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### RESEARCH ARTICLE

## PHYTOMONITORING AND PHYSIOCHEMICAL CHARACTERIZATION OF *FICUS BENGHALENSIS* L. EXPOSED TO VEHICULAR POLLUTION

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### Abstract

Rapid urbanization and industrialization has resulted in increased pollution to the environment. Out of these, atmospheric pollution raised by vehicles cannot be avoided since it accounts for a considerable fraction of atmospheric pollution. To mitigate the adverse effect of vehicular pollution, plants constitute a potential candidate since it can absorb much of the polluted air through their aerial parts. In this piece of work, effect of vehicular pollution was monitored in a road side plant *Ficus benghalensis* as they were growing vigorously in the polluted air. From the various morpho-physiological parameters studied, it was clear that *F. benghalensis* develop certain adaptations to the increased level of polluted air. The larger leaf area, increased dust trapping efficiency, increased pH of the polluted leaves and the increased accumulation of osmolyte-proline seems to be a mitigating strategy of these plants developed in response to vehicular pollution. Hence, from this study it can be suggested that *F. benghalensis* offer a potential candidate for greening the roadsides since it can reduce the rate of vehicular pollution to certain extent.

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### Introduction:-

Plants as successful candidates for biomonitors of air pollution are of incredible environmental significance since they are continuously exposed to the pollution due to their static nature. Although there are many sources of air pollution, automobile pollution contributes about 70% of the air pollution in urban areas (Gaikwad *et al.*, 2004). Motor vehicles account for the world's air pollution more than any other human activity. They are responsible for all of the carbon monoxide (CO) and lead (Pb) in the air of cities, and a major portion of the NO (nitrous oxides), VOCs (Volatile organic compounds), fine particles and toxic chemicals (Chauhan, 2010).

Changes in the gaseous composition of earth's atmosphere due to human activities have become a prime concern of today's world. Normal atmosphere consists of about 78% nitrogen, 21% oxygen, 0.93% argon 0.038% carbon dioxide, and several other gases in trace amounts. The discharge of pollutants in air can cause changes in these constituents of atmosphere. Urban air pollution which poses a significant threat to animal, plants and human health, is receiving more attention nowadays as a growing share of the world's population is now living in urban centers and demanding a clear urban environment. India and other developing countries have experienced a progressive degradation in air quality due to industrialization, urbanization, lack of awareness, number of motor vehicles, use of

fuels with poor environmental performance, badly maintained roads and ineffective environmental regulations (Joshi and Chauhan, 2008). Air pollution in several large cities of India is amongst the highest in the world (Agarwal *et al.*, 2006). According to an estimate, dust pollutants comprise around 40% of total air pollution problem in India (Khan *et al.*, 2005).

The worst thing about vehicular pollution is that it cannot be avoided as the vehicular emissions are emitted at the near-ground level where we breathe. Air pollutants produce various kinds of morphological, physiological and biochemical changes in plants. The effect of auto exhaust pollutants on roadside vegetation has been rarely investigated. Vehicular emission is the major source of air pollution which causes traffic pollution. Traffic pollution increases day by day due to the increased number of vehicles like bus, car, motor cycle, wagons, rickshaw, trucks, etc.

Plants can be used as both passive bio-monitors and bio-mitigators in the urban environment to indicate the environmental quality and to reduce the pollution level in a locality. Plants, the main green belt component, act as a sink and as living filters to minimize air pollution by absorption, adsorption, detoxification, accumulation and metabolism without sustaining serious foliar damage or decline in growth, thus improving air quality by providing oxygen to the atmosphere. But to the surprise not as much as consideration has been given to morphological, physiological and anatomical parameters of plants, which can be used as markers of changing air quality. Hence, an attempt is made here to analyse the effect of vehicular pollution in the metabolic activities of roadside plants. In this study, *Ficus benghalensis*, a luxuriantly growing tree on road sides was selected as a candidate species so as to assess the tolerance level towards vehicular pollution.

## **Methodology:-**

### **Plant Material**

*Ficus benghalensis* L. belonging to the family Moraceae were selected for the present study as they were common along roadside. Fresh leaf samples were collected from these luxuriantly growing roadside plants from different locations of the National Highway 17 of Kannur district, Kerala. Nonpolluted control leaves were also collected from areas remote from the main road.

