

Air Pollution Tolerance Potential of *Alternanthera sessilis* in Urban Roadside Environments

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Abstract: For over two centuries, it has been recognized that air pollution adversely affects plant life. Plants exposed to polluted environments exhibit noticeable changes in their morphology, physiology, and biochemical processes. However, certain plant species demonstrate a degree of tolerance to such conditions. In this study, various physiological parameters of the plant species *Alternanthera sessilis* were examined to assess its tolerance to air pollution. Parameters such as fresh weight (FW), dry weight (DW), chlorophyll a, chlorophyll b, carotenoid content, protein content, and the activity of the enzyme nitrate reductase were analyzed. Samples were collected from plants growing along the roadsides of Khanda Colony, where they are exposed to vehicular emissions. These were compared with control plants grown in the Botanical garden of C.K.T. College. The results showed that roadside plants had higher fresh and dry weights, increased levels of chlorophyll a, chlorophyll b, and carotenoids, but exhibited lower protein content and reduced nitrate reductase activity compared to the control plants from the botanical garden. Based on the findings of this study, it can be concluded that *Alternanthera sessilis* exhibits a notable tolerance to air pollution, indicating its potential use as a bioindicator as well as a pollutant-scavenging plant.

Keywords: *Alternanthera sessilis*, Air Pollution Tolerance, Nitrate Reductase, Carotenoid Content.

I. INTRODUCTION

Air pollution is among the most serious environmental threats. While the air we breathe sustains life, it can also contain harmful components that damage living organisms. For over two centuries, it has been recognized that polluted air can adversely affect plants. Both gaseous pollutants and particulate matter are known to cause measurable impacts on plant health and functioning [1]. Chaphekar [2] reported that the accumulation of dust on leaf surfaces can have harmful effects on plant health and function. The harmful effects of air pollution on vegetation have already been well documented. Several researchers agree that the air pollutants affect plant growth adversely. Plants exposed to polluted air environments exhibit noticeable alterations in their morphology, physiology, and biochemical processes as a response to stress conditions. But there are some plant species which have the ability to show tolerance against air pollution. Plants are very effective in absorbing pollutants that they can create localized zones of cleaner air around them [3]. Bernatsky proposed that establishing green belts could play a role in mitigating air pollution [4].

Alternanthera sessilis is widely consumed as a leafy vegetable and is traditionally used in folk medicine across Southeast Asia [5]. Its juice is also incorporated into medicinal hair oils. In addition, the plant functions effectively as a ground cover and is used as fodder for livestock [6]. *A. sessilis* often grows right next to heavy - traffic roads, so it is continuously exposed to pollutants like dust, smoke, and vehicular emissions. That makes it an ideal **real-world test organism**. This plant is easily available along the roadsides where the rate of vehicular air pollution remains very high. It is also easily available in our botanical garden from where we can collect it and can use it as control. This is the reason why we have chosen this plant for our study.



II. OBJECTIVE OF THE STUDY

The aim of this study is therefore to compare different parameters of a plant species *Alternanthera sessilis* growing near roadsides and growing in control conditions for identifying its tolerance levels against air pollution.

III. MATERIALS AND METHODS

For this study *Alternanthera* plants growing roadsides of Khanda Colony were selected to study the effect of vehicular pollution on their physiology. Plants of same species growing in the Botanical garden of C.K.T. College were used as control plants. The effects of vehicular pollution on plants were assessed by analyzing various physiological and biochemical parameters.

These are – FW (Fresh weight), DW (Dry weight), Chlorophyll a content, Chlorophyll b content, Carotenoid content, Protein content and Nitrate reductase activity.

3.1. Fresh Weight (FW) and Dry Weight (DW) measurement

Fresh leaves were collected from roadside plants as well as plants growing in the Botanical Garden. FW was obtained by weighing the fresh leaves. The leaves were dried in hot air oven at 80°C for 24 hours and reweighed to obtain DW.

3.2. Estimation of chlorophyll a, chlorophyll b and carotenoid content (mg g⁻¹ FW)

To estimate chlorophyll a, chlorophyll b, and carotenoids, 50 mg of fresh plant tissue was taken and soaked in 20 ml of 80% acetone in a conical flask. The sample was kept overnight at 4°C in a refrigerator. After incubation, it was homogenized and then centrifuged at 4000 rpm for 10 minutes. The supernatant was then collected and the volume was adjusted to 25 ml using 80% acetone. Finally, the absorbance of the extract was measured at 645, 663, 480, and 510 nm using a colorimeter. The chlorophyll and carotenoid contents were calculated according to the formula of Witham et al. (1971) [7].

3.3. Nitrate Reductase Activity

To study the activity of enzyme Nitrate Reductase (NR) following chemicals and reagents were used – Tris- HCl buffer (pH – 7.5), 0.1 M KNO₃ (substrate for NR), Sulphanilamide Reagent, NEDD (N-1 naphthyl ethylene diamine dihydro chloride). Two tubes were prepared – one blank and one RM (reaction mixture). In blank, 2 ml buffer and 0.1 ml. KNO₃ were added. In RM, added 2 ml buffer + 0.1 ml. KNO₃ + 5 leaf discs as enzyme source. Both the tubes were incubated at 37°C for 30 minutes. After cooling the contents of RM without leaf discs were transferred to another test tube. 1 ml each of Sulphanilamide and NEDD were added to blank and RM tubes. O.D. was read at 540 nm. The amount of nitrite formed was calculated using multiplication factor (it is derived from Standard Graph of nitrite with varying concentration plotted against Δ O.D.)

