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A STUDY ON VARIATION IN PIGMENT CONTENT IN PLANTS UNDER AIR POLLUTION STRESS

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ABSTRACT

Plants are sensitive to gaseous and particulate pollution and so can be used as indicators of air pollution. Air pollution can alter the physiological processes of plants, thereby affecting growth patterns. Variations in the concentration of different photosynthetic pigments (Chlorophylls and carotenoids) were determined in the leaves of four tree species namely Azadirachta indica, Pongamia pinnata, Peltophorum ferrugenium, and Acacia arabica exposed to air pollution due to vehicular emissions. These studies clearly indicate that the air pollution effects the concentration of photosynthetic pigments in the trees exposed to road side pollution. There is a sharp seasonal variation in the pigment content in these plants. Total chlorophyll decreased during winter in these plants demonstrating air pollution stress.

Key words: air pollution, pigments, photosynthesis, stress.

I. INTRODUCTION

Air pollution is a serious problem throughout the world and the most common challenges of all our cities, arising mainly from industrialization and continuously increasing vehicular traffic especially in the urban areas. The air quality challenges in the city are complex and it is in the grip of multi pollution crisis.

Hyderabad, exhibiting semi-arid type of climate is one such zone where air pollution has ill effects on health. The major pollutants include SO_2, NO_2 and particulate matter. Mehdipatnam is a high traffic prone area in Hyderabad. The air environment in this region is contaminated with different concentrations of SOx, NOx and COx. The major source of pollution in this region is automobile exhaust.

Plants are good indicators of air pollution and act as tools to evaluate the effect pf pollution they are integral basis of all ecosystems and are identified as the most potent to receive the stress caused by pollution. Pollutants can enter plants directly through stomata on the leaves or indirectly through soil which gets acidified during precipitation [1]. A number of studies show that air pollution can alter physiological and biochemical processes of the plants, thereby adversely affecting the growth. Air pollution can damage the leaf cuticles and affect the stomatal conductance, photosynthetic systems, leaf longevity and patterns of carbon assimilation within plants [2]. The extent of injury or damage depends on the concentration of atmospheric gases, duration of exposure and the existing environmental conditions. In spite of adverse effects of these pollutants there are few reports on pollution tolerant plants [3]. Plants play an important role in monitoring and maintaining the ecological balance.

II. MATERIALS AND METHODS

The present study was carried out in Mehdipatnam area, located in Hyderabad zone of Telangana state. The air environment of this region is contaminated with different concentrations of SO_2, CO_2 and NO_2. The major source of pollution in this region is automobile exhaust. Major pollution source in this region is due to vehicles. The study was conducted during summer and winter seasons in the year 2013 - 2015.

The plants species selected for the study include *Azadirachta indica*, *Pongamia pinnata*, *Peltophorum ferrugenium*, and *Acacia arabica.* Fully mature leaves were collected in the morning hours from the selected trees from the polluted zones of Mehdipatnam and were brought to the lab in an ice box for analysis. Utmost care was taken to see that the samples from each study site were collected from plants growing under isoecological conditions. The leaves were thoroughly washed, weighed and the fresh leaf samples were analyzed for total chlorophyll and carotenoids.

2.1 Estimation of Chlorophyll

Chlorophylls were estimated by [4] method. Pre weighed (200 mg) quantity of fresh leaf material was ground into a fine paste. 10 ml of 80% acetone was added to it. The extract was centrifuged and the green supernatant was obtained. Using small quantities of acetone the extract was centrifuged repeatedly till the pellet became colourless. The supernatants were collected and made up to 25 ml with 80% acetone. The extract was kept away from direct sunlight. The optical density of the extract was read at 470, 645 and 663nm wave lengths. The samples were analyzed in triplicates using a Systronics double beam UV- VIS Spectrophotometer (model-2202). From the optical density values, the chlorophyll content was calculated by employing the following formula and expressed in mg/ g. FW.

Total Chlorophyll (mg/ g. FW) = (0.0202) × (A.645) + (0.00802) × (A.663)

Chlorophyll ‘a’ (mg/g. FW)) = (0.0127) × (A.663) – (0.00269) × (A.645)

Chlorophyll ‘b’ (mg/ g. FW) = (0.0229) × (A.645) – (0.00468) × (A.663)

Where, A is absorbance in nm.

