# Polluted plants... on Crissu

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# RESPONSES OF SEVERAL TROPICAL PLANT SPECIES TO POLLUTED AIR CONDITION IN THE CITY

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**Abstract**

*It is common to use plant species to fight air pollution problem. This research was design to evaluate several tropical plant species with respect to its tolerance to polluted air condition in the city. Field observations were took place at Palembang City, South Sumatra, Indonesia. Research incorporated fifteen plant species grown at two different sites of Highly Polluted Air (HPA-site), and Non-Polluted Air (NPA-site), which consisted of 30 samples of mature plants per site. Quick measurement on the chlorophyll content were imposed on five mature leafs per sample. Research indicated that tropical plant species showed various responses. With respect to the chlorophyll content, certain plant species, such as Ficus sp, Hemigraphis sp, and Allamanda sp, showed no-significant reduction either they were grown at HPA-site or NPA-site.*

***Keywords***: *Tropical, plant, air, pollution,*

## INTRODUCTIONS

It is common to use plant species to fight polluted air problem. Many cities in the world use various plat species to establish such beautiful garden, huge greenbelt to clean polluted air which especially derive from transportation modes such as cars, motorcycles, trucks and buses. Irwan (1996 and 1997) described the importance of establishing green belt in the city which mainly to solve environmental crisis, environmental recovery, and other aesthetical purposes.

Transportation modes, such as cars, motorcycles, truck and buses are the major factor to cause polluted air in the city. Wardhana (2001) stated that transportation devices produce emission gas which contributes more than half of air pollution problem in the city. Emission gas such us Carbon Monoxide (CO), Nitrogen Oxide $(NOx)_2$, Sulfur Oxide $(Sox)_2$, Hydrocarbon (HC), and Pb particles considered as pollutants that are toxic materials to the people, animal, and plants (Hawkes, 1996; Sastrawijaya, 1991).

Indonesian Government Rule Number 41, May 26, 1999, described the maximum content of that emission gas in clean air (Table 1).

Table 1. The maximum content of emission gas in the clean air

| No. | Gas and particles | Maximum content (micro g/N $m^3$ | Measurement periode (hours) | Instrument to use |
|---|---|---|---|---|
| 1. | SO2 | 900 | 1 | Spectrophotometer |
| 2. | CO | 30 000 | 1 | NDIR Analyzer |
| 3. | NO2 | 400 | 1 | Spectrophotometer |
| 4. | O3 | 235 | 1 | Spectrophotometer |
| 5. | HC | 160 | 3 | Gas Chromatography |
| 6. | Pb particles | 2 | 24 | Hi-Vol AAS |
| 7 | Dust | 230 | 24 | Hi-Vol AAS |

Furthermore, Hawkews (1996) stated that the presence of pollutants in the air migth result in the climate change and alteration in the plant growth and development. High content of Nitrogen Oxide, Sulfur Dioxide, and CFC cause the ozone layer to be thinner that increase in UV radiation and therefore, the atmosphere temperature might incresase to certain level. When the pollutant enter stomata, and invade the cells, the plant growtht and development will be effected due to depreciation in the cholophyll content and change in sugar mobilization. These change will alter some essential metabolic process in the plant, such as photosynthesis and respiration. Sinot and Wilson (1955) eventually stated that chlorophyll played very important role in metabolic process of Photosynthesis that lead to the change in growth and development of the plants.

Sikora and Chappelka (1996) reported physical effects of the pollutant to the plant organ which include burning on leafs edge and reduction in shoot innitiation. The objective of this research, therefore, was to evaluate several tropical plant species with respect to its tolerance to polluted air condition in the city by measuring chlorophyll content on the plants. Tolerant plant species is indicated by no significant reduction of the chlorophyll content of the plant grown in the highly polluted area as compared to the plant grown in non-polluted area.

