https://doi.org/10.48047/AFJBS.6.15.2024.1081-1089

African Journal of Biological Sciences

Research Paper Open Access

EFFECT OF AIR POLLUTION ON CHLOROPHYLL CONTENT OF LEAVES

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Volume 6, Issue 15, Sep 2024

Received: 15 July 2024

Accepted: 25 Aug 2024

Published: 05 Sep 2024

doi: 10.48047/AFJBS.6.15.2024.1081-1089

ABSTRACT

Comparative studies were conducted in the current investigation to determine the impact of air contaminants produced by the exhaust of automobiles and industries on the chrorophyll content of leaves. The leaves of Azadirachta indica, Nerium oleander, Mangifera indica, and Dalbergia sissoo were collected from regions with potentially higher and reduced levels of air pollution. Chlorophyll a, chlorophyll b, and carotenoids were used to quantify photosynthetic pigments. A decrease in the photosynthetic pigments of plant foliage that are planted in more polluted areas as opposed to those that are not or are less polluted.

Key words: Chlorophyll, Carotenoids, Air Pollution, Quantification, Photosynthetic Pigments.

INTRODUCTION

Due to industrialization, urbanization, economic growth, and the ensuing rise in energy consumption, the quality of the air has significantly declined in emerging nations like India. The main gases and particulates released by vehicles and industry are nitrogen oxides, sulfur oxides, and fly ash. Because of the contaminants' exposure to the leaves, the concentration of the plant's photosynthetic pigments—specifically, chlorophyll and carotenoids—reduces, which affects the productivity of the plant, germination of seeds, length of pedicles, and number of flowers inflorescence.

The principal photoreceptor, chlorophyll, is mostly responsible for facilitating photosynthesis, the light-driven process that converts carbon dioxide into carbohydrates and oxygen. Carotenoids are a type of naturally occurring fat-soluble pigments that are mostly found in algae, plants, and photosynthetic bacteria. However, they also serve as a protective barrier against photoxidative destruction of chlorophyll, which is why they are vital to the photosynthetic process. When plants are exposed to environmental pollution above the physiologically acceptable threshold, photosynthesis is inhibited.

The industrial, automobile, and less polluted jungles provided the plant samples utilized in this investigation with constant exposure to air pollution. They had consequently integrated, collected, and assimilated five contaminants onto their surface, which had produced a particular reaction. Plants can therefore be used as bioindicators in a range of scientific domains.

In addition to being a popular tourist destination, Chennai, the City of Lakes, is experiencing industrial expansion. It is heavily trafficked by cars and has a high population density. The dramatic increase in air pollution is having an adverse effect on the healthy development of nearby plants. The abrupt introduction of harmful compounds into the environment modifies the ecology. Thus, a range of pollutants, such as SMP, RSMP, NoX, and So2, are exposed to plants grown in high-traffic areas.

MATERIALS AND METHODS

A comparison between plants grown in heavily trafficked locations and those grown in less or no polluted areas is the focus of this study. For this objective, leaf samples of Nerium oleander (Kaner), Dalbergia sissoo (Sheeshame), Mangifera indica (Mango), and Azadirachta indica (Neem) were obtained from highly polluted and less or unpolluted locations.

Study Area and Sample Collection

Four sites were selected for polluted area as well as for less or non polluted area from Chennai City district and capital of Tamilnadu in India. For polluted area samples were collected from

Ambattur and Guindy as industrial area and two more places as highly traffic area. For non polluted or less polluted area we selected Besant Nagar, Anna University and two more places.

Determination of Chlorophyll Content

Extraction of chlorophyll was accomplished by crushing the leaf and then suspending it in test tubes that contained 10 milliliters of dimethyl sulphoxide (DMSO). The weight of the fresh leaf tissue was precisely measured and recorded. A hot air oven was used to incubate test tubes at temperatures ranging from 60 to 65 degrees Celsius for a period of four hours. Following the decantation of the supernatant, the chlorophyll extract was transferred to a cuvette, and the absorbance was measured using a spectrophotometer at 645 and 663 nm in comparison to a blank of DMSO8. In order to determine chlorophyll a, chlorophyll b, total chlorophyll, and the ratio of chlorophyll a to chlorophyll b, formulas were utilized.

RESULTS AND DISCUSSION

Alterations to the Photosynthetic Pigment There are variations in the physiological properties of some plant species that have been exposed to cement dust pollution. These variations are presented in Table 1, 2, 3, and 4 (Figure 1). A comparison was made between the findings obtained with contaminated and non-polluted Azadirachta indica, Nerium oleander, Mangifera indica, and Dalbergia sissoo. Generally speaking, plants exhibited a reduction in the amount of photosynthetic pigments as a result of air pollution. According to the findings of the study, the total chlorophyll content, chlorophyll a, and chlorophyll b of Azadirachta indica, Nerium oleander, Mangifera indica, and Dalbergia sissoo all experienced a considerable decrease during the course of the investigation. However, there is no discernible difference in the percentage of total carotenoids found in the plant species that were chosen.