Carotenoids = 1000 A470 – 1.90Chl a – 63.14 Chl b/214.

III. Results and Discussion

Pigments are functionally important molecules in photosynthetic organisms. They not only harvest the light energy necessary for carbon reduction but some serve to protect the plants from excess stress. The chlorophyll pigment content that directly determines photosynthetic potent and production depends on the amount of solar radiation absorbed by a leaf. Chlorophyll ‘a’ and ‘b’ (Fig. 1.) content recorded higher values in rainy season. Whereas, showed a decrease in winter. A sharp decline was observed in *Pongamia pinnata* in chl. ‘a’ & ‘b’ during winter. Total chlorophyll decreased in winter season in all the plants (Fig. 2.). However a slight increase in the carotenoid content (Fig. 2) was observed in *Peltophorum ferrugenium* and *Acacia arabica* in winter under air pollution stress.

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Fig.1. Effect of Air pollution stress on chlorophyll 'a' and 'b' content in selected plants during rainy and winter seasons.

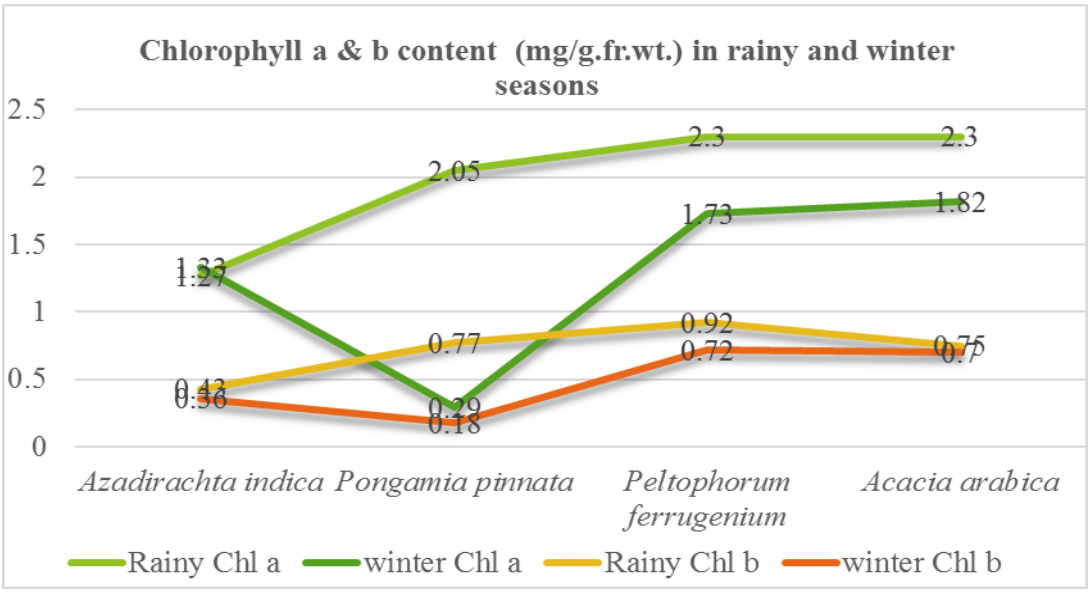

Fig. 2. Effect of Air pollution stress on Total chlorophyll and Carotenoid content in selected plant during rainy and winter seasons.

