BIOVALENTIA: BIOLOGICAL RESEARCH JOURNAL
***e*-ISSN: 2477-1392**
Vol. 9 No. 1, May 2023

Impact of Particulate matter 2.5 Concentration and Density Trichomes Leaf of Shade Plants on Protocol Road, Seberang Ulu II District, Palembang City

Eka Haryati Yuliany[1]*, Sarno[2], Laila Hanum[2], Sulton Nawawi[3], Erie Agusta[3], Sapta Handaiyani[3], Herlina Abay[3], Ella Pranata[3]

[1] *Department of Conservation Biology Program, Faculty of Science, Sriwijaya University. Jalan Padang Selasa 524, Palembang, Indonesia.*
[2] *Department of Biology, Faculty of Mathematics & Natural Sciences, Sriwijaya University. Jalan Raya Palembang-Prabumulih km 32, Indralaya, Indonesia.*
[3] *Department of Biology Education Program, Faculty of Teacher Training and Education, Muhammadiyah University of Palembang. Jalan Ahmad Yani No. 13, Palembang, Indonesia*

*Corresponding author

E-mail address: adinndaekka@gmail.com (Eka Haryati Yuliany).
Peer review under responsibility of Biology Department Sriwijaya University

Abstract

An increase in the number of motorized vehicles has the potential to increase air pollution, es-pecially on protocol roads, one of which is Particulate matter (PM 2.5). The response of tri-chomes from shade plants to vehicle exhaust gases can be used as environmental biomonitor-ing. The main road in Seberang Ulu II District has a fairly dense mobility in terms of the Ve-hicle Volume Ratio to Road Capacity (VCR). The purpose of this study was to determine the relationship between particulate dust levels and the density of leaf trichomes of shade plants on the protocol road, Seberang Ulu II District, Palembang City. The method in this research is ex post facto with a laboratory approach. Determination of the plot of this study using purpos-ive sampling based on consideration of the circumstances surrounding the study. Plots 1 and 2 are on Jalan A. Yani, Plots 3 and 4 are on DI. Panjahitan Street and Plot 5 as a comparison plot are on Kapten Abdullah Street. The results in this study showed that the highest trichome density values were found in polluted areas.

Keywords : Density, particulate matter 2.5, seberang ulu II sub-district, trichome

Received: April 7, 2022, Accepted: May 7, 2023

1. Introduction

Environmental services are services provided by natural and artificial ecosystem functions, whose value and benefits can be felt directly or indirectly to help maintain and improve the quality of the environment and people's lives, and achieve sustainable ecosystem management [1].

The increase in the number of motorized vehicles has the potential to increase air pollution, especially on protocol roads, to reduce the increasing level of pollutants produced by motorized vehicles, it is necessary to have trees that function as absorbents and absorbents of pollutants and dust in the air produced by motorized vehicles [2]. Existenceshade plants can help local people to take shelter on the streets, and reduce the reflection of light trails from surrounding buildings and filter dust, air pollution emitted by vehicles [3].

The presence of trichomes in road shade plants can be associated with pollutants resulting from vehicle emissions. Trichomes are found in almost all plant organs located in the epidermis, as long as the organ is active. Trichomes are mainly found on the leaves [4].

Study [5][6]states that leaves that have trichomes in polluted conditions will increase the number of trichomes to defend themselves, the density and number of trichomes due to the plant's response to vehicle exhaust gases. In addition, trichomes function to prevent water loss, and as environmental biomonitoring.

One of the environmental pollutants is particulate matter (PM 2.5). [5] Concluded that particulate matter is one of the pollutants that is often used as an indicator of air pollution to indicate the level of danger to the environment and to health. Particulate matter (PM) or particulate dust

including air pollution emissions according to Government Regulation of the Republic of Indonesia No. 22 by 2021. PM2.5 comes from soil dust, vehicle emissions and biomass burning and industry [7].

Palembang city has 16 districts. One of the sub-districts in the city of Palem-bang is Seberang Ulu II District. The main road in Seberang Ulu II Subdistrict has a fairly dense mobility. Judging from the Volume Capacity ratio (VCR), this area includes the highest VCR level in Palembang City [8].

Based on the background, the purpose of this study was to determine the relationship between particulate dust levels and the density of leaf trichomes of shade plants in Seberang Ulu II District, Palembang City.

