Pollution Resistance Characteristics of Street Trees

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Abstract: Garden or urban street construction planting plants with high pollution resistance can not only play a remedial role in the surrounding environment, such as reducing dust and noise, absorbing toxic gases and substances, but also beautify the environment and play a role in shade and soil preservation, climate regulation, etc. Three street trees, Cassia nodosa, Cinnamomum camphora and Spathodea campanulata were selected as the objects, conductivity, chlorophyll content and plant leaf dust retention were used to reflect the pollution resistance characteristics of these three plants. The results showed that C. Camphor had the strongest anti-pollution characteristics, followed by Spathodea Campanulata, and Cassia Nodosa was the weakest. This conclusion provides theoretical guidance for the selection and utilization of street trees.

1 INTRODUCTION

Accelerated urbanization and increased population,as well as the using of various non-clean energysources have led to prominent environmental pollution problems, which seriously affect the humanliving environment and the sustainable development of the future economy(Lan 2017). Anti-pollution plants are plants that can absorb harmful gases, retain dust, kill bacteria, attenuate noise, and maintain the balance of oxygen and carbon dioxide in the atmosphere (Xu 2006). In general anti-pollution plants have great advantages in environmental pollution prevention, and compared to artificial treatment, plant regulation is greener and more in line with the development of ecological balance.

Some trees are significantly resistant to atmospheric pollution, and most tree species exhibit greater pollution resistance in areas with suitable environmental conditions than in other areas, while the anti-pollution properties of plants are relatively reduced when planted in areas that are not adapted. Thus it can be seen that municipal engineer for each district should select tree species with pollution resistance characteristics that are more suitable for the area according to the natural environmental conditions of the locality.

The needs and development of society require us to continue to discover or breed tree species with better pollution resistance. Some of the ways we can take include: discovering and introducing new tree species with pollution resistance characteristics; obtaining varieties or types with stronger pollution resistance characteristics through single plant selection; and breeding new tree species with pollution resistance characteristics through hybridization, mutagenesis, and other breeding means.

There are also some related studies in China, in which the response of *Dianthus superbus* L., *Iris tectorum* Maxim., *Zephyranthes candida* (Lindl.) Herb., *Reineckea carnea* (Andrews) Kunth and *Sedum sarmentosum* Bunge, cadmium and lead was studied in the selection of anti-pollution garden plants. The results of the study showed that *Dianthus superbus* L. had a significant remediation effect on cadmium-contaminated soils, *Reineckea carnea* (Andrews) Kunth had the best remediation effect on copper-contaminated soils and *Sedum sarmentosum* Bunge had the best remediation effect on lead-

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contaminated soils; in heavy metal-contaminated soils, *Dianthus superbus* L. had the best remediation effect, followed by *Sedum sarmentosum* Bunge, *Reineckea carnea* (Andrews) Kunth and *Iris tectorum* Maxim., and the worst was *Zephyranthes candida* (Lindl.) Herb (Zhang 2004).

Nowadays, there are a lot of harmful gases, dust and other pollutants in the atmosphere, and it is urgent to protect the environment. For different sources of pollution, choosing suitable anti-pollution tree species can improve the ecological environment more effectively (Yang 1983). Anti-pollution plants can absorb harmful substances in the soil and also purify the air, which can improve the environment. This paper investigates and analyses data on the anti-pollution characteristics of street trees in the urban area, ranks the anti-pollution ability of anti-pollution tree species in the area, and advocates planting more of such anti-pollution plants.

The development of pollution-resistant plants will not only reduce the burden on the city but also bring efficient returns to the urban environment. Through this study, we compare the pollution resistance of street trees in the urban area of Pu'er City, Yunan Province, and offer constructive suggestions for urban garden plant configuration and even garden development.

2 MATERIALS AND METHODS

2.1 Materials

Three main street trees, *Cassia nodosa*, *Cinnamomum camphora* and *Spathodea campanulata*, were selected for the study on Pu'er Avenue in Pu'er City.

2.2 Method

2.2.1 Selection of Survey Sites

One representative trunk road was selected based on the distribution of trunk roads: Pu'er Avenue.

2.2.2 Sample Collection

On the main road of Pu'er Avenue, three plants with similar growth and condition, namely *C. nodosa*, *C. camphora* and *S. campanulata*, were selected. Three plants of each species were selected and spaced at a certain distance (4-5m) from each other. Plants of similar growth, height and tendency were selected and then fresh leaves of the current year were taken from the middle of the tree canopy. A sample of 10 leaves was taken from each plant. Samples were collected in the morning and taken back to the laboratory in self-sealing bags, well marked.

