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VEHICULAR POPULATION AND PIGMENT CONTENT OF CERTAIN AVENUE TREES

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ABSTRACT

The present study was under taken to work out the impact of vehicular pollution on the pigment content of four plant species namely- *Alstonia scholaris, Ficus religiosa, Nerium odorum* and *Polyalthia longifolia* growing at different road sides with varying number and type of plying vehicles and also to observe, if any, correlation exists between the two. For this, leaf samples from different sites of the above-referred species were collected and analyzed for leaf extract pH, chl.a, chl.b, total chlorophyll, carotenoid and protein content. Leaves were sampled from all the four directions and from almost equal heights of the plants. All the parameters registered a definite reduction with the increase in vehicular density in comparison to the control (least polluted) site. However, no definite trend was seen in case of the leaf extract pH. Thus, the study pinpoints a possibility of using these modifiable parameters as traits to be used as biological indicators of pollution loads in the city.

KEY WORDS : Carotenoid, Chlorophyll, Protein, Vehicular pollution, Lucknow

INTRODUCTION

The city of Lucknow lies between 26°52 non-industrial N latitude and 80°56 'E, and 128m above sea level in the central plane of the Indian sub-continent with a total area of 310 square km, supporting a population of 36.47 Lakh (Census, 2001). Rise in population, urbanization and expansion of the city drastically increased the vehicular traffic. According to a survey report released by ITRC, Lucknow on 5th June 2005, the total number of vehicles in Lucknow city, as on 31 March 2005, is about 7.5 Lakh. Depending upon the fuel, the main exhaust emissions are nitrogen oxides (NO_x), carbon oxide, sulphur oxides (SO_x), carbon particles, heavy metals, water vapor and hydrocarbons including aldehydes, single and polyarometic hydrocarbons, alcohol, olefins, alkylnitriles besides, a number of secondary products such as ozone etc. (Singh, *et al.*, 1995; Pandey, *et al.*, 1999; Kammerbauer and Dick, 2000). It is estimated that in all the big cities in the country about a million tons of pollutants are being released into the atmosphere every day and out of which about 75% contribution is from automobiles (Chauhan *et al.*, 2004). As Lucknow is almost a non industrial city, automobiles are the main source of pollution (60-70%) in the urban sphere of the city (Singh *et al.*, 1995).

Vehicular pollution has a drastic impact on living and nonliving components of the ecosystem, because air being an important and vital component of earth's environment and any slight change in its composition can have varied effects on the growth, development and survival of different organisms on this planet. Polluted air may have profound effect on the growth and development of vegetation, trees by virtue of their perennial habit, experience the greatest exposure and are greatly influenced by any appreciable change in the environment (Raina and Sharma, 2003).

Air pollution is responsible for innumerable problems like ozone depletion, green house effect, acid deposition, disease outbreaks, physico-chemical changes of soil etc. (Khan and Chalkoo, 2005), which consequently have serious effects on the biotic and abiotic components of the environment. Regional impacts of air pollution on

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different plant species is one of the major ecological issues, as they are continuously and directly exposed to the changing environment as compared to the animal population. Several studies have been carried out to highlight the impact of air pollution, vehicular pollution on the morphological, anatomical, physiological and biochemical aspects of different plants (Sharma and Tyree, 1973, Yunus, *et al.*, 1982, Mandal and Mukherji, 1999, Chauhan, *et al.*, 2004). Various air pollutants released, apart from serious health hazards to the animals (such as, asthama, nausea, heart pulpitation, hypoxia, lung cancer, headache and eye irritation etc.), cause extensive damage to vegetation including cash crops, fruit trees and ornamental plants. Plants being directly and constantly exposed to the pollutants (both gaseous and particulates) play a significant role as indicators and in mitigating the problem. They absorb, accumulate and integrate the pollutants impinging on their foliar surface and show diverse responses. The common visual symptoms of vehicular pollution include injury such as chlorotic symptoms, necrotic lesions, reduction in leaf area etc.

The present study is a step in the direction to draw a correlation between the vehicular population and the pigment content of certain avenue trees. For this purpose, four plants were selected namely- *Alstonia scholaris* (Chitwan), *Ficus religiosa* (Pepal), *Nerium odorum* (Kaner) and *Polyalthia longifolia* (Ashok), which are common along the different road sides.

