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RESEARCH PAPER

Assessment of urban air pollution impact on micro morphological and biochemical parameters of *Jatropha podagrica* Hook. (Euphorbiaceae)

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Abstract

The present study was carried out to assess the air pollution effects on micro morphological and biochemical parameters of *Jatropha podagrica*. In polluted area samples the number of stomata and unclogged stomata were found to be less than control, whereas the number of clogged stomata is found to be higher in the polluted site when compared to control. The stomatal pore length and breadth were also found to be less in polluted area in both the plants when compared to control. The number of epidermal cells, trichome length values was found to be less than control in both the plants. The stomatal index in both the species is higher than the control. The amount of chl. a, chl. b, total chlorophyll content was found to be higher in control samples when compare to polluted samples. But relative water content, ascorbic acid, pH and air pollution tolerance index were found to be higher in polluted site samples when compare to control samples.

INTRODUCTION

Air pollution is a foremost problem in modern society. All combustion releases gases and different particles into the atmosphere. These particles comprise sulphur and nitrogen oxides, carbon monoxide and soot particles, as well as minor quantities of toxic metals and organic molecules. Changes in the gaseous composition of atmosphere due to anthropogenic activities have become a major concern for present world. India and other developing countries have experienced a progressive degradation in air quality due to industrialization, urbanization, lack of awareness, number of motor vehicles, and use of fuels with poor environmental performance and ineffective environmental regulations (Loganathan and Ilyas 2012). The concentration of pollution is increasing in developing country like India. Each year, more than 308 crores tons of CO_2 and other pollutants are released into the earth's atmosphere. Pollutants that are pumped into the atmosphere and directly pollute the air are called primary pollutants while those that are formed in the air when primary pollutants react or interact are known as secondary pollutants. In India, the problem of air pollution has assumed serious proportions in most of the major metropolitan cities, where vehicular emissions contributed about 72 % and industrial emissions about 20 % to the ambient air pollution. Air pollutants such as ozone may enter plant tissues via stomata and elevate the level of Reactive Oxygen Species (ROS) causing serious damage to the DNA, proteins and lipids (Ghorbanli et al. 2007). Plants which are growing near roadside are becoming relatively precarious because of environment pollution of different type of heavy metals such as cobalt, nickel, cadmium, lead. The advantage of using trees and shrubs for road side plantings is their long lives and large size. They can make a positive visual impact for a long time. Thus, a best plant for the roadside is selected which help in investigating the environmental pollution as an indicator. Biological indicators have been used for many years to detect the deposition, accumulation, and distribution of heavy metal pollution (Verma et al. 2013). Plants species differ in their strategies relative to O_3 air pollutants responses, with some plants having greater tolerances than others (Ali and Yemeni 2010). Mysore is the Historical city, due to escalating urbanization and industrialization and augment in vehicles altered the vegetation particularly roadside plants and Mysore has a rapid development in urban area in demography, migration, transportation, industrial sector (Harish 2012). In the present study two plant species have been taken in an industrial area. The major industries in Mysore include BEML, J. K. Tyres, Falcon Tyres, L & T, Theorem India Pvt. Ltd. and Infosys. Located 8 km from Mysore city center on KRS Road, which is having elevated traffic density. *J. podagrica* plant grows generally even in poor soil and the seed are used to produce the biodiesel (Bojan and Durairaj 2012). Hence the present work is designed for the study of air pollution consequence on leaf characteristics of *J. podagrica* Hook. in the city of Mysore, Karnataka state, India.

MATERIALS AND METHODS

Collection of plant materials: The leaf samples of control site were collected from Mahadevapura village, Mandya district 40 km away from Mysore city. It is of great religious, cultural, and historic importance, where there is no disturbance of any kind and is relatively unpolluted. Similarly, plant species for polluted site were collected randomly from an industrial area, Mysore like J. K. Tyres, L & T and Theorem India Pvt. Ltd.

Micro morphological studies: Leaf samples collected in polythene bags from both polluted and control areas were processed for micro-morphological studies following the method of Ahmed and Yunus (1974). The matured leaf samples were cut into small bits and taken in separate test tube 30 % Nitric acid solution was added to each test tube. The mixture was boiled in a water bath for 3 hours till the leaf bits became transparent. The leaf bits were washed in distilled water and stained with 2 % safranin. Excess stain was removed by washing with distilled water and mounted using gelatin jelly. A small amount of jelly was taken in a slide and gently warmed using Bunsen burner. The epidermal peels were added to the jelly and a cover slip was mounted over it and observed under light microscope. Micro morphological characteristics such as frequency of stomata, and trichomes, size of the stomata, stomatal index, and trichome length were studied in 10 microscopic fields selected at random from each slide and measured using ocular micrometer. Photomicrographs were taken with a digital camera at different magnifications.

Biochemical studies: Fresh leaves were used for the estimation of chlorophyll a, chlorophyll b, total chlorophyll (Arnon 1949) and total ascorbic content (Berhens and Madere 1994).

Relative Water Content: Relative water content of leaf samples was calculated by the method described by the Singh and Rao (1968).

P^H: P^H of aqueous leaf extract was determined by digital P^H meter

APTI: APTI was calculated by determining the ascorbic acid content, total chlorophyll content, and pH of leaf extract and relative water content of leaf by the method described by Singh and Rao (1983).

RESULTS AND DISCUSSION

In the present study plant species *J. Podagrica* were observed and analyzed from two different sites like Industrial area and control site. These two areas served as polluted and control areas respectively. The ability of each plant species to adsorb and absorb pollutants varies greatly and depends on several physiological, biochemical, and morphological characteristics.

