Research Article

Adverse Effect of Air Pollutants on the Chlorophyll Content in Leaves from Pune, Maharashtra (India).

Nirbhay Sudhir Pimple*
Assistant Professor, Department of Zoology, AbasahebGarware College, Karve road, Pune-4, India.
***Corresponding author's E-mail:** nirbhay.pimpale@yahoo.com

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ABSTRACT

The present study was undertaken to find out the comparative status of air pollutants on the chlorophyll contents in leaves of *Azadirachta indica* (Neem), *Nerium oleander* (Kaner), *Mangifera indica* (Mango) and *Ficus bengalensis* (banian).These pollutants which are been created and realised through automobiles and industries detoriates the quality of air. They affect the photosynthesis process. Four polluted areas were selected based upon the traffic condition of the region and were compared with four areas which are less polluted. In the present studies chlorophyll a, chlorophyll b and Carotenoids were quantified. Reduction in the chlorophyll a and b along with the Carotenoid from polluted area was observed when compared with the non/less polluted area.

Keywords: *Azadirachta indica, Nerium oleander, Mangifera indica* and *Ficus bengalensis* Chlorophyll, Carotenoids, Air Pollution, Quantification, Photosynthetic Pigments.

INTRODUCTION

The quality of air is the most alarming issues related to the environment. There is increase in the pollutants which are detoriating the quality of air that we breathe in. Pollutants from automobiles, industries have created a brown cloud zone over many cities. Apart from causing respiratory disorders in humans the air pollutants have caused various effects on the plants. Chemicals such as sulphur dioxide, fluorides and peroxyacyl nitrate which are commonly found in air damage the leaves. Sulfur dioxide causes changes in the colours of leaf tissue which result in white, yellow or brown batches. The exposure of these pollutants to the leaves cause a reduction in the concentration of their photosynthetic pigments viz., chlorophyll and carotenoids, which affects the plant productivity, germination of seeds, length of pedicles, and number of flowers inflorescence[1]. Chlorophyll absorbs solar energy in the blue portion of the electromagnetic spectrum, followed by the red portion. Chlorophyll molecules are specifically arranged in and around photo systems that are embedded in the thylakoid membrane of chloroplast. Chlorophyll a and Chlorophyll b plays a key role in the process of energy fixation giving carbohydrate and oxygen as the end product. carotenoid is a natural fat soluble pigment found principally in plants, algae and photosynthetic bacteria, where they play a critical role in the photosynthetic process and also protect chlorophyll from photoxidative destruction[2].

Plants which are exposed to the environmental pollution above the recommended normal physiologically acceptable range, photosynthesis gets inactivated[3]. Green plants have always played a role in determining the status of the environment. Many green plants acts as an environmental indicator (bio indicators).[4] The present study was undertaken from Pune city. Being an educational hub and by the introduction of IT industry. The city has rapidly grown in all the direction which has caused a huge load of vehicles on the streets, which is the main reason of detoriation of the air quality. The present work is to find out the level at which the chlorophyll pigment in the leaves have been affected.

MATERIALS AND METHODS

In the present studies the main focus was on the comparative analysis of plants growing in heavy trafficular areas with those growing is less polluted area. The sites for the study were selected based on the number of vehicles that usually commutes through the area. The plants under investigation were *Azadirachta indica* (Neem), *Nerium oleander* (Kaner), *Mangifera indica* (Mango) and *Ficus bengalensis (*banian). Leaves were collected from these plants from the polluted area as well as the unpolluted area.

Area under investigation

Pune city is located at 18.5204˚N, 73.8567˚E. Four sites were selected for polluted area as well as for less or non polluted area. For polluted area samples were collected from Sinhagad road, Laxmi road, Nagar road, and industrial area (Nasik Phata). Non- polluted or less polluted area were (Botanical Garden Savitribai Phule University of Pune), Koregoan Park lane no.7, Khirkee cantonment road. Empress Garden Hadapsar.