2.2.3 Relative Conductivity

Leaves were selected from the same parts of each plant, wiped clean with distilled water on the front and back of the leaves, the midrib was removed with scissors and the remaining parts were cut to 5 mm × 5 mm. 0.2 g was placed in a conical flask and 30 ml of distilled water was added, placed on a HY-5 dual purpose shaker and shaken in a rotary mode for 4-5 hours, after which the conductivity L1 was measured promptly. The conical flask was then corked again, boiled for 20 min, removed and cooled to room temperature, after which the conductivity L2 was measured and repeated 3 times. The conductivity was measured using a DDS-6700 conductivity meter. The formula was calculated as follows:

Relative conductivity (%) = (L1/L2)*100%(Gao 2003)

2.2.4 Chlorophyll Content using Acetone Extraction

The fresh leaves were cut into pieces, weighed 0.5 g and put into a mortar with 3 ml of pure acetone, a little calcium carbonate and quartz sand, and ground into a homogenate, then added with 5 ml of 80% acetone (v/v), the homogenate was transferred into a centrifuge tube, centrifuged at 4 000 r/min for 10 min and the precipitate was discarded, the supernatant was fixed to 10 ml with 80% acetone. 0.5 ml of the above pigment extract was taken, diluted with 4 ml of 80% acetone and transferred into a colorimetric cup. The absorbance values at 663 nm and 645 nm were measured using 80% acetone as control. Finally, the concentrations of chlorophyll a, chlorophyll b and chlorophyll a+b in the pigment extracts were calculated separately, and then the content of pigment per gram of fresh weight leaf was calculated according to the dilution times respectively (Gao 2003).

2.2.5 Dust Retention

There is no unified standard on the method of determining the amount of stagnant dust. Jiang Shengli found that the water washing and filtration method is more accurate than the wiping method in his research, and the reference in this paper is the water washing and filtration method. The specific operation is as follows.

First, the petiole is removed from the sample leaves, after which the leaves are soaked in distilled water for 2 to 3 hours, while the self-sealing bags are washed 2 to 3 times, stirring intermittently with a glass rod during the soaking process and brushing the leaves lightly with a soft brush.

The leaves were taken out with tweezers to dry and the beaker of the dip was filtered, the inside of the flask was washed with distilled water using a dropper during the extraction process, the filter paper used had been dried and weighed and was padded with 2 layers to prevent the dip from penetrating the filter paper.

The filtered filter paper was put into an oven at 65 °C for 24 hours, after which the dried filter paper was weighed on a balance and the difference between the two filter papers before and after was the total dust retention.

3 RESULTS AND ANALYSIS

3.1 Conductivity Analysis

Numerous studies have proven that the first thing affected in plants subjected to environmental pollution is the cell membrane, and that the disruption of the permeability of the cell membrane leads to the extravasation of electrolytes, mainly potassium ions in large quantities, thus causing the conductivity of the leaf extravasate to increase in varying degrees with the degree of pollution. The greater the degree of injury to the cell membrane, the more serious the contamination of the area (Fig.1).

The relative conductivity of *C. nodosa* is significantly higher than that of *S. campanulata* and *C. camphora.* The *Cassia Nodosa* is in a more polluted environment, and the fact that it has the largest relative conductivity value means that it is less resistant to pollution. Conversely, the smallest relative conductivity of the three plants was that of *C. camphora*, reflecting its relatively greater resistance to pollution than that of *C. nodosa*, and more than that of *S. campanulata*.

3.2 Chlorophyll Content

It has been shown that both chlorophyll a and chlorophyll b are damaged in the presence of atmospheric pollution (Gao 2003, Du 2007). Chlorophyll b plays an auxiliary and protective role, because chlorophyll b tends to break down when exposed to environmental pollution, so that in both types of plants in heavily polluted and less polluted locations, the more polluted plants will have greater chlorophyll a/b values (Yang 1983). The combined results chlorophyll content depends on the pollution the plants are subjected to. As can be seen from Fig.2 below, there is no significant difference between the chlorophyll a/b content and the total content of the three plants selected here (P>0.05) (Fig.2-3).

3.3 Dust Retention

Although there is no significant difference in the amount of dust retained on the three plants, *S. campanulata* has a higher dust retention capacity (0.12 g/cm2>P>0.10 g/cm2). Possibly on the one hand, the plant itself, which has sunken veins like *S. campanulata*, and a fine-tomentose leaf surface, a structure that tends to trap dust, and the relatively smooth, leathery leaf surface of *C. camphora*, which has no tufts, and therefore does not tend to trap dust (Fig.4).

The canopy of plants has the effect of reducing wind speed, the large particles of dust carried in the wind will sink and fall onto the leaves of the trees or the ground, which produces a stagnant dust effect. Some garden plants have more fluff on the leaf surface, and some plant leaves also secrete sticky grease and sap, etc., so that they can absorb large amounts of dustfall. The dust retention capacity of tree species varies, with the strongest trees being *S. campanulata*, *Ficus religiosa* L. and *Ficus altissima* Blume, and studies have shown that after 12 d of accumulated dust retention in street trees, *S. campanulata* and *Ficus religiosa* L. have the best dust retention capacity per unit leaf area, while *Terminalia neotaliala* Capuron and *Khaya senegalensis* (Desr.) A. Juss. have the worst. The difference in the dust retention capacity of different species of street trees was related to the structure of the leaves. The dorsal and ventral surfaces of the leaves of *S. campanulata* and *Ficus religiosa* L. were densely packed with hairs, which had a high dust retention capacity, whereas the leaf surfaces of *Terminalia neotaliala* Capuron, *Khaya senegalensis* (Desr.) A. Juss. and *C. camphora* were waxy, and the leaf surfaces were not deeply veined, had few folds and were smooth, which had a poor dust retention capacity. In another study, similar conclusions were made for *S. campanulata*, what can be used as a green belt and barrier for highways, railways, embankments and river slopes as well as a fast mulching plant for slope protection and sand sealing due to its advantages of dust retention and noise reduction, resistance to rough management and strong soil fixation to improve the environment efficiently. The difference in dust retention between the three plants in this study was not significant.