Morphological Studies: The air pollutants affect the plant growth and morphological characters adversely. Of all the parts of the plant body, leaf is the most sensitive part to be affected by air pollutants. The effect of air pollution at morphological level such as foliar injury and decreased leaf size have been observed in leaf samples collected from polluted area when compared to control.

Micro morphological Studies: Micro morphological studies were carried out using the leaf samples of *J. podagrica*. Micro morphological characteristics such as stomatal number, subsidiary cell number, stomatal pore length and breadth, stomatal index, trichome number, length, and breadth in leaf samples of control and polluted areas is represented in Table 1. Significant changes were observed in the structure of stomata, stomatal pore in polluted area as compared to control area. The stomatal number was found to be increased in the leaf sample of growing at polluted area when compared to control (Table 1). Leaf micro morphology has often been interspersed as a sensitive indicator of environmental pollution; leaf surface characteristics are sensitive to the air pollution. Response of leaf character to air pollution will indicate the adverse effect of air pollution, which thus can be used as a bioindicator (Saadabi 2011). Tiwari et al. (2008) reported on the two species of *Cassia* growing at three different sites in Indore city indicates that air pollution brought significant changes in foliar morphology. The fresh and dry weight of leaf was reduced. Reduction of leaf area and petiole length under pollution stress was reported by Tiwari (2006). Krishnaveni et al. (2013) reported that the amount of dust accumulated on the leaf surface cause clogging of stomata, like wise leaf length was found to be reduced in *Polyalthia longifolia* and leaf width in *Pongamia pinnata.* Saadabi (2011) reported that, in polluted sites leaves become smaller with reduced length and width and stomatal index per leaf area.

Similar results were reported by Loganathan and Ilyas (2012) significant reduction in fresh and dry weight of leaves, leaf area, petiole length, stomata and stomatal index were observed in both control and polluted plants. The plant under study is not able to escape from the site of pollution but they are quite efficient in escaping the pollution effect by altering their physiology pathway which are regarded as micro evolutionary changes by ecologist (Mandal 2006). The number of stomata increased in polluted area plants 32 % when compared to control. The length and breadth of the stomatal pore in polluted plants were found to be decreased 11.4 % and 5.8 % compared to control. Most of the stomata in the leaf sample from polluted area were found to be clogged. Loganathan and Ilyas (2012) reported heavy dust deposition in *Adhathoda vasica*, *Datura metel*, *Jatropha gossypifolia* and *Nerium oleander* plant species at polluted sites, in Ariyalur district. Seyyednejad (2011) reported the adverse effects of air pollution on biota and ecosystems where much experimental work has been conducted on the analysis of air pollutant effects on crop. Urban air pollution is a serious problem in both developing and developed countries. Air pollution can directly affect plants via leaves or indirectly via soil acidification. When exposed to airborne pollutants, most plants experienced physiological changes before exhibiting visible damage to leaves.

Biochemical studies: In the present study the effect of air pollution on the biochemical parameters viz. chlorophyll a, chlorophyll b, and total chlorophyll, ascorbic acid content, relative water content and p^H is represented in Table 2. In the current study chlorophyll, a, chlorophyll b, and total chlorophyll in the leaves of both plant species was found be increased in polluted sites when compared to control sites. The chlorophyll a, chlorophyll b, total chlorophyll content in the leaves increased from 0.65 to 2.32, 1.71 to 1.87 mg / g F. Wt., 0.21 to 2.0, 0.81 respectively. Reduction in the concentration of chlorophyll content in leaves of control area was observed in both the plant species. Similar changes in concentration of total chlorophyll were also observed in leaves of few species exposed to air pollution due to vehicular emission (Krishnaveni et al. 2013). Air Pollution Tolerance Index denotes capability of a plant to combat against air pollution. Plants which have higher APTI value are tolerant to air pollution (30-100) and can be used as sink to mitigate pollution, while plants with low APTI value (17-29) show less tolerance and can be used to indicate levels of air pollution. Plants with tolerance index 1-16 between are sensitive to air pollution. In this study, Ascorbic acid concentration was increased in leaves of *J. podagrica.* Ascorbic acid being a strong reductant protects chloroplast against SO_2 induced H_2O_2, O_2 and OH^- accumulation and thus protects the enzyme of the CO_2 fixation cycle and chlorophyll for inactivation together with p^H it plays a significant role in determining the SO_2 sensitivity of plant. Thus, the plant maintaining high ascorbic acid under pollutant condition is tolerant to air pollution (Tiwari 2006). Increase in ascorbic acid concentration with respect to leaves from control area also reported (Krishnaveni et al. 2013). The relative water content in the leaf samples of polluted area showed increased 0.2 % in *J. podagrica* as compared to control. p^H in the leaf samples of *J. podagrica from* polluted area showed an increase of 18.6% when compared to control. The ascorbic acid content was increased in the leaves sample of *J. podagrica*. The leaf p^H values of increased in the polluted area compared with that of control area, similar increase in p^H values in polluted site was observed by Tiwari (2006). The photosynthesis efficiency of plant species depends on the leaf p^H (Krishnaveni et al. 2013). Leaf extract p^H plays a significant role in regulating SO_2 sensitivity of plants and in presence of an acidic pollutants the leaf p^H is lowered and the decline is greater in sensitive species. However, the reducing activity of ascorbic acid increased the p^H, Hence the leaf extract p^H on the polluted side give tolerance to plants against pollution (Tiwari 2006). The Ambient air quality monitoring data at Industrial area was obtained from KSPCB, Mysore.The concentration of SO_2, NO_2 and PM 10 were within the permissible limits of CPCB. Plant species growing at Industrial