2. Materials and Methods

This research was conducted from December 2021 to January 2022. The research design used was a quantitative descriptive study. To identify the density of trichomes based on the type of shade plants to trap the particles and measure the concentration particulate dust (PM2.5) in Seberang Ulu II District, Palembang City. The method in this research is ex post facto with a laboratory approach. The ex post facto method is a research method where the independent variables occur before the researcher makes observations on the dependent variable. Determination of the plot of this study using purposive sampling based on consideration of the circumstances surrounding the study. Plots 1 and 2 are on A. Yani Street, Plots 3 and 4 are on DI. Panjahitan Street and Plot 5 as a comparison plot are on Captain Abdullah Street.

2.1 Trichome Data Collection Techniques

Steps for making replication preparations using varnish according to [9] is as follows:

a. Leaf samples were taken at 1 meter from the base of the stem. The leaf taken is the third leaf facing the road.
b. The leaves of the sample were washed from the dust attached to them with slow running water.
c. Leaves are dried by aerating, clear varnish is applied to 2x5 cm2 leaf sheets and allowed to stand for 3-5 minutes or more until completely dry.
d. The clear tape is affixed to the leaves that have been smeared with nail polish carefully so that the surface of the leaves sticks well to the tape.
e. The tape with the epidermis layer was carefully pulled and affixed to the slide that had been prepared beforehand.
f. Observation of the shape of the trichome using a microscope. Counting the number of trichomes using the optical lab. Repetition is done a maximum of 5X and a minimum of 1X. Wide field of view in leaf area of 5-7 cells. The magnification of the lens used is 4x10.

2.2 Measurement Particulate Dust Level (PM2.5)

Measurement of air samples in this study was carried out based on the Regulation of the Minister of the Environment Number 12 of 2010 concerning Guidelines for Air Pollution Control in the Regions. The sample measurement time was carried out three times, the results of which would be converted into 24-hour measurements. Measurement of particulate dust content (PM2.5) is based on adjustments to SNI 19-7119.3-2005 regarding the total suspended particle test method.

The data obtained were analyzed by descriptive test, bivariate correlation test, and partially tested using Statistic Product and Service Solution (SPSS).

3. Results and Discussion

The results in this study can be seen in Figure 1. Based on Figure 1. Above, it can be seen that the highest particulate dust content (PM2.5) is in Plot 3, which is 28.3333. Plot 3 is the intersection of 3 roads, namely Jalan A. Yani, KH. Azhari and DI. Panjahitan, besides that the activities around this road are fairly congested, close to schools and shopping centers. The lowest particulate dust content (PM2.5) is in plot 5 which is 13, 6667 as a comparison plot. This road has less dense activity. Furthermore, the highest trichome density level was in plot 3 of 71.29 and the lowest level of trichome density was in plot 5 of 23.915.

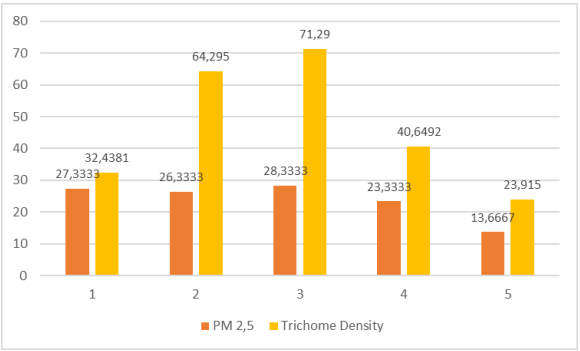

Figure 1. Average Particulate Dust Level (PM 2.5) and Trichoma Density in Seberang Ulu II Palembang City

Results obtained 5.446> 1.6629 which means-particulate dust content(PM2.5) had a significant effect on the density of the trichomes. Judging from the bivariate correlation test, the results obtained were 0.509**> 0.1755, meaning that there was a significant relationship between particulate dust (PM2.5) and Trichoma Density in Seberang Ulu II Palembang City. Next, it is seen from Figure 1The highest trichome density values were found in polluted areas.This is in

line with research[10]which concluded that vehicle emissions affected the density and size of the trichomes, where the trichome length decreased three times in polluted areas, while the trichome density increased. This is a plant response caused by pollutants, plants make efforts to reduce the diffusion of pollutants in leaf tissue [6] [10].