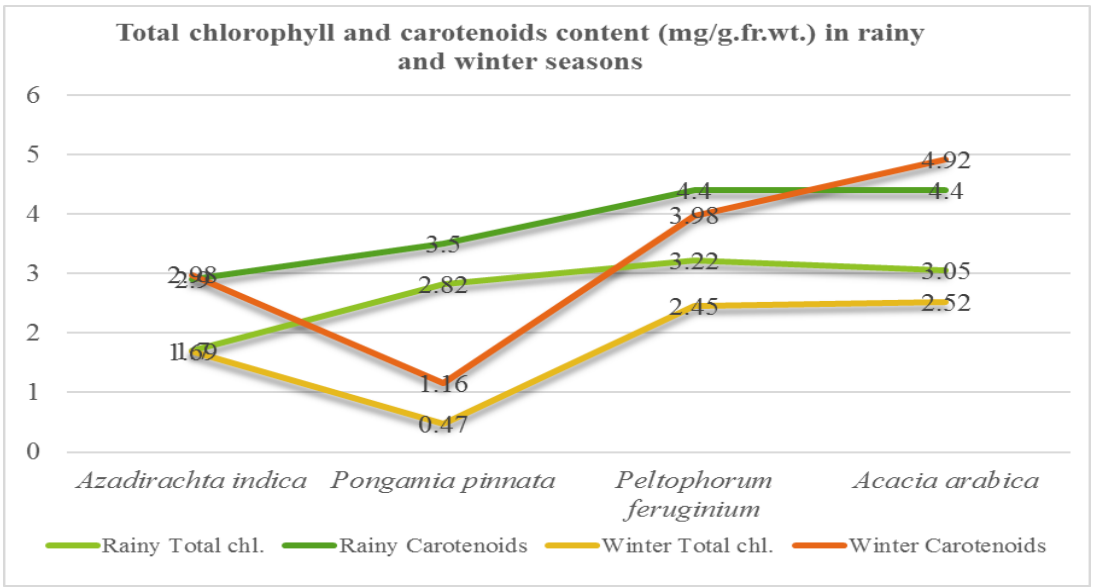

Table.1. Effect of Air Pollution on pH, RWC and Air Pollution Tolerance Index (APTI) during two different seasons.

S.No.	Plant Species	Chl. a/b ratio		pH		RWC %		APTI	
		R	W	R	W	R	W	R	W
1	*Azadirachta indica*	2.95	3.69	7.3	6.5	87.2	85.5	15.2	13.1
2	*Pongamia pinnata*	2.66	1.61	6.7	6.7	89.9	79.7	11.0	11.0
3	*Peltophorum ferrugenium*	2.5	2.40	7.2	6.5	82.7	56.9	21.0	29.1
4	*Acacia arabica*	3.06	2.60	6.9	6.3	88.4	58.4	10.4	9.3

R – rainy, W - winter

The total chlorophylls, Chl. 'a', Chl, 'b' and Carotenoids are essential pigments for the conversion of light energy to chemical energy to chemical energy, The chlorophyll pigment content that directly determines photosynthetic potent and production depends on the amount of solar radiation absorbed by the leaf. Reduction in chlorophyll content in the plants growing in polluted zones could be due to carbon and dust accumulation on the leaf lamina and other parts of the plant leading to photosystem damage. Air pollution induced degradation in photosynthetic pigments was reported by number workers [5,9]

Lichtenthaler [6] stated that the increase in the ratio of chl. a/b (Table 1) is associated with a change in pigment composition of the photosynthetic apparatus towards a more sun – type chloroplast possessing less light harvesting proteins. A decrease in a/b ratio in winter was observed in winter season in all selected plants except Azadirachta. Decrease in a/b ratio in plants under pollution stress was shown by a number of workers [7]. Different ranges of chl. a/b ratio was observed by researchers in plant under air pollution stress.

Carotenoids are the structural components of the photosynthetic antenna and reaction center. They play a critical role in photosynthetic process and protect chlorophyll from photo-oxidative damage. Reduction in carotenoid content under air pollution was reported by many researchers [8, 9, and 10]. The increase content could be a protective role of carotenoids to prevent the damage caused to chlorophylls and photosynthetic system against reactive oxygen species (ROS) caused by pollution [11].

The relative water content as depicted in Table 1. was high among the plant species studied during rainy with a decline in the level during winter. The least water content was recorded in *Peltophorum ferrugenium* followed by *Acacia arabica* during winter season. Relative water content is a crucial prerequisite for plant life. The shortage of water may cause severe stress in plants. High water content within the plant maintains its physiological balance under stress. Air pollution increases cell permeability resulting in loss of water and nutrients causing stress leading to early senescence of leaves.

The results of air pollution tolerance index [APTI] as shown in Table 1. was calculated for each plant species studied during different seasons is depicted in Table 1. Among the trees studied *Peltophorum ferrugenium*

exhibited the highest APTI value. The plants with high and low APTI can serve as tolerant and sensitive species respectively.

VI. CONCLUSION

These studies clearly indicate that the air pollution effects the concentration of photosynthetic pigments in the tree species exposed to road side vehicular pollution. There is a sharp seasonal variation in the pigment content in the experimental plants. Total chlorophyll decreased during winter indicating air pollution stress. Further investigations are necessary, to study the variation of these pigments in the plants during all vegetative seasons to get precise potential responses**.**

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