3.4. Estimation of Protein by Lowry's Method

To estimate the amount of proteins in the given plant material following chemicals and reagents were required – Standard protein solution, suitable plant material, Reagent C, folin's reagent, test tubes, pipettes, mortar and pestle, colorimeter.

Preparation of Reagents:

Standard protein solution – 10mg. bovine serum albumin (BSA) in 100 ml. distilled water.

Reagent C: 50 ml reagent A + 1 ml reagent B

Reagent A: 200mg NaOH and 1 gm Na₂CO₃. Dissolved separately in small amount of distilled water and final volume was made 50 ml with distilled water.

Reagent B: 120mg CuSO₄ and 250 mg Sodium tartarate dissolved separately in small amount of distilled water and final volume was made 25 ml with distilled water.



0.5 gm of suitable plant material was weighed and homogenized in a mortar with pestle using 10 ml of distilled water. It was then filtered with muslin cloth and final volume of the filtrate was made 100 ml with distilled water.

0.1 ml of the Plant extract was taken in a test tube and 1.9 ml distilled water was added to it. Added 5.0 ml of Reagent C to all the above test tubes, mixed thoroughly and allowed them to stand. After 15 minutes 0.5 ml of folin's reagent was added to all the tubes and they were shaken vigorously. All the tubes were allowed to stand for 20 minutes. After that O.D. was read at 625nm. The amount of protein/100 gm plant tissue with the help of the standard graph for protein was calculated.



Fig. 1. Plants of *A. sessilis* growing in the botanical garden (BG) and plants growing along the roadsides (RS)



IV. RESULTS AND DISCUSSION

As the plants are continuously exposed to their surroundings, they take in, build up, and incorporate pollutants that settle on their leaf surfaces. In the present investigation, observations recorded by studying the plants growing near road sides (continuously exposed to vehicular pollution) and in botanical garden (served as control).

The FW and DW was found to be higher in plants growing roadsides as compared to the plants growing in the botanical garden. Chl a, Chl b and carotenoid content were also observed greater in plants growing roadsides as compared to the plants growing in the botanical garden.

The higher FW, DW and Chl a, Chl b contents in plants exposed to vehicular air pollution might be due to some kind of mechanisms developed in these plants for tolerance against air pollutants.

Carotenoids are found in the membranes of all photosynthetic organisms and play a protective role by defending against oxidative stress conditions [8]. The presence of more carotenoid content in plants exposed to air pollution might be for the protection of the plants from stress caused by air pollutants.

Total protein content and activity of enzyme nitrate reductase were found to be higher in control plants as compared to those growing near roadsides. This decrease might be due to presence of several heavy metals and other particulate matters present in the polluted air.

The present findings are consistent with those of Rai et al. (2004) [9] and Foyer et al. (1998) [10], who similarly reported a reduction in nitrate reductase activity and total protein content under stress conditions.

Gharge and Menon (2012) have calculated the Air Pollution Tolerance Index (APTI) values of some plants including *Alternanthera sessilis*, and in all the different seasons studied they found the values more than 30. According to Kalyani and Singaracharya (1995) [11] plants with APTI values above 30, represent tolerant category, hence, *Alternanthera sessilis* is a tolerant plant.

Moreover, the findings indicate that plants growing in polluted environments adjust to stress by modifying their structural features and biochemical processes. Further research at the molecular level, particularly studies on gene expression, could reveal more detailed mechanisms behind these adaptations. Evaluating tolerance through APTI values is therefore important for identifying suitable plant species that can be effectively used in air pollution control and environmental management.

Table 1. FW, DW and FW/DW ratio of plants collected from control and polluted area

PLANT	FW (g)	DW (g)	FW/DW
BG	0.131	0.028	4.68
RS	0.144	0.036	4.00

Table 2. Nitrate Reductase activity and Protein content in plants collected from control and polluted area

PLANT	Nitrate Reductase Activity (mg of nitrite/5 leaf discs/30 min. at 37°C)	Protein content (µg/g plant tissue)
BG	0.0160	0.66
RS	0.0128	0.56



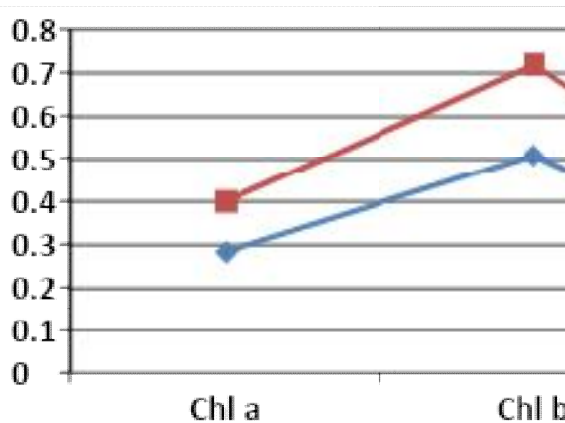


Fig. 2. Chlorophyll a, Chlorophyll b and Carotenoid content in plants collected from control and polluted area
BG = Plants growing in botanical garden a (control)
RS = Plants growing roadsides

V. CONCLUSION

On the basis of our results we can conclude that *Alternanthera sessilis* shows tolerance against air pollution thus it can be used as indicator of pollutant scavenger.

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