Determination of Chlorophyll Content

Freshly collected leaves from the three plants from polluted as well as non-polluted areas were collected and brought to the laboratory. 50 mg of fresh leaf tissue was weighed accurately using an electronic balance. For the extraction of Chlorophyll the leaves were crushed and

suspended in test tubes which were incubated at 60° C – 65° C for 4 hour in a hot air oven containing 10 ml of dimethyl sulphoxide (DMSO). The supernatant was decanted and the chlorophyll extract was transferred to a cuvette and the absorbance was studied using a spectrophotometer at 645 and 663 nm against DMSO blank8 Chlorophyll a, b, total chlorophyll and chlorophyll a/b ratio were calculated by using formulae stated by [5,6.]

RESULTS AND DISCUSSION

Photosynthetic pigment Changes: The changes which were observed in the selected plant under study is been tabulated below in Table 1, 2, 3 and 4. In general the leaves on the plant showed a decreased in the photosynthetic pigment.

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

	P	NP	%R
Chlorophyll a	0.50	1.62	70.29
Chlorophyll b	0.26	0.57	53.77
Total chlorophyll	1.06	2.16	52.38
Caretenoid	0.39	0.54	35.69

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

Azadirachta indica

As shown in table: 1, the leaves of *Azadirachta indica* from polluted sites, the concentration of chlorophyll 'a' was recorded as 0.59±0.08 mg/g which was 1.62±0.25 mg/g at the control site. 70.29% in Chlorophyll 'a' was recorded in the samples from the polluted sites in comparison to control site.

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

	P	NP	%R
Chlorophyll a	1.89	2.35	21.13
Chlorophyll b	0.18	0.58	66.47
Total chlorophyll	1.98	2.73	26.34
Caretenoid	0.17	0.29	39.59

The concentration of Chl 'b' was 0.26±0.09 mg/g in the leaf samples collected from polluted sites while it was 0.69±0.09 mg/g in the samples from control site. 53.77% less Chl 'b' content was recorded from the polluted site. In case of Total chlorophyll content from the studies it was found out to be 1.06±0.04 mg/g and 2.16±0.04 in the leaf samples collected from polluted and control site respectively. Thus, reduction of 52.38% in the total chlorophyll content was obtained in the samples from polluted site. In case of total carotenoids in the leaf samples from polluted and control site was recorded as 0.39±0.05 mg/g and 0.54±0.15 mg/g respectively. The total reduction of 35.69% in leaf samples from polluted sites.

Mangifera indica

As shown in Table: 2, The leaves of *Mangifera indica* from polluted sites, the concentration of chlorophyll 'a' was recorded as at polluted sites was recorded as 1.89±0.34 mg/g which was 2.35±0.38 mg/g at the control site. 21.13% in Chlorophyll 'a' was recorded in the samples from the polluted sites in comparison to control site. The concentration of Chl 'b' was 0.18±0.05 mg/g in the leaf samples collected from polluted sites while it was 0.58±0.13 mg/g in the samples from control site. The polluted sites sample thus had 66.47% less Chl 'b' content. In the leaves of *Mangrifera indica* the total chlorophyll content was 1.98±0.45 mg/g and 2.73±0.64 in the leaf samples collected from polluted and control site respectively. The studies show total reduction of 26.34% in the total chlorophyll content in the samples from polluted site. In case of total caretenoids content in the concentration in the leaf samples from polluted and less polluted site were leaf samples from polluted and control site was recorded as 0.17±0.08 mg/g and 0.29±0.11 mg/g respectively. The percentage reduction of 39.59% in leaf samples from polluted sites.

