the School were different, the leaf surface characteristics, which are intrinsic properties of each species, should also differ.

2. If the leaf surface characteristics were different among trees and leaves with hairy surface have higher effective area in trapping dust particles, dust covered area will be higher in leaves with such characteristics.

Materials and methods of research:

1. Determination of sample collection sites and a survey of tree varieties for leaf sample collections

1.1 We determined 3 sample collection sites on the side of the street around the school: north, south and east sides of the road, adjacent to the school fence. Then, we selected one area on each side for sample collection, facing out to the road. Each area was divided into 3 sub-points, i.e. the first point is on the left side of the road, the second point in the middle of the road, and the last one is on the right side of the road. At each point, we collected samples from perennials found in a radius of 1 m.

1.2 We collected leaf samples in the morning 07.30-08.30 hrs, and in the evening 16.30 - 17.30 hrs. These two specific time slots were chosen as parents would drop off and pick up students during these periods of time, resulting in higher number of personal and public vehicles on the road surrounding the school.

1.3 At each sample collection, we recorded species name, took pictures, and also determined the air quality in the study area using Air Quality Detector tool to measure the dust volume of 3 sizes, i.e. PM 10, PM 2.5 and PM 1. Three fresh leaf samples were collected from the ground below each tree of interest, and immediately stored in a bag.

2. Determination of leaf surface characteristics, leaf area and dust covered area

2.1 We quantified the amount of dust covered area on the leaf surface on both sides of the leaf using a clear adhesive tape. Once peeled off from the leaf, the dust from the leaf surface were transferred onto the tape surface. The dust covered tape were then placed on a paper with tables of a known size (a grid of 0.5 x 0.5 cm; 0.25 cm2)

2.2 We used a pencil to draw leaf edge on the same paper and later use this area to as a total leaf area when calculating a proportion of dust covered surface.

3. Quantification of dust covered area

3.1 We determined the total leaf surface area by counting the number of grids on the table paper.

3.2 We then determined the amount of dust covered area on the leaf surface using a USB Digital Microscope camera. If each grid of 0.5 x 0.5 cm was covered by more than 50% of the total are, we considered it as a dust covered area.

3.3 We calculated the ratio of dust covered area versus the total leaf area and compared it to the leaf surface characteristics observed in the previous steps.

Research results

Leaf surface characteristics of perennials growing around the school. Consistent with objectives and research questions, 1 and 2 Get research results As shown in Table 1 as follows.

Table 1 Common names, scientific names and leaf surface characteristics of perennials growing around Kasetsart University Laboratory School

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Collection site** | | **Perennials** | | | |
| **#** | **common name** | **Scientific name** | **surface of the leaves** |
| North | Left | 1 | Yellow Poinciana-1 | ***Peltophorum pterocarpum*** | rough leaf surface and a clear mid-rib |
| Middle | 2 | False Mahogany | Swietenia macrophylla | smooth, and glossy leaf surface |
| Right | 3 | Yellow Poinciana-2 | ***Peltophorum pterocarpum*** | rough leaf surface and a clear mid-rib |
| 4 | Yellow Poinciana-3 | ***Peltophorum pterocarpum*** | rough leaf surface and a clear mid-rib |
| East | Left  Middle | 5 | Golden Shower | ***Cassia fistula*** | smooth, and glossy leaf surface |
| 6 | Malay rose apple | Syzygium malaccense | smooth, and glossy leaf surface |
| Right | 7 | Orange Jasmine | *Murraya paniculata* | smooth, and glossy leaf surface |
| 8 | Rosy trumpet tree | *Tabebuia rosea* | smooth, and glossy leaf surface |
| South | Left | 9 | Golden Fig | *Ficus benjamina* | smooth, and glossy leaf surface |
| Middle  Right | 10 | Krapeechan | *Millettia brandisiana* Kurz. | smooth leaf with a slightly hairy surface |
| 11 | Rain Tree | *Samanea saman* | smooth leaf with a slightly hairy surface |
| 12 | Purple Orchid Tree | *Bauhinia purpurea* | smooth, and glossy leaf surface |
| Left | - | - | - | - |

From Table 1, it was found that the perennial plants, which are found composed of 10 species, consisting of 12 trees, namely Yellow Poinciana, False Mahogany, Golden Shower, Malay rose apple, Orange Jasmine, Rain Tree, Golden Fig, Rosy trumpet tree, Purple Orchid Tree, and Krapeechan, From the observations found that every tree that grows fully Observed from the size of the trunk, height and some species bloom and are effective.