### **Experimental Design**

Ten samples each from healthy and mature leaves of selected *F. benghalensis* plants were plucked by random selection in early morning hours (7.00-9.00 am) and brought in polythene bags to the laboratory. All the samples were analysed for various morphological, physiological, biochemical and anatomical parameters within twenty four hours of their harvesting so as to minimize the errors.

### **Morphological Studies**

#### **Leaf Area**

Mature leaves from both control and polluted plants were collected. Leaf area was calculated by drawing the outline of the leaf on a graph paper and calculating the enclosing area. Leaf area expressed as cm<sup>2</sup>.

#### **Dust trapping efficiency**

Leaves of roadside plants were collected and weighed each one without removing the dust on it. Then the dust on leaves was removed using a fine brush and weighed again. The differences in weight of leaves were calculated. The area of the leaf weighed was found out. Amount of dust per square centimetre of leaf was estimated as the average amount of dust divided by average area of leaf.

### **Physiological Studies**

Estimation of pigment composition of the leaf

Total chlorophyll and carotenoid pigment were estimated according to the method of Arnon (1949).

Estimation of malondialdehyde content (MDA)

MDA content in the polluted as well as control plants were estimated according to the method of Heath and Packer (1968).

### Proline

Free proline content was extracted from fresh samples using 3% sulfosalicylic acid and estimated following the method of Bates et al. (1973) using L-proline as standard.

### Leaf extract pH

Leaves of plants from the roadside and non polluted areas were collected separately. They were ground well and centrifuged. The supernatant was collected and measured pH using a pH meter.

### Anatomical studies

#### Stomatal index (SI)

A leaf segment of an area of 1cm<sup>2</sup> from each specimen was cut and immersed in water. The lower (abaxial) surface was separated with dissecting needle and forceps and rinsed with clean water. Each specimen was stained with 1% aqueous safranin for 3 to 10 minutes. Excess stains were rinsed off with clean water and were mounted in glycerin. The stomatal index was calculated as suggested by Salisbury et al. (1992).

$$SI = \frac{S}{S + E} \times 100$$

Where, SI is the stomatal index, S- number of stomata/unit area of leaf, and E- number of epidermal cells/unit area of leaf.

### Statistical Analysis

Statistical analysis of the results was carried out according to Duncan's multiple range tests at 5% probability level. Data were subjected to one-way ANOVA using the SPSS software 16.0. The data represent mean  $\pm$  standard error.

### Results:-

Various morphological, physiological and anatomical parameters were analysed in *F. benghalensis* exposed to vehicular pollution so as to assess the tolerance level.

### Morphological Parameters

#### Leaf area

While analysing the data, it was clear that the surface area of polluted leaves were significantly increased from that of control leaves in *Ficus benghalensis*. Leaf area was much higher than that of the control plants, i.e., about 29% increase compared to the control leaves (Figure 1, Table 1).



**Figure 1:-**Effect of vehicular pollution in the leaf area of *Ficus benghalensis* plants.

### Dust trapping efficiency

Dust trapping efficiency of polluted leaves were significantly higher when compared to the control leaves, i.e., about 11 fold increase were recorded (Table 1).

### Physiological Parameters

#### Photosynthetic pigments

In the case of *F. benghalensis* significant reduction was observed for the total chlorophyll content, i.e., about 83% decrease over the control samples. Significant decrease in carotenoid content was also recorded for *Ficus benghalensis* (23%) when compared to the control leaves (Table 1).

#### MDA

The rate of lipid peroxidation was found to be increased in the polluted leaves of *F. benghalensis* exposed to vehicular pollution. An increase of about 68% increase in MDA content were recorded in the polluted leaves as compared to the control leaves (Table 1).

#### Proline

Proline accumulation significantly increased in the polluted leaves compared to the control leaves, i.e., about 10 fold increase was registered for polluted leaves over the control (Table 1).

#### Leaf extract pH

Significant increase was observed in the leaf extract pH of the polluted leaves when compared to the control plants, i.e., about 70% increase over the control leaves (Table 1).

### Anatomical Parameters

#### Stomatal Index (SI)

In *F. benghalensis* SI tends to decrease than the control samples, i.e., about 10% decrease as compared to the control leaves (Table 1).

**Table 1:-**Effect of vehicular pollution in the physiochemical parameters of *Ficus benghalensis* leaves. Values are the mean  $\pm$  SE of three independent experiments. Different letters indicate statistically different means at  $p = 0.05$ .