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

	P	NP	%R
Chlorophyll a	**0.98**	**1.99**	**50.26**
Chlorophyll b	**0.33**	**0.43**	**24.34**
Total chlorophyll	**1.20**	**2.11**	**40.69**
Caretenoid	**0.30**	**0.48**	**36.98**

Nerium Oleander

As shown in Table: 3, The leaves of *Nerium oleander from* polluted sites, the concentration of chlorophyll 'a' was recorded as at polluted sites was recorded as 0.89±0.33 mg/g which was 1.99±0.37 mg/g at the control site. 50.26% in Chlorophyll 'a' was recorded in the samples from the polluted sites in comparison to control site. The concentration of Chl 'b' was 0.33±0.05 mg/g in the leaf samples collected from polluted sites while it was 0.43±0.12 mg/g in the samples from control site. The polluted sites sample thus had 24.34% less Chl 'b' content. In the leaves of *Nerium oleander, the* total chlorophyll content was 1.20±0.44 mg/g and 2.11±0.63 in the leaf samples collected from polluted and control site respectively. The studies show total reduction of 40.69% in the total chlorophyll content in the samples from polluted site. In case of total caretenoids content in the concentration in the leaf samples from polluted and less polluted site were leaf samples from polluted and control site was recorded as 0.30±0.08 mg/g and 0.48±0.11 mg/g

respectively. The percentage reduction of 36.98% in leaf samples from polluted sites.

Table 4: Concentration of Different Photosynthetic Pigments mg g-1) in the Leaves of *Ficus bengalensis* (banian).Collected from Polluted and Control Sites

	P	NP	%R
Chlorophyll a	1.70	2.68	34.54
Chlorophyll b	0.57	0.75	24.12
Total chlorophyll	2.23	3.60	38.30
Caretenoid	0.75	1.20	36.47

Ficusbengalensis

As shown in Table: 4,The leaves of *Ficus bengalensis* from polluted sites, the concentration of chlorophyll 'a' was recorded as at polluted sites was recorded as 1.70±0.32 mg/g which was 2.68±0.36 mg/g at the control site. 34.54% in Chlorophyll 'a' was recorded in the samples from the polluted sites in comparison to control site. The concentration of Chl 'b' was 0.57±0.05 mg/g in the leaf samples collected from polluted sites while it was 0.75±0.12 mg/g in the samples from control site. The polluted sites sample thus had 24.12% less Chl 'b' content. In the leaves of *Ficus bengalensis* the total chlorophyll content was 2.23±0.43 mg/g and 3.60±0.62 in the leaf samples collected from polluted and control site respectively. The studies show total reduction of 38.30% in the total chlorophyll content in the samples from polluted site. In case of total caretenoids content in the concentration in the leaf samples from polluted and less polluted site were leaf samples from polluted and control site was recorded as 0.75±0.08 mg/g and 1.20±0.11 mg/g respectively. The percentage reduction of 36.47% in leaf samples from polluted sites.