## MATERIALS AND METHODS

Observations were took place at Palembang City, South Sumatra, Indonesia, which temperature ranges from 23 to 31 $^{o}$C and rainfall ranges from 80 to 469 mm per month. Observation on each plant species were done at two different sites of Highly Polluted Air (HPA-site), and Non-Polluted Air (NPA-site). The HPA-site was defined as the area closed to city road, in which, jam-packed vechicles were usually occur, while the NPA-site was defined as the area that far from the city road, such as remote farmland, villages, and housing complex. The research utilized 30 mature plants grown in the site, in which, 5 leafs were use to measure cholorophyll content. Quick measurements on the Chlorophyll Content Value (CCV) were imposed on the mature leafs by using portable chlorophyll meter of SPAD 502. Statistical analysis method of Two Sample T-test (Bender and Kramer,1989) were used to determine significant reduction in the mean value of chlorophyll content of the plant in the HPA-site as compared tho that of NPA-site. The analysis were done by using computer program of Statistical Analysis System (SAS Institute, 1983).

## RESULTS AND DISCUSSION

1

Responses of several tropical plant species to polluted air condition were assessed by chlorophyll measurement on the leafs. Hopkins (1999) and Smith and Mansfield (1984) stated that air pollutants enter the plants through stomata on the surface of the leafs. This toxic material, then involve into metabolic process of $CO_2$ diffussion that end up with the destruction of the chloroplyll body (chloroplast) and chlorophyll formation. Small concentration of 0.035 $\mu L\ L^{-1}$ $SO_2$ in the air, for example, was reported to significantly inhibit chlorophyll membrane, and in higher concentration was reported to make significant destruction on the chlorophyll bodies (Hopkins, 1999 and Huttunen and Soikkeli, 1982. In addition to Sikora and Chappelka (1996) report, this research observed significant alteration on the leaf color and necrosis on the leafs of the several sensitive plant due to reduction of chlorophyll content.

Hopkins (1999) reported that pollutants, such as, $SO_2$ in the leafs will dissolve into water to be ionic form of $SO_3^{-2}$ and $HSO_3^{-1}$. These ionic forms were reported to be

harmfull for several plant species, but no-effect for others, as the plants showed ability to eliminate the effect by certain mechanisms such as chelatitation. Furthermore, Wilmer (1983) reported that anatomy and number of stomata on the leaf surface contribute to the ammount of pollutants to enter the plant, while Amperawati and Basuki (2000) stated that leaf texture was also determine the ammount of pollutants to enter the plants. Apparently, these cability and characteristics play an important role on tolerance of plant species to polluted air condition in the city.

As shown on Table 2, this research indicated that tropical plant species had various content of chlorophyll. In normal air condition (NPA-site) the chlorophyll content ranged from 40 to 60 CCV, while in high polluted air condition (HPA-site) the chlorophyll content ranged from 18 to 59 CCV. In NPA-site, the plant species with highest chlorophyll content of 59.32 CCV was attained by Alamanda sp and the plant with lowest chlorophyll content of 28.02 CCV was attained by Pisonia sp. On the other hand, in HPA-site, the plant species with highest chlorophyll content of 58.89 CCV was also attained by Allamanda sp and the plant with lowest chlorophyll content of 18.81 CCV was also attained by Pisonia sp. It is interesting, as the same plant species attained the highest and the lowest chlorophyll content either for NPA-site or HPA-site.

Statistictical analysis method (Table 2) of Two Sample T-test (Bender and Kramer,1989) that were used to determine significant reduction in the mean value of chlorophyll content of the plant in the HPA-site as compared tho that of NPA-site by using computer program of Statistical Analysis System (SAS Institute, 1983), indicated that more tropical plant species showed significant reduction of chlorophyll content when they were grown at high polluted air condition (HPA-site). These reduction ranged from 3.39 to 21.38 CCV, which was statistically significant at $P<0.01$, and therefore they were apparently considered as sensitive plant species to polluted air condition in the city . These tropical plant species include Ixora sp., Pisonia sp., Bauchinia sp., Chrysalidocarpus sp., Cyatostachys sp., Canna sp., Duranta sp., Lantana sp., Chlorophytum sp., Bougainvillea sp., Nephrolepsis sp., and Licuala sp.. The common name of these plants in Indonesia is, “Asoka”, “Kol Banda”, “Bunga kupu-kupu”, “Palem kuning”, “Palem merah”, “Kana”, “Duranta”, “Lantana”, “Lili paris”, “Bogenvil”, “Pakis”, and “Palem kol”, respectively.