PARAMETERS	CONTROL	POLLUTED
Leaf area (cm <sup>2</sup> )	12408.33 $\pm$ 510 <sup>b</sup>	16018.00 $\pm$ 726 <sup>a</sup>
Amount of dust trapped/cm <sup>2</sup>	0.027 $\pm$ 0.0004 <sup>b</sup>	0.31 $\pm$ 0.005 <sup>a</sup>
Chlorophyll (mg/g FW)	12.46 $\pm$ 0.44 <sup>a</sup>	8.07 $\pm$ 0.39 <sup>b</sup>
Carotenoid (mg/g FW)	1.18 $\pm$ 0.042 <sup>b</sup>	3.91 $\pm$ 0.15 <sup>a</sup>
MDA (mg/g FW)	2.45 $\pm$ 0.11 <sup>b</sup>	3.59 $\pm$ 0.17 <sup>a</sup>
Proline (mg/g FW)	0.18 $\pm$ 0.002 <sup>b</sup>	1.71 $\pm$ 0.06 <sup>a</sup>
pH	4.25 $\pm$ 0.213 <sup>a</sup>	6.03 $\pm$ 0.132 <sup>b</sup>
SI	13.05 $\pm$ 0.59 <sup>a</sup>	11.70 $\pm$ 0.46 <sup>b</sup>

### Discussion:-

Vehicular pollution causes significant alterations in the physiochemical parameters of plants growing nearby roads. Leaf area is generally considered as one of the qualities, which mirror the capacity of plant to ensure against stress (Assadi *et al.*, 2011). So the increased leaf area in the polluted plants of *F. benghalensis* might be an adaptive response of the plant towards the vehicular pollution. This increase in leaf area also correlates with the increased dust trapping efficiency of the polluted leaves.

Chlorophyll is often measured in order to assess the impacts of environmental stress since the changes in the pigments are linked with visual symptoms of growth disorder and photosynthetic productivity. One of the most common impact of vehicular pollution is the gradual disappearance of chlorophyll content which may be associated with a decrease in net photosynthesis rate (Joshi and Swami, 2007). Reduction of total chlorophyll content and inhibited photosynthesis as a result of vehicular pollution has been reported earlier in *Phaseolus vulgaris* (Lima *et al.*, 2000). This correlates with the reduced chlorophyll content of the *Ficus benghalensis* leaves exposed to vehicular pollution. 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. In *F. benghalensis*, the increased carotenoid content could be a protective role of carotenoids against potentially harmful pollutants.

Proline plays an important role in mitigating stress since it is an efficient antioxidant compound. Proline may stabilize protein complexes, act as a scavenger of oxygen free radical or function as a signal for regulation of downstream events (Alia and Matysik, 2001; Kaviet al., 2005). The increased accumulation of proline in the polluted leaves of *F. benghalensis* thus helps the plants to counteract the deleterious effects of pollution stress. In accordance with our results significant increase of proline was recorded in *Albizia lebbek* plants grown in polluted area (Seyyednejad et al., 2009).

Lipid peroxidation is one of the most excellent criteria to check the membrane damage caused by reactive oxygen species. The free radicals generated during stress condition will attack the unsaturated fatty acid side chain of lipid hydroxyl peroxides in the membrane. As MDA is a well known indicator of oxidative stress it is possible to state that *F. benghalensis* is experiencing slight oxidative stress. The present results substantiate the earlier studies by Zhang et al. (2007).

Plants with low pH are generally more prone to air contamination, while those with pH around 7 are more tolerant (Singh and Verma, 2007). In the presence of acidic pollutants, the leaf pH is brought down and decrease extraordinarily in sensitive species. In the present study, leaf extract pH is increased towards neutral pH in the polluted plants which indicate the tolerance of these plants to vehicular pollution hence this plant might be tolerant towards air pollution.

Changes in the frequency and sizes of stomata in response to vehicular pollution are an important adaptive strategy for controlling the absorption of pollutants by plants (Gostin, 2009). Decrease in stomata could be regarded as an adaptive feature developed by plants in order to cope up with the effect of the gaseous pollutant which enters the leaf and injures the tissue (Marie et al., 2008). This was in accordance with the decreased SI observed for *Ficus benghalensis* leaves exposed to vehicular pollution. Similar with our results Verma and Singh (2006), find a significant decrease of stomatal density and stomatal index in *Ipomea pestigridis* grown under various degrees of environmental stresses.