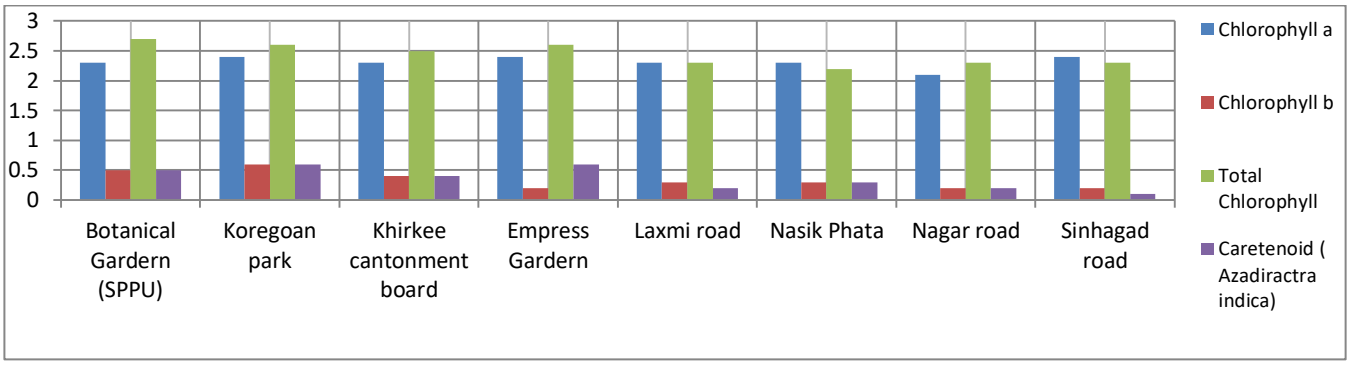

Figure 1: Effect of Pollution in the Chlorophyll content of *Magnifera indica*

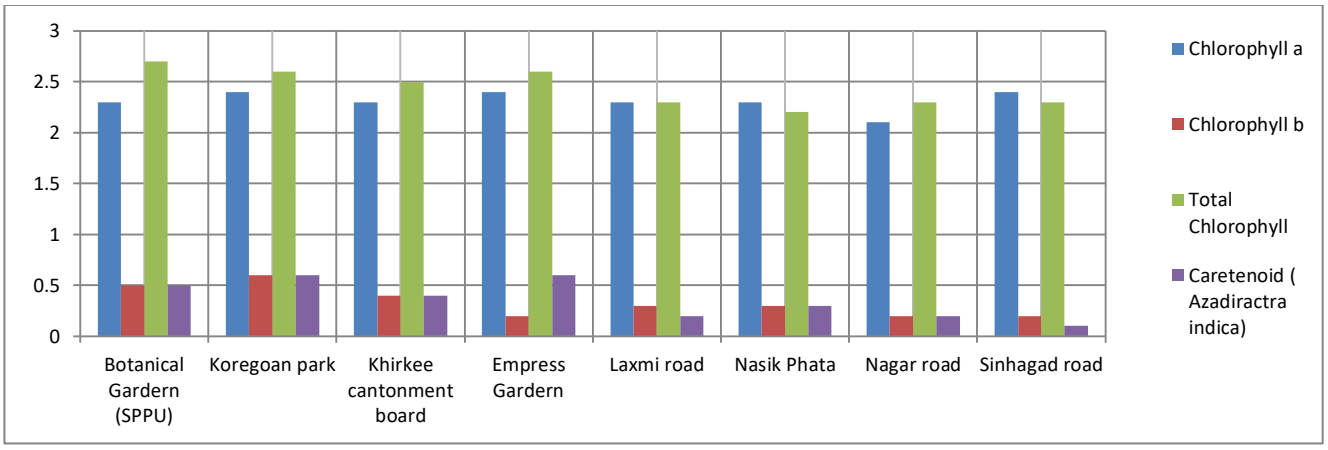

Figure 2: Effect of Pollution in the Chlorophyll content of *Nerium Oleander*

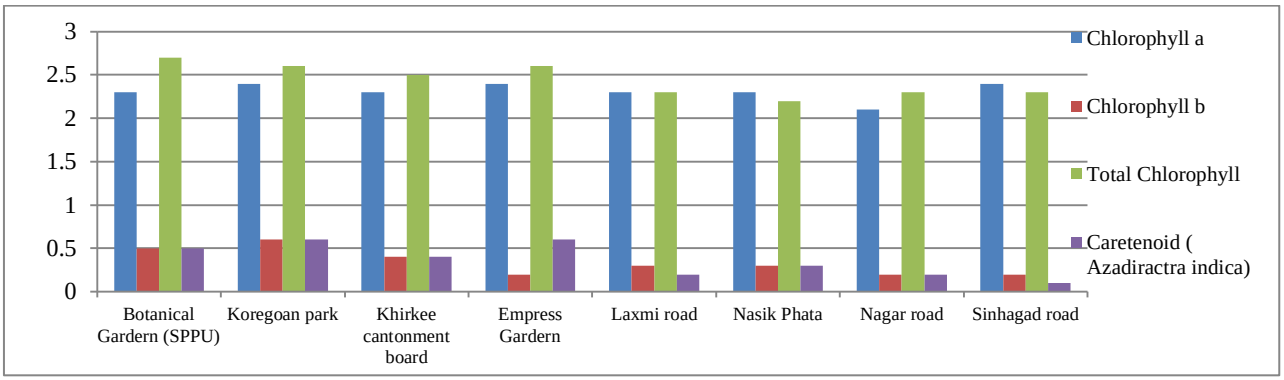

Figure 3: Effect of Pollution in the Chlorophyll content of *Ficus bengalensis*

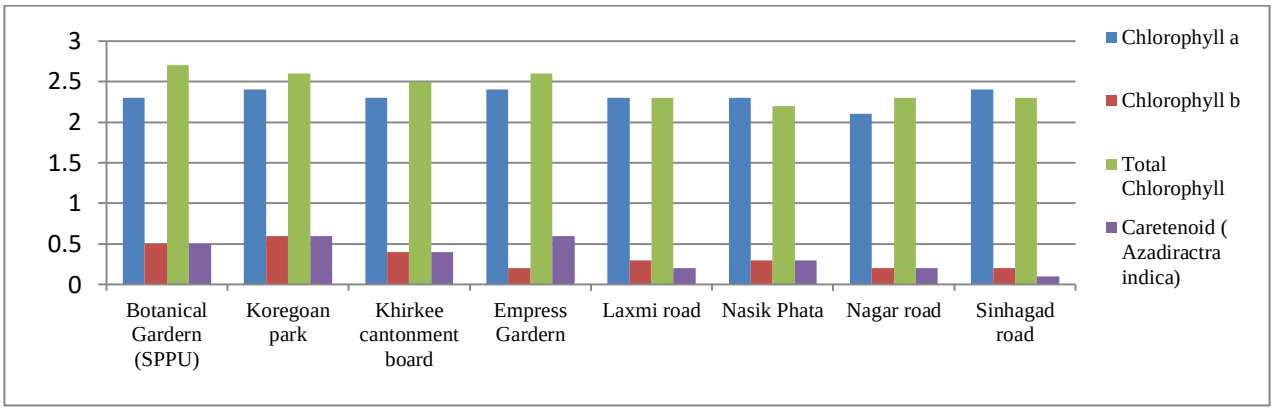

Figure 4: Effect of Pollution in the Chlorophyll content of *Azadiractra indica*

Leaves which grow in polluted area shows reduced photosynthetic activity and thereby show reduction in the chlorophyll content.[7]. Various studies have proved the impact of air pollutants.[8-12] The two ways ANOVA showed that the reduction in chlorophyll content in all the four plant under studies were significant at 0.05% level. The present studies clearly highlight the decreased in the concentration of chlorophyll in all the four plants that were selected for the studies The chlorophyll a, b, and the carotenodic pigments, ratio had extremely low values in case of plant from polluted area when compared with the plants from non-polluted area. This resulted due to the significant drop in chlorophyll and increase in the caretenoid pigments. This is a clear indication that the plant is very much under the environmental stress caused by human activities. The photosynthetic pigments are usually damaged due to various air pollutants. These pollutants cause oxidation, reduction and various other photochemical reactions. [12.13.] These adverse effect will bring about changes in the physiological as well as morphological status of the plant. Air pollution-induced degradation in photosynthetic pigments was observed in various studies by many workers. [14, 15]. The present work shows reduced in the level of chlorophyll a, b in the plants growing in polluted area. Reduction in chlorophyll content usually results in conversion of chlorophyll into phaeophytin which results due to loss of magnesium ions. The present studies show the effect of pollutants on the growth of plants.

CONCLUSION

It is clear that the air pollutants released from industries and automobile smoke are operative ecological factor causing deterioration in the quality of our environment. [16] The present studies show the effect of environmental stress on the plant which is directly proportion to the energy production in the plant. Hence a more constructive planning and execution is needed to as to stop the detoriation of air. Unless the air pollution is controlled it is not possible to prevent the detoriation in the energy production capacity of the plants.