Plant organs such as leaves adapt to a polluted environment, with their morphological or anatomical structures. Changes occur in cell thickness epidermis, shape, size, number and density of trichomes. This situation describes the stress of plants to stress. This makes trichomes can be used as bio-environmental indicators because trichomes can describe the stress level and tolerance of plants to stress. In line with research [11], the impact on green plants exposed to pollutants originating from motorized vehicles can be seen in the damage to leaf epidermal cells such as differences in trichome density.In this study, it was found that leaf density in plot 3 increased significantly more than plot 5, this can be seen in Figures 2 and 3. In Figure 2, the trichomes in Figure 2 are denser than plot 5. This is in accordance with the study. [6] Damage that is not visible or hidden will result in abnormal growth so that it can slow down the rate of photosynthesis and will further reduce the production of a certain plant without showing visible symptoms. The most common histological changes due to air pollution are plasmolysis, damage to cell content (granulation), collapsing cells, pigmentation or changes in cell color to darken to changes in the number and density of trichomes [6] [10] [11].

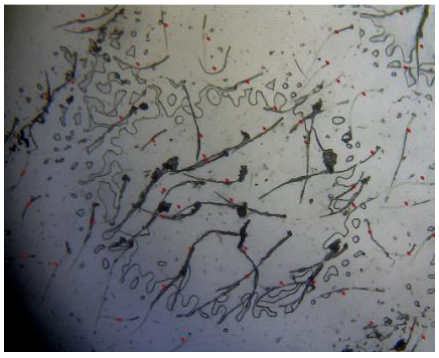

Figure 2. Density of Trichomes on Plot 3

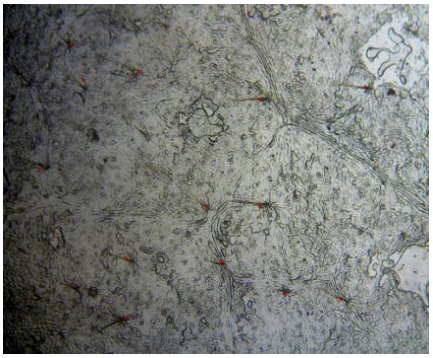

Figure 3. Density of Trichomes on Plot 5

Further research conducted [10] explained the relationship between plant morphophysiological parameters, traffic intensity and vehicle pollutants causing morphological changes, young and mature leaves, and affecting the density of trichomes.

The increase in the number of trichomes is another adaptation of stress caused by air pollution by providing external defense by trapping particles that fall directly on the leaf surface so as not to block the stomatal pores and affect the gas exchange process. This is a plant response caused by pollutants, plants make efforts to reduce the diffusion of pollutants in leaf tissue[6] [10] [12].

Air pollution can generally cause damage to leaves, namely acute, chronic or hidden damage. In acute damage, initially seen there is an appearance of a lack of water content which will later dry up and turn white to ivory in most species to brown or red-brown. A similar pattern of ugliness is due to the absorption of polluted gas in the air with relatively high levels, the tissue in the leaves is damaged in a short time[13].

Plants that grow in polluted environments or areas of high pollution will increase the number of trichomes to defend themselves. The high number of trichomes in a polluted environment is a form of plant response to pollutant gases. Trichomes function to reduce evaporation and protect leaves from external threats, trichomes in polluted areas will protect leaves by trapping particulate matter and preventing it from entering the stomata. The greater number of trichomes also serves to reduce the rate of leaf transpiration. Exhaust emissions from motor vehicles contribute greatly to air pollution. The higher the exhaust emissions, the worse the air quality. Poor air quality has an impact on the photosynthesis process of plants [14].

[15] in his research said that trichomes on Mimusops elengi plants grow more in polluted areas. Trichomes grow on the underside of the leaves near the stomata. The trichomes that grow near the stomata are evidence that the trichomes function to protect the stomata from particulate matter that will enter through the stomata opening.

[16] Increasing the number of trichomes, in accordance with their function, namely reducing evaporation so that the trichomes can keep plants from drying out. This is in line with research [17] who said in his research that environmental temperature affects the density of trichomes on the leaf surface. Several factors that affect the growth of trichomes are light, temperature or temperature, air humidity, and soil conditions [18].

The negative effect of pollutants is on the rate of carbon dioxide assimilation. The biggest effect due to gas pollution is leaf injury (necrosis and leaf fall). The metabolism and absorption mechanism of gaseous pollutants starts from gaseous pollutants that enter plants through stomata, directly damaging photosynthetic cells in leaves. The effect of pollutants on plants when exposed to exhaust emissions generally results in both physical and biochemical changes in the structure of the chloroplast stroma. Physical changes such as thickening of the stroma, swelling of the grana compartment, and rupture of the chloroplast structure [19].

Plant tissue responds to unfavorable environmental conditions in two ways, namely by eliminating or avoiding stress and tolerance to stress. The mechanism of plant resistance to environmental stress conditions depends on the ability of the plant itself to avoid or defend itself from these unfavorable environmental conditions. If the plant is still able to adapt, then the plant is able to live, grow and develop in the area [20].

In most of the air pollution, causing damage and changes in plant physiology then expressed in growth disorders. Pollution causes changes at the biochemical level of cells followed by physiological changes at the individual level to the plant community level. However, the effect of air pollution on plant growth not only has a destructive effect, but also provides a response to adapt, namely plants control themselves which is called plant tolerance to pollution [21].

Previous studies have explained that vehicle exhaust emissions are the most influential on the anatomical and morphological structure damage. Acute damage occurs if the pollutant concentration is high in the ambient air for a long time, because it can cause several symptoms on some parts of the leaves, usually the leaves become dry and pale. Leaves that are in contact with low concentrations of pollutants for a long time will cause chronic damage to plants marked by yellowing of leaf color due to inhibition of the mechanism of chlorophyll formation [22].

In some cases, the leaves can be identified by the symptoms of the damage caused, such as chlorosis in the veins. Pollutants cause irregular black or brown spots on leaf veins or leaf margins. Air that has been polluted by pollutants is not only harmful to humans and animals, but also harmful to plant life. Influence on plants, among others, the emergence of spots on the surface of the leaves. At higher concentrations, these gases can cause necrosis or damage to leaf tissue [23].

The presence of broadleaf trees can absorb pollutants in the air. Every one hectare of green open space can produce 0.6 tons of oxygen per day. To reduce the concentration of PM2.5 pollutants that exist, it can be done by doing reforestation in the surrounding environment.

4. Conclusion

The results of this study concluded that the highest trichome density values were found in areas with the highest particulate dust content.

5. Acknowledgement

We appreciate all the parties who have helped us in conducting the research. Thank you and appreciate for supervisors, the anonymous reviewers and editors of Biovalentia Journal for their meaningful comments and suggestions.

References

[1] Suprayitno, “Teknik pemanfaatan jasa lingkungan dan wisata alam,” 2008.

[2] N. K. T. Martuti, “Peranan Tanaman terhadap Pencemaran Udara di Jalan Protokol Kota Semarang (The Role of Plants Against Air Pollution in The Protocol Street of Semarang City),” *Biosantifika*, vol. 5, no. 1, pp. 37–42, 2013.

[3] D. Arithama, “Kajian Eksperimental Pengurangan Gas Emisi Co 2 dengan Teknologi Biosphere,” vol.

4, no. Juni, pp. 6–11, 2016.
[4] N. Mashud, A. Ilat, Y. R. Matana, and V. K. Masing, "Trikoma dan Fungsinya pada Tanaman Kelapa," *Balai Litbang*, pp. 23–25, 2012, [Online]. Available: http://balitka.litbang.pertanian.go.id/wp-content/uploads/2017/03/4-Trikoma-dan-Fungsinya-04.pdf.
[5] E. P. D. Putri, "Konsentrasi PM2,5 di Udara dalam Ruang dan Penurunan Fungsi Paru pada Orang Dewasa di Sekitar Kawasan Industri Pulo Gadung Jakarta Timur Tahun 2012," p. Pm, Konse, 1–143., 2012.
[6] R. Azmat, S. Haider, H. Nasreen, F. Aziz, and M. Riaz, "A viable alternative mechanism in adapting the plants to heavy metal environment," *Pakistan J. Bot.*, vol. 41, no. 6, pp. 2729–2738, 2009.
[7] Peraturan Pemerintah No 22 Tahun 2021, "Peraturan Pemerintah Nomor 22 Tahun 2021 tentang Pedoman Perlindungan dan Pengelolaan Lingkungan Hidup," *Sekr. Negara Republik Indones.*, vol. 1, no. 078487A, p. 483, 2021, [Online]. Available: http://www.jdih.setjen.kemendagri.go.id/.
[8] RKPD, *Rencana Kerja Pemerinta Daerah (RKPD) Kota Palembang*, vol. 1. 2020.
[9] D. E. Rantau, E. Al Hafiizh, W. Rahman, and T. M. Ermayanti, "Analisis ukuran dan kerapatan stomata pada artemisia annua l.hasil perlakuan kolkisin," *Pros. Semin. Nas. XXIII. Kim. dalam Ind. dan Lingkungan.*, no. August 2016, pp. 45–52, 2014.
[10] S. Jagannath, "Air pollution impact on micromorphological and biochemical response of Tabernaemontana divaricata L. (Gentianales: Apocynaceae) and Hamelia patens Jacq. (Gentianales: Rubiaceae)," *Brazilian J. Biol. Sci.*, vol. 2, no. 4, pp. 287–294, 2015.
[11] M. Des, Vauzia, and Y. S. Gusti, "Stomata Characteristics of Ketapang Leaves (Terminalia catappa L.) Based on Environmental Differences," *J. Phys. Conf. Ser.*, vol. 1940, no. 1, p. 012051, 2021, doi: 10.1088/1742-6596/1940/1/012051.
[12] A. S. K. Andri Windi Satolon, Novri Y Kondowangko, *Analisis kadar klorofil, indeks stomata dan luas daun tumbuhan mahoni (Swietenia macrophylla King.) pada beberapa jalan di Gorontalo*, no. 6. Gorontalo: Universitas Negeri Gorontalo, 2013.
[13] A. Wijaya, "Penggunaan tumbuhan sebagai bioindikator dalam pemantauan pencemaran udara," *J. Pertan.*, no. 41, pp. 1–37, 2009.
[14] M. T. Agustin, *Pengaruh Emisi Kendaraan Bermotor Terhadap Kerapatan Trikoma Pada Daun Angsana (Pterocarpus indicus willd) Sebagai Tanaman Pelindung Jalan*. Lampung: Fakultas Tarbiyah Dan Keguruan Universitas Islam Negeri (Uin)Raden Intan, 2018.
[15] R. Sett, "Responses in Plants Exposed to Dust Pollution," *Hortic. Int. Journal* , vol. 1, no. 2, pp. 53–56, 2017, doi: 10.15406/hij.2017.01.00010.
[16] D. G. M. and F. P. L. Magtoto, Liezel M., "Morpho-Anatomical Characterization of Tithonia Diversifolia (Hemsl.) Gray Growing on Sites Exposed To Vehicular Emissions," *Int. J. Plant, Anim. Environ. Sci.*, no. February, pp. 168–172, 2013.
[17] T. J. Gianfagna, C. D. Carter, and J. N. Sacalis, "Temperature and photoperiod influence trichome density and sesquiterpene content of Lycopersicon hirsutum f. hirsutum," *Plant Physiol.*, vol. 100, no. 3, pp. 1403–1405, 1992, doi: 10.1104/pp.100.3.1403.
[18] H. Haruna, A. A. Aliko, F. A. Ahmad, and A. W. Abubakar, "Effect of automobile exhaust on some leaf micromorphological characteristics of some members of *Verbanaceae, Annonaceae* and *Euphorbiaceae* families," *Bayero J. Pure Appl. Sci.*, vol. 10, no. 1, p. 251, 2017, doi: 10.4314/bajopas.v10i1.37.
[19] L. Agustina, P. P. Simanjuntak, and A. N. Khoir, "Pengaruh Parameter Meteorologi Terhadap Konsentrasi Co2 Dan Ch4 Di Dki Jakarta," *J. Meteorol. Klimatologi dan Geofis.*, vol. 6, no. 2, pp. 30–38, 2019, doi: 10.36754/jmkg.v6i2.121.
[20] S. G. Mundree *et al.*, "Physiological and molecular insights into drought tolerance," *African J. Biotechnol.*, vol. 1, no. 2, pp. 1–19, 2002.
[21] A. Z. Mutaqin, R. Budiono, T. Setiawati, M. Nurzaman, and R. S. Fauzia, "Studi Anatomi Stomata Daun Mangga (Mangifera indica) Berdasarkan Perbedaan Lingkungan," *J. Biodjati*, vol. 1, no. 1, p. 13, 2016, doi: 10.15575/biodjati.v1i1.1009.
[22] D. Waryanti, Irawan Sugoro, "Angsana (Pterocarpus indicus) sebagai Bioindikator untuk Polusi di Sekitar Terminal Lebak Bulus," *Al-Kauniyah J. Biol.*, vol. 8, no. 1, pp. 46–50, 2016, doi: 10.15408/kauniyah.v8i1.2705.
[23] D. E. Onwuegbuchunam, F. Egelu, M. O. Aponjolosun, and K. O. Okeke, "Measuring Traffic Induced Air Pollution in Onne Port's Environment," *Open J. Air Pollut.*, vol. 10, no. 04, pp. 63–75, 2021, doi: 10.4236/ojap.2021.104005.