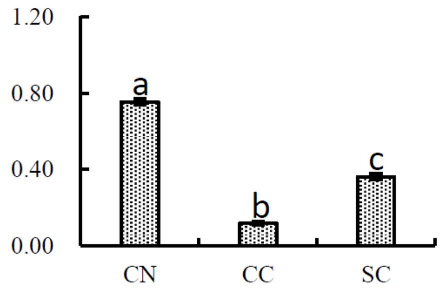

Figure 1: Relative conductivity (μS/cm).

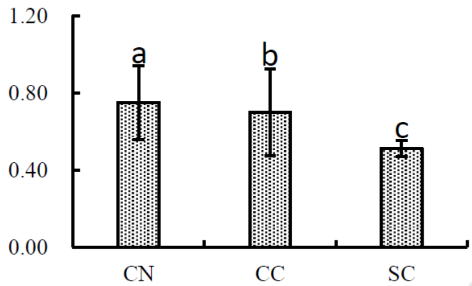

Figure 2: Chlorophyll a/b content (mg/L).

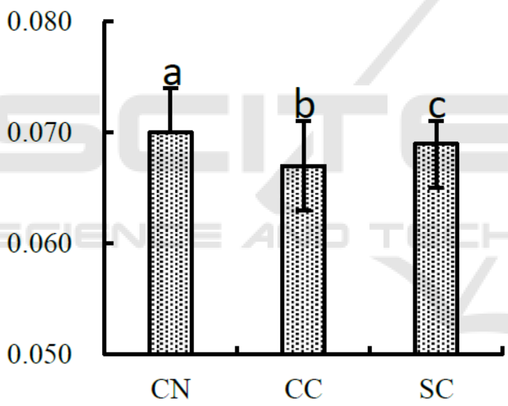

Figure 3: Total chlorophyll content (mg/L).

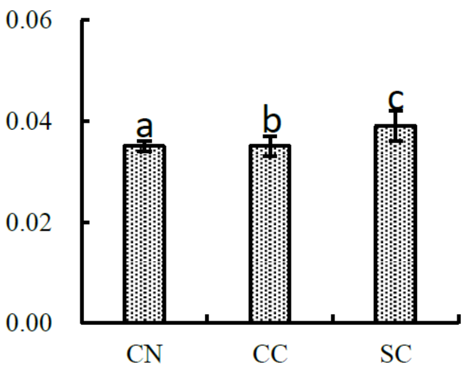

Figure 4: Dust retention (g/cm^2).

CN: Cassia nodosa CC: Cinnamomum camphora
SC: Spathodea campanulata

4 DISCUSSION AND CONCISUSIONS

4.1 Discussion

Plant photosynthesis can be used to judge the degree of plant growth, and chlorophyll content is an important indicator of plant photosynthesis, so the amount of chlorophyll content can be used to measure the growth of plants, and can even be used as an important indicator of plant resilience. The chlorophyll content of plants is used here as an indicator of their resistance to pollution, with those with more chlorophyll being more resistant to pollution. The chlorophyll content of the three plants in this study was not significantly different.

When plant tissues are exposed to various unfavourable environmental conditions (e.g. low temperature, high temperature, salinity and air pollution), the structure and function of cell membranes are firstly damaged and the permeability of cell membranes is increased, mainly by potassium ion extravasation, resulting in different degrees of increase in the conductivity of leaf exudates with the increase in the degree of contamination. At this point, measuring the conductivity of plant tissue extracts or exudates and observing changes in cell membrane permeability can reflect the degree of plant resistance and injury, where the magnitude of plant conductivity is chosen to reflect the degree of plant resistance to contamination. In the conductivity measurements, the relative conductivity of *C. nodosa* was greater than that of *S. campanulata* than *C. camphora*. In the effect of environmental pollution on the physiological characteristics of plants in Nanyang City, the same relative conductivity was chosen to reflect plant resistance to pollution (PANG 2012). After the environment is polluted the permeability of the cell membrane is changed and electrolytes are extravasated, so the greater the relative conductivity of that plant. The greater the relative conductivity, the weaker the plant's resistance to pollution, and the results show that for relative conductivity, *C. camphora* is more resistant to pollution than *S. campanulata* and *C. nodosa.*

4.2 Conclusion

C.camphora is more resistant to environmental pollution, followed by *S. campanulata* and finally *C. nodosa*. *C. camphora* is suitable for planting in polluted areas and can also be used to prevent environmental pollution, while *C. nodosa* and *S.*

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campanulata can be used as indicators to detect the level of pollution. This study provides a partial basis for the planting configuration of urban greenery. More physiological and ecological characters are needed in further related researches for analysing the resistant of steet trees.

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