Table 1: Concentration of Different Photosynthetic Pigments (mgg-1) in the Leaves of *Azadirachta Indica* Collected from Polluted and Control Sites

Parameter	P	NP	%R
Chlorophyll a	0.49	1.65	70.30
Chlorophyll b	0.28	0.60	53.78

Total chlorophyll	1.04	2.19	52.40
Carotenoids	0.36	0.56	35.71

Where P= Polluted area, NP= non Polluted area and %R=percent reduction

Table 2: Concentration of Different Photosynthetic Pigments (mgg-1) in the Leaves of *Mangifera Indica* Collected from Polluted and Control Sites

Parameter	P	NP	%R
Chlorophyll a	1.87	2.37	21.14
Chlorophyll b	0.20	0.62	67.48
Total chlorophyll	2.02	2.75	26.55
Carotenoids	0.19	0.32	40.63

Table 3: Concentration of Different PhotosyntheticPigmentsmgg-1) in the Leaves of *Nerium Oleander* Collected from Polluted and Control Sites

Parameter	P	NP	%R
Chlorophyll a	1.00	2.02	50.37
Chlorophyll b	0.36	0.47	24.51
Total chlorophyll	1.25	2.14	41.71
Carotenoids	0.31	0.49	37.11

Table 4: Concentration of Different PhotosyntheticPigmentsmgg-1) in the Leaves of *Dalbergia Sissoo* Collected from Polluted and Control Sites

Parameter	P	NP	%R
Chlorophyll a	1.74	2.71	35.98
Chlorophyll b	0.59	0.79	24.66
Total chlorophyll	2.25	3.64	38.32
Carotenoids	0.78	1.22	36.48

Azadirachta indica

In the polluted areas, the concentration of Chl'a' in the leaves of Azadirachta indica was reported as 0.49±0.09 mg/g, whereas at the control site, the concentration was 1.65±0.27 mg/g during the same time period. Consequently, a decrease of 70.3% in chlorophyll a was seen in the samples taken from the contaminated areas in compared to the control group. In the leaf samples taken from contaminated areas, the concentration of Chl'b' was found to be 0.28±0.10 mg/g. On the other hand, the concentration of Chl'b' in the samples collected from the control site was 0.69±0.09 mg/g. Therefore, the polluted sites sample contained 53.78% less Chl 'b' than the sample. In the leaf samples collected from the contaminated location, the total chlorophyll concentration was measured to be 1.04±0.05 mg/g, while the control site had a chlorophyll value of 2.19±0.05 mg/g. Therefore, there was a decrease of 52.4% in the total chlorophyll content in the samples that were taken from the polluted site. Over the course of the study, the concentration of total carotenoids in leaf samples obtained from polluted and control locations was determined to be 0.36±0.06 mg/g and 0.56±0.16 mg/g, respectively. It was observed that the leaf samples obtained from polluted sites exhibited a drop of 35.71%.

Mangifera indica

When the leaves of Mangifera indica were collected from contaminated areas, the concentration of Chl'a was found to be 1.87±0.35 mg/g. On the other hand, the control site had a concentration of 2.37±0.42 mg/g.As a result, a decrease of 21.14 percent in chlorophyll a was seen in the samples taken from the contaminated areas in comparison to the control. In the leaf samples taken from contaminated sites, the concentration of Chl'b' was found to be 0.20±0.04 mg/g. On the other hand, the concentration of Chl'b' in the samples collected from the control site was 0.62±0.14 mg/g. Consequently, the polluted sites sample contained 67.48% less Chl 'b' than the sample. The total chlorophyll content was detected to be 2.02±0.46 mg/g.In the leaf samples collected from the polluted location and the control site, the values were 2.75±0.65 correspondingly. Therefore, there was a decrease of 26.55% in the total chlorophyll content in the samples that were taken from the polluted location. The concentration of total carotenoids in leaf samples obtained from polluted sites and control sites was discovered to be 0.19±0.09 mg/g and 0.32±0.12 mg/g, respectively. It was shown that the concentration of carotenoids in leaf samples obtained from polluted sites was reduced by 40.63 percent.

Nerium oleander

It was observed that the concentration of Chl'a' in the leaves of Nerium oleander at polluted areas was recorded as 1.00±0.35 mg/g, but at the control site, the concentration was found to be 2.02±0.32 mg/g. The results showed that the chlorophyll-a content of the samples taken from contaminated areas was significantly lower than that of the control group by a factor of 50.37 percent. In the leaf samples taken from contaminated areas, the concentration of Chl was at 0.36±0.14 mg/g. On the other hand, the concentration of Chl in the samples collected from the control site was found to be 0.47±0.24 mg/g. Therefore, the polluted sites sample contained 24.51% less Chl'b' than unpolluted sites. When leaf samples were taken from polluted and control sites, the total chlorophyll content was 1.25±0.46mg/g for the polluted site and 2.14±0.35mg/g for the control site. The total chlorophyll content in the samples taken from the polluted location was found to have decreased by 41.71 percent as consequences. The concentration of total carotenoids in leaf samples obtained from polluted sites and control sites was recorded as 0.31±0.08 mg/g and 0.49±0.11 mg/g, respectively. The total carotenoids concentration in leaf samples from polluted sites was found to be 37.11% lower than the control site's value.