The surface of the leaves of 10 kinds of perennials can be divided into 3 groups, namely, smooth, glossy, covered leaves such as False Mahogany, Golden Shower, Malay rose apple, Orange Jasmine, Golden Fig, Rosy trumpet tree, and Purple Orchid Tree. The leaves have slightly smooth. With a little hair, including Krapeechan, Rain Tree. The leaves have stingy leaves, clear middle lines leaves characteristic as following Yellow Poinciana.

Part 2

The study of the amount of dust covering the leaf surface of the perennial plant growing along the road around the Demonstration School of Kasetsart University. Consistent with the objective and research question 3 as follows.

Table 2 Characteristics of the leaf surface, leaf surface area and amount of dust covering the leaf surface of the perennial plant that grows along the roadside around Kasetsart University Laboratory School.

In the morning (07.30 - 08.30)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Perennials name** | **The first**  **leave** | | | **The second**  **leave** | | | **The third**  **leave** | | | **Average** | | |
| Leave area (cm2) | Dust covered upper the leaves (%) | Dust covered lower the leaves (%) | Leave area (cm2) | Dust covered upper the leaves (%) | Dust covered lower the leaves (%) | Leave area (cm2) | Dust covered upper the leaves (%) | Dust covered lower the leaves (%) | Leave area (cm2) | Dust covered upper the leaves (%) | Dust covered lower the leaves (%) |
| 1 | Yellow Poinciana | 10.00 | 100.00 | 97.50 | 11.50 | 97.83 | 52.17 | 12.50 | 100.00 | 90.00 | 11.33 | 99.28 | 79.89 |
| 2 | False Mahogany | 61.25 | 86.73 | 17.08 | 63.25 | 83.79 | 11.46 | 59.25 | 87.34 | 22.78 | 61.25 | 85.95 | 17.11 |
| 3 | Yellow Poinciana -2 | 11.25 | 86.66 | 31.11 | 6.75 | 100.00 | 26.19 | 10.50 | 90.47 | 26.19 | 9.50 | 92.38 | 27.83 |
| 4 | Yellow Poinciana -3 | 13.25 | 88.89 | 62.96 | 41.00 | 79.51 | 65.06 | 24.75 | 80.80 | 23.23 | 26.33 | 83.07 | 50.42 |
| 5 | Golden Shower | 37.50 | 86.71 | 22.00 | 97.00 | 55.41 | 6.44 | 99.25 | 77.33 | 0.75 | 77.92 | 73.15 | 9.73 |
| 6 | Maley Rose Apple | 60.00 | 80.74 | 13.00 | 81.50 | 85.34 | 0.00 | 14.25 | 91.59 | 3.28 | 85.25 | 85.89 | 5.43 |
| 7 | Orange Jasmine | 10.25 | 97.56 | 0.00 | 12.25 | 97.96 | 16.33 | 13.25 | 100.00 | 22.64 | 11.92 | 98.51 | 12.99 |
| 8 | Rosy Trumpet Tree | 91.00 | 90.38 | 19.53 | 56.00 | 78.13 | 20.98 | 67.25 | 69.89 | 9.29 | 71.42 | 79.47 | 16.60 |
| 9 | Golden Fig | 62.00 | 68.55 | 31.00 | 59.00 | 80.51 | 23.00 | 60.25 | 48.55 | 17.00 | 60.42 | 65.87 | 23.67 |
| 10 | Krapeechan | 14.50 | 67.24 | 55.17 | 14.75 | 55.93 | 42.37 | 14.25 | 100.00 | 49.12 | 14.50 | 74.39 | 48.89 |
| 11 | Rain Tree | 12.50 | 62.00 | 34.00 | 13.50 | 62.96 | 37.04 | 14.50 | 100.00 | 27.59 | 13.50 | 74.99 | 32.88 |
| 12 | Purple Orchid Tree | 25.25 | 88.00 | 13.86 | 28.50 | 94.74 | 33.33 | 27.50 | 68.18 | 0.00 | 27.08 | 83.64 | 15.73 |

Table 3 Characteristics of the leaf surface, the leaf surface area and amount of dust that covered the leaf surface of the perennial plant growing along the roadside around Kasetsart University Laboratory School.