MATERIALS AND METHODS

An extensive survey of the city was under taken to select more polluted and less polluted sites, on the basis of the number of vehicles plying through these sites (Table 1). The sites selected are as follows: Site I (Near Charbagh Railway Station), Site II (Hazratganj Crossing), Site III (Nishatganj), Site IV (Nakhas) and Site V (B.B.A. University Campus, relatively clean site). Traffic density (different type of vehicles, separately) was recorded on normal working days between 9.00 AM to 11.00 AM, a period of maximum traffic load (Table 1).

Plant Analysis

Mature leaves of all the plant species, under study, were collected from all the four sides of the trees at almost same height. Samples collected from each plant were mixed to get a composite sample, which was analyzed for different parameters (pH, chlorophyll a, chlorophyll b, total chlorophyll, carotenoid and protein) to represent the average.

For determining the leaf extract pH, 5gm of fresh leaf material was homogenized with 50 ml of water (DD) and the pH of the homogenate, after centrifugation at 5000 rpm for 10 minutes was determined using pH meter (CAT NO. CL-14 Toshniwal). The photosynthetic pigments were extracted in 80% ice-cold acetone using a small amount of sodium carbonate during extraction. The optical density of clear pigment extract was measured at 480, 510, 645 & 663 nm after centrifugation at 5000 rpm for 15 minutes following the method of (Arnon, 1949), with the help of UV-visible spectrophotometer (UV-160, SHIMADZU). The amount of chlorophyll a, b, total chlorophyll and carotenoids (mg/g) were calculated using the formulae given by Machachlan and Zalik (1963) and Duxbery and Yentsch (1956) respectively. For Protein estimation, the sample was homogenized in 10% Trichloro acetic acid (TCA), after centrifugation, the supernatant was discarded and the pallet was dissolved in 1N NaOH with little warming. Following centrifugation, a blue colour was developed in the supernatant solution by adding the analytical reagent and Folin-Ciocalteau reagent and the colour was read at 660nm as per the methodology of Lowery *et al.*, (1951) with the help of UV- visible spectrophotometer (UV-160, SHIMADZU).

Table 1. Traffic density at the different sites

Vehicle Type	Site I	Site II	Site III	Site IV	Site V
Two Wheeler	3060	3400	3280	3428	50
Three Wheeler	1320	850	620	420	—
Car, Jeep etc.	1088	1050	880	390	13
Truck, Bus	1578	200	152	12	1
Total	7046	5500	4932	4250	64

RESULTS AND DISCUSSION

Vehicular pollution is posing a great problem in metropolitan cities. Industrialization and urbanization made a huge increase in transportation. In Indian, two and three wheelers constitute about 70% and the number of these vehicles is increasing at a rate of 25% per year. Besides increase in the number of vehicles, other factors like type of the engine, age of the vehicle, poor road conditions resulting in congestion also significantly contribute to the vehicular pollution (Jayasree, 2000). Among the five selected sites, Site I registered the maximum traffic density (more than 3500 vehicles/ hour). After Site I, traffic density was maximum at Site II (2750) followed by Site III (2466) and Site IV (2125) vehicles/ hour. Site V comprises of an area of 250 Acers, which is not open for the thorough passes and has not developed the connecting roads, as it is a newly established campus of the university. It hardly has more than 60 vehicles, which include both four and two wheelers. (Table 1).

The vegetation growing along the roadside of different transactions did not show any visible symptoms of injury. Also, there was no significant change in the leaf extract pH in all the plant species along the different sites. However, chlorophyll, carotenoid and protein content registered a remarkable change along the different sites (Table- 2).

Marked damage in the total chlorophyll content was recorded in all the species (A. *scholaris*, *F. relegiosa*, *N. odorum*, *P.longifolia)* along the different study sites. It registered higher value at Site I as 82%, 56%, 85% and 80% respectively in comparison to the other sites and the respective controls. This reduction in the total chlorophyll content may be attributed to the heavy vehicular population (especially diesel driven four wheelers) that are responsible for the release of huge quantities of SO_x in particular and other pollutants as diesel contains four times more sulphur than petrol. This reduction may be due to the SO_2 induced activity resulting in removal of Mg^{++} ions, which converts it into Phaeophytin. It modifies the light spectrum characteristics as reported by Malhotra (1977). While as another study by Zeigler (1997) suggests that the reduction in the chlorophyll content is caused by toxic ions formed by the dissolution of SO_2 in water inside the leaf tissue, which preferentially incorporates into thylakoid membrane. Reduction in the chlorophyll content of plants exposed to air pollution enriched by SO_2 has been also reported by

Table 2. Pigment and protein contents (µg/g) of *A. scholaris, F. relegiosa, P.longifolia and N. odorum* at the different sites

	A. scholaris					*F. relegiosa*					*P. longifolia*					*N. odorum*				
	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V
pH	6.32	7.53	5.54	6.72	7.23	7.20	7.20	7.89	7.29	6.99	6.41	6.92	7.80	7.72	7.42	6.64	6.86	6.69	6.65	6.65
Chl. a (mg/g)	0.40 *78	0.66 *64	0.84 *55	1.02 *46	1.88	0.46 *76	0.71 *64	1.36 *31	1.16 *41	1.97	0.08 *82	0.16 *65	0.28 *40	0.44 *06	0.47	0.15 *79	0.43 *41	0.62 *15	0.71 *3	0.73
Chl. b (mg/g)	0.58 *80	0.75 *74	1.28 *57	1.55 *48	2.98	1.20 *63	1.60 *51	1.70 *48	2.12 *35	3.26	0.29 *68	0.32 *65	0.51 *45	0.70 *24	0.92	0.42 *85	0.75 *73	0.95 *66	1.06 *63	2.83
Totall Chl. (mg/g)	0.89 *82	1.02 *79	2.14 *57	2.64 *47	4.97	1.97 *56	2.70 *39	3.02 *32	3.32 *26	4.46	0.88 *80	1.02 *78	1.45 *68	2.33 *49	4.60	0.60 *85	1.19 *70	1.70 *58	2.01 *50	4.00
Caroteoid (mg/g)	0.02 *91	0.09 *77	0.12 *45	0.14 *36	0.22	0.10 *67	0.11 *63	0.13 *57	0.20 *33	0.30	0.02 *93	0.06 *79	0.09 *69	0.20 *31	0.29	0.10 *60	0.11 *56	0.13 *48	0.16 *36	0.25
Protein (µg/g)	41.1 *44	50.2 *31	55.4 *24	62.0 *15	73.2	37.4 *57	44.3 *49	50.1 *42	61.2 *32	87.2	38.0 *62	45.2 *54	63.0 *36	82.5 *16	98.8	21.0 *65	23.0 *60	35.0 *41	48.1 *19	59.2

All the values are averages of three replicates

* % Damage.

many workers (Pawar and Dubey, 1982; Boralkar and Shinde, 1983; Darrall and Jager, 1984; Yunus *et al.*, 1985; Ayer and Bedi, 1986; Kumawat and Dubey 1988 and Panigrahi, *et al.*, 1992).

In the present study, a marked reduction in the carotenoid content along all the study sites in all the four plant species was also noted. Maximum reduction was recorded in *P. longifolia* at Site I (93%) followed by A. *scholaris, F. relegiosa* and *N. odorum* as 91%, 67% and 60% respectively in comparison to the other sites and the respective controls. The reduction may be attributed to the high vehicular load at this site (round the clock) in comparison to the other sites. These findings are in concurrence with those of Singh *et al.* (1988) and Siddiqui *et al.* (2004).

Plant protein is an essential component for the plant growth and development. Significant lowering of the protein content was recorded in all the plant species at the different sites in comparison to the control. It registered higher values at Site I and the most affected species was *N. odorum* (65%), followed by *P.longifolia* (62%), *F. relegiosa* (57%) and A. *scholaris* (44%). These findings are in agreement with the studies of Wagh, *et al.* (2006), who have also reported reduction in protein content in *A. indica, F. relegiosa, F. bengalalensis* and *T. catapa* while working under different traffic densities. The effect of air pollution on the protein metabolism has also been reported by many workers. Yunus *et al.* (1985) and Sisodiya and Bedi (1986) have reported decrease in protein content with rise in SO_2 concentrations. Reduction in the protein content may be attributed to decreased photosynthesis (Constantinidou and Kozlowski, 1979). However, another study by Malhotra and Sarkar (1979) suggests that the reduction in the protein content is a result of its breakdown into free amino acids.

The observations clearly reveal a conspicuous difference on the amount of the changes, be it chlorophyll a, b, total chlorophyll, carotenoid or protein content at the site which has the highest traffic density in comparison to site IV, where the difference is minimum in reference of the site I; however, even the site IV has the minimum traffic load also exhibits marked differences from the plants growing at the control site, hence showing a direct correlation with the number of automobiles. At site I (Charbagh), the significant differences can also be attributed because of the very high number of heavy automobiles, *i.e.*, diesel driven vehicles, as the diesel contain four times more sulphur content as compared to petrol and SO_2 happens to be main phytotoxicant.

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