Furthermore, this research observed that three plant species showed less reduction in chlorophyll content when they were grown at highly polluted air conditions. The reduction was less than 1.0 CCV (0.35-073 CCV). The statistictical analysis method (Table 2) of Two Sample T-test (Bender and Kramer,1989) by using computer program of Statistical Analysis System (SAS Institute, 1983), indicated that these reduction is not significant (P>0.6) and therefore they were apparently considered as tolerant plant species to polluted air condition in the city . These tropical plant species include Ficus sp., Hemigraphissp., and Alamanda sp.. The common name of these plants in Indonesia is, "Beringin", "Sambang Merah", and "Alamanda", respectively.

Table 2. Chlorophyll content of several tropical plant species grown at Highly Polluted Air (HPA-site), and Non-Polluted Air (NPA-site) and their Statistical Analysis of Two Sample T-test.

| No. | Plant species | Chlorophyll content | | Δ | Calculated [T] | Prob>[T ] |
|---|---|---|---|---|---|---|
| | | NPA-site | HPA-site | | | |
| 1. | Ixora sp | 53.47 | 48.65 | 4.82 | 3.39** | 0.0014 |
| 2. | Ficus sp | 59.14 | 58.41 | 0.73 | 0.46ns | 0.6418 |
| 3. | Pisonia sp | 28.08 | 18.81 | 9.21 | 10.63** | 0.0001 |
| 4. | Bauchinia sp | 40.96 | 36.34 | 4.62 | 4.28 ** | 0.0001 |
| 5. | Chrysalidocarpus sp | 58.36 | 45.84 | 12.52 | 6.66** | 0.0001 |
| 6. | Cyatostachys sp | 59.32 | 46.3 | 13.29 | 8.85** | 0.0001 |
| 7. | Hemigraphis sp | 47.54 | 47.05 | 0.49 | 0.45ns | 0.6548 |
| 8. | Canna sp | 57.90 | 38.21 | 19.69 | 10.43** | 0.0001 |
| 9. | Allamanda sp | 59.24 | 58.89 | 0.35 | 0.27ns | 07870 |
| 10. | Duranta sp | 49.20 | 32.41 | 16.79 | 12.38** | 0.0001 |
| 11. | Lantana sp | 40.66 | 37.27 | 3.39 | 2.89** | 0.0054 |
| 12. | Chlorophytum sp | 44.24 | 28.37 | 15.87 | 9.49** | 0.0001 |
| 13. | Bougainvillea sp | 53.15 | 31.77 | 21.38 | 16.96** | 0.0001 |
| 14. | Nephrolepsis sp | 52.37 | 45.84 | 6.53 | 20.29** | 0.0001 |
| 15. | Licuala sp | 54.52 | 43.48 | 11.04 | 6.09** | 0.0001 |

## CONCLUSIONS

This research conclude that tropical plant species had various content of chlorophyll range from 40 to 60 CCV. Response of o f tropical plant species when they were grown at high polluted air condition (HPA-site) were indicated by reduction in the chlorophyll content with ranged from 18 to 59 CCV. Plants that are sensitive to high polluted air condition indicated by great reduction in the chlorophyll content ranged from 3.39 to 21.38 CCV. These senstive plants include Ixora sp., Pisonia sp., Bauchinia sp., Chrysalidocarpus sp., Cyatostachys sp., Canna sp., Duranta sp., Lantana sp., Chlorophytum sp., Bougainvillea sp., Nephrolepsis sp., and Licuala sp., with is usually called in Indonesia as, "Asoka", "Kol Banda", "Bunga kupu-kupu", "Palem kuning", "Palem merah", "Kana", "Duranta", "Lantana", "Lili paris", "Bogenvil", "Pakis", and "Palem kol", respectively. On the other hand, plants that are tolerant to high polluted air condition indicated by less reduction in the chlorophyll content ranged from 0.35-073 CCV. These plant species include Ficus sp., Hemigraphissp., and Alamanda sp., with is usually called in Indonesia as, "Beringin", "Sambang Merah", and "Alamanda", respectively.

## RECOMMEDANTION

The use of tropical plant species in establishment of city garden and green-belt to fight polluted air problem in the city, should consider tolerance of the plant to high polluted air condition. Research is required to determine tolerant plants, before they are grown at high polluted air condition.

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