REFERENCES

1. Nithamathi, C. P., and Indir A, V., “Imp act of air p ollution On *Ceasalpinia sepiaria Linn.* In Tuticorin City”.,*Indian Journal of Environment and Ecoplanning*, 10(1), 2005, 449–452.
2. Miszalski, Z., and Mydlarz, J., “SO2 influence on photosynthesis of tomato plants at different CO2 concentrations”, *Photosynthetica*, 24, 1990. pp. 2-8,
3. Govindaraju., Ganesh kumar.R.S Suganthi. PM uthukumaran.V.R, Visvanathan.P” Impact Assessment of Air Pollution Stress on Plant Species through Biochemical Estimations” ,2010.
4. Joshi, O.P., Wagela, D.K., and Pawar., K., “Urban air pollution effect on two species of cassia.” *poll res.* 16(1), 1997, 1-3.
5. Niragau, J. D., and Davidson, C. I., Toxic metals in the atmosphere, Jon Wiley and Sons, Newyork, 1986.
6. Hiscox, J.D., Israelstam, G.F., a method for the extraction of chlorophyll from leaf tissue without maceration. *canadian journal ofbotany;* 57, 1979, 1332-1334.
7. Kalyani, V., and Singaracharya M.A., “Bio monitoring of air pollution in Warangal city (A.P.)”. *Act Botanica indica*; 23, 1995, 21-23.
8. Rabe, R. and Kareeb, K. H., Enzyme activites and chlorophyll and protein content in plants as indicator of air pollution. *Environ. Pollut*.16, 1979, 119-137.
9. Dubey, P. S. and Pawar, K., Air pollution and plant response-Review. In: Perspective in environment botany (Eds.:D. N. Rao,K. J. Ahamed. M. Yunus and S. N. Singh). Print House,Lucknow. 1, 1985, 101-118.
10. Shah, F. H., Ilahi, I. and Rashid, A., Effect of cement dust on the chlorophyll contents, stomatal clogging and biomass of some selected plants. *Pakistan J. Sci. Indust. Research*. 32(8): 1989, 542-545.
11. Swami, A. D., Bhatt and Joshi, P. C., Effect of automobile pollution on Sal(Shorearobusta)and Rohini (Mallotusphillipinesis) at Asarori, Dehradun. Him.*J. Environ. Zool*. n18, 2004, 57-61.
12. Tripathi, A. K. and Gautam, M. Biochemical parameters of plants as indicators of air pollution. *J. Environ. Biol.* 28: 2007, 127-132.
13. Puckett, K.J., Nieboer, E., Flora W.P., and Richardson, D.H.S. “Sulphur dioxide: Its effect on photosynthetic 14C fixation in

lichens and suggested mechanism of phytotoxicity" *The New Phytologist*, 72, pp. 98 GIRI *et al.*, *Curr. Agri. Res.,* Vol. 1(2), 93-98, 2013, 141–154.

14. Singh, N., Singh, S.N., Srivastava., K., Yunus, M., Ahmad, K.J., and Sharma S. C., et al., "Relative sensitivity and tolerance of some Gladiolus cultivars to sulphur dioxide", *Annals of Botany*, 65, 1990, pp. 41–44,
15. Sandelius, A.S., Naslund., K., Carlson, A.S., Pleijel, H., and Sellden, G., "Exposure of spring wheat (*Triticum aestivum*) to ozone in open top chambers. Effects on acyl lipid composition and chlorophyll content of flag leaves", *The New Phytologist*, 131, 1995, pp. 231– 239.
16. Shah, F. H., Ilahi, I. and Rashid, A., Effect of cement dust on the chlorophyll contents, stomatal clogging and biomass of some selected plants. *Pakistan J. Sci. Indust. Research*. 32(8): 1989, 542-545.
17. Britton, G., "Structure and properties of carotenoids in relation to function", *FASEBJ*, 9, 1995, pp. 1551-1558.

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