In the evening (16.30 - 17.30)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No .** | **Perennials name** | **The first**  **leave** | | | **The second**  **leave** | | | **The third**  **leave** | | | **Average** | | |
| Leave area (cm2) | Dust covered upper the leaves (%) | Dust covered lower the leaves (%) | Leave area (cm2) | Dust covered upper the leaves (%) | Dust covered lower the leaves (%) | Leave area (cm2) | Dust covered upper the leaves (%) | Dust covered lower the leaves (%) | Leave area (cm2) | Dust covered upper the leaves (%) | Dust covered lower the leaves (%) |
| 1 | Yellow  Poinciana | 8.25 | 100.00 | 63.64 | 9.00 | 100.00 | 88.89 | 6.50 | 84.61 | 72.00 | 7.91 | 94.87 | 74.84 |
| 2 | False Mahogany | 60.50 | 95.87 | 72.73 | 67.75 | 94.00 | 73.43 | 85.25 | 99.12 | 79.47 | 71.16 | 96.33 | 75.21 |
| 3 | Yellow  Poinciana -2 | 28.50 | 96.49 | 90.35 | 22.25 | 98.88 | 88.76 | 25.50 | 99.02 | 95.10 | 25.41 | 98.13 | 91.40 |
| 4 | Yellow  Poinciana -3 | 32.75 | 100.00 | 24.43 | 22.75 | 100.00 | 32.97 | 19.00 | 84.21 | 59.27 | 24.83 | 94.73 | 38.89 |
| 5 | Golden Shower | 45.00 | 90.18 | 0.18 | 43.75 | 82.25 | 0.00 | 42.50 | 96.41 | 0.90 | 43.75 | 89.61 | 0.36 |
| 6 | Maley Rose Apple | 109.50 | 95.21 | 0.00 | 108.50 | 85.25 | 0.00 | 110.00 | 82.00 | 0.00 | 109.33 | 87.48 | 0.00 |
| 7 | Orange Jasmine | 11.25 | 100.00 | 0.00 | 9.00 | 100.00 | 0.00 | 12.00 | 83.33 | 0.00 | 10.75 | 94.44 | 0.00 |
| 8 | Rosy Trumpet Tree | 105.00 | 87.86 | 31.43 | 95.50 | 91.36 | 39.00 | 88.75 | 83.00 | 48.45 | 96.41 | 87.40 | 39.63 |
| 9 | Golden Fig | 41.25 | 90.91 | 83.03 | 48.75 | 93.33 | 73.33 | 37.50 | 74.67 | 16.00 | 42.50 | 86.30 | 57.45 |
| 10 | Krapeechan | 7.00 | 75.42 | 35.71 | 8.00 | 90.63 | 28.13 | 8.50 | 79.00 | 20.59 | 7.83 | 81.68 | 28.14 |
| 11 | Rain Tree | 14.50 | 96.55 | 25.86 | 15.25 | 75.41 | 46.45 | 11.00 | 100.00 | 65.91 | 13.58 | 90.65 | 46.07 |
| 12 | Purple Orchid Tree | 28.00 | 100.00 | 0.00 | 22.50 | 100.00 | 4.44 | 26.75 | 84.00 | 6.54 | 25.75 | 94.66 | 3.66 |

Summarizing and discussing research results

1. The perennial plants found were composed of 10 species, consisting of 12 trees including False Mahogany, Golden Shower, Malay rose apple, Orange Jasmine, Golden Fig, Rain Tree, Purple Orchid Tree, Krapeechan, Rosy trumpet tree and Yellow Poinciana.

2. The study of leaf surface characteristics and the amount of dust cover showed that if the leaves surface of each perennial plant had different leaf surface characteristics, so they can trap the different amount of dust volume. So the group that has a smooth, and glossy leaf characteristic and the group that has an insignificantly smooth leaf with a slightly hairy characteristic are less entrap the dust than the group of leaves that has a rough leaf surface, clear middle lines leaf characteristic. As consistent to the research of Wichitra (2008 referred to in Sinee Sunakorn Ong-tharaphonphat and Phatchariya Boonkoew, 2016) that the group of leaves that has a rough leaf surface with a slightly hairy characteristic has more friction to trap the dust.

However, some species of the perennial plant for example Rain tree, False Mahogany have a lot of dust cover on the leaves surface cause the volume of dust in this area may be different from another area, so they may be an effective ability to store the dust and another cause is when we collect the example of the leaves, it may be miss out. Also, the sticker that uses to trap the dust from the leaves may not be able to trap all of the particles of the dust that covers on the leaves surface so this all factor will be controlled in the future.

From the result of this research may be the information for people who want to grow the perennial plant to trap the dust, you should select the perennial plant that has a rough leaf surface, clear middle lines leaf characteristic such as Yellow Poinciana, etc.

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