### Conclusion:-

Concisely, different plant species vary considerably in their susceptibility to vehicular pollution. Consequently the planting of pollution tolerant species at strategic location can indicate the air pollution health of the area. The present study reveals that *Ficus benghalensis* has several adaptive responses towards vehicular pollution like increased leaf area, leaf extract pH, proline accumulation, etc. Hence, *Ficus benghalensis* seems to be a promising candidate for phytoremediation of vehicular pollution.

### References:-

1. Agarwal R., Jayaraman G., Anand S, Marimuthu P. 2006. Assessing respiratory morbidity through pollution status and meteorological conditions for Delhi. Environ. Monit. Assess. 114:489-504.
2. Alia, M.P. and Matysik, J. (2001): Effect of proline on the production of singlet oxygen. Amino Acids 21: 191-203.
3. Arnon, D.J. (1949): Copper enzymes in isolated chloroplasts. Plant Physiol. 24:1-25.
4. Assadi A., Ghasemi A., Pirbalouti AG., Malekpoor F., Teimori N., Assadi L. 2011. Impact of air pollution on physiological and morphological characteristics of *Eucalyptus camaldulensis* Den. J. Food Agric. Environ. 9:676-679.
5. Bates, L., Waldren, R.P. and Teare, I.D. (1973): Rapid determination of free proline for water stress studies. Plant Soil 39: 205-207.
6. Chauhan A. 2010. Photosynthetic pigment changes in some selected trees induced by automobile exhaust in Dehradun, Uttarakhand. New York Sci. J. 45-51.
7. Gaikwad US., Ranade CD., Gadgil JM. 2004. Plants as bioindicators of automobile exhaust pollution - A case study of sangli city. J. En. 1:26-28.
8. Gostin IN. 2009. Air pollution effects on the leaf structure of some Fabaceae species. Not. Bot. Hort. Agrobot. Cluj. 37:57-63.
9. Heath, R.L., and Packer, L. (1968): Phytoperoxidation in isolated chloroplasts. I-kinetics and stoichiometry of fatty acid peroxidation. Arch. Biochem. Biophys. 125: 189-198.
10. Joshi PC, Chauhan A. 2008. Performance of locally grown rice plants (*Oryza sativa* L.) exposed to air pollutants in a rapidly growing industrial area of district Haridwar, Uttarakhand, India. Life Sci. J. 5:41-45.

11. Joshi PC., Swami A. 2007. Physiological responses of some trees under roadside automobile pollution stress around city of Haridwar, India. Environ. 2.
12. Kavi, K.P.B., Sangam, S., Amrutha, R.N., Laxmi, P.S., Naidu, K.R., Rao, K.R.S., Rao, S., Reddy, K.J., Theriappan, P. and Sreenivasulu, N.(2005): Regulation of proline biosynthesis, degradation, uptake and transport in higher plants: its implications in plant growth and abiotic stress tolerance. Curr. Sci.88: 424-438.
13. Khan AM., Pandey V., Yunus M., Ahmad KJ. 2005. Plants as dust scavengers-a case study. Indian Forester. 115:670-672.
14. Lima JS, Fernandes EB, Fawcett WN. 2000. *Mangifera indica* and *Phaseolus vulgaris* in the bioindicator of air pollution in Bahia, Brazil. Ecotoxicol. Environ. Saf. 46:275-278.
15. Marie DCG, Romeo GA. 2008. Effect of vehicular emission on morphological characteristics of young and mature leaves of sunflower and Napier grass. Benguet State University, Res. J. 16:142-151.
16. Salisbury, F.B. and Ross, C.W. (1992): Plant Physiology (4<sup>th</sup> Edn.), Wadsworth Publishing Company, California.
17. Seyyednejad, S.M., Niknejad, M. and Yusefi, M. (2009): The effect of air pollution on some morphological and biochemical factors of *Callistemon citrinus* in petrochemical zone in South of Iran. Asian J. Plant Sci.8: 562 - 565.
18. Singh SN., Verma A. 2007. Phytoremediation: A review In: Environmental bioremediation technology. Singh SN., Tripathi RD. (Eds). Springer, Berlin Heidelberg. pp:293- 324.
19. Verma, A., Singh, S.N. (2006): Biochemical and ultrastructural changes in plant foliage exposed to auto pollution. Environ. Monit. Assess. 120: 585-602.
20. Zhang, F., Wang, Y., Lou, Z., Dang, J. (2007): Effect of heavy metal stress on antioxidative enzymes and lipid peroxidation in leaves and roots of two mangrove plant seedlings, *Kandelia candel* and *Bruguiera gymnorhiza*. Chemosphere. 67: 44-50.