Dalbergia sissoo

At polluted areas, the concentration of Chl'a' in the leaves of Dalbergia sissoo was reported as 1.74±0.35 mg/g, but at the control site, the value was much higher at 2.71±0.42 mg/g. As a result, a reduction of 35.98% in chlora concentration was seen in the samples taken from the polluted areas in comparison to the control group. In the leaf samples taken from contaminated areas, the concentration of Chl'b' was found to be 0.59±0.14 mg/g. On the other hand, the concentration of Chl'b' in the samples collected from the control site was 0.79±0.24 mg/g. Therefore, the contaminated sites sample contained 24.66% less Chl'b' than unpolluted sites. In the leaf samples collected from the contaminated location, the total chlorophyll concentration was found to be 2.25±0.46mg/g, while the control site had a chlorophyll level of 3.64±0.65 correspondingly. Therefore, there was a decrease of 38.32% in the total chlorophyll content across the samples that were taken from the polluted location. Over the course of the study, the concentration of total carotenoids in leaf samples obtained from polluted and control locations was determined to be 0.78±0.08 mg/g and 1.22±0.11 mg/g, respectively. It was observed that the leaf samples obtained from polluted sites exhibited a reduction of 36.48%.

There is a significant influence that air pollutants, fly ash, and dust emissions have on the concentration of various colors that are produced by photosynthesis. A leaf surface that is polluted and covered in dust is the cause of decreased photosynthetic activity, which in turn leads to a decrease in chlorophyll concentration. It has been documented by a number of different works that air pollutants have an influence that is comparable to the one that they have on the concentration of chlorophyll contents. According to the findings of this study, the plant with the greatest reduction in total chlorophyll was Azadirachta indica, which had a fall of 52.40 percent. Nerium oleander, Delbergia sissoo, and Mangifera indica came in second, third, fourth, and fifth, respectively. Based on the results of the two-way analysis of variance, it was determined that the reduction in chlorophyll content of Azadirachta indica, Nerium oleander, Dalbergia sissoo, and Mangifera indica was statistically significant at the 0.05% level. Total average amount of assimilating pigments

The total average amount of absorbing pigments (a+b+c) in the leaves of the control plant Azadirachta indica was reduced by the greatest amount (53.27%) when compared to the leaves of Mangifera indica (43.08%), Neriumoleander (37.33%), and Delbergiasissoo (31.48%).The chlorophylla+b, carotenoidic pigments, (a +b/c) ratio had extremely low values in comparison to the control. This was due to the considerable decline in both types of chlorophyll a swell that occurred as the amount of carotenoidic pigments increased. This suggests that the plant species are experiencing stress and have also suffered harm as a result of pollution. Pollution in the air is more likely to cause damage to the pigments that are responsible for photosynthesis. Although chlorophyll pigments are found in a highly structured state, they are capable of undergoing a number of photochemical processes when they are subjected to stress. These reactions include oxidation, reduction, pheophytinization, and reversible bleaching. Therefore, any change in the concentration of chlorophyll has the potential to modify the morphological, physiological, and biochemical behavior of the plant. There were additional observations made by a number of workers regarding the degradation of photosynthetic pigments that was caused by air pollution. Chlorophyll a and chlorophyll b concentration were found to be significantly lower in both of the plants when they were grown in contaminated environments. Based on the findings of this study, it was found that the amount of chlorophyll found in trees that were growing in industrial areas decreased. A decrease in chlorophyll content can be attributed to the transformation of chlorophyll into phaeophytin, which occurs as a result of magnesium ions being lost. It is possible for the chlorophyll concentration to change over time, depending on the type of pollution stress and the weather conditions that are present at the time. The conclusion that can be drawn from this is that the area under investigation requires the establishment of a green belt in order to improve both the environment and the lives of people. According to the findings of this research, it is possible to draw the conclusion that cement dust hinders the growth of plants. This may be the result of the presence of many harmful chemicals in cement dust, which may be the cause of the observed effect. According to the findings, the phonological behavior of Azadirachta indica was shown to be significantly more influenced than that of Mangifera indica, Neriumoleander, and DelbergiasisSoo. It is evident that the air pollution that is caused by industries and automobile smoke is an active ecological factor that is responsible for the deterioration in the quality of our environment. Based on the data that was obtained, one can draw the conclusion that, in addition to specific manifestations of interactions between atmospheric pollutants (gas and solid) and vegetations, there is a common series of manifestations that occur as a general response to the stress that is caused by the aggressions of pollutants, regardless of the chemical nature of the pollutants. The amount of photosynthetic pigment that is produced on average decreases when it is subjected to the influence of solid and gas polluting agents, with the values occurring most frequently in correlation with the pollutants. Further investigations are necessary, in order to analyze the fluctuation of the sediments in the control leaves along all vegetative season and to anticipate more correctly the various 'answers' that the vegetation might have when subject ted to a chronic aggression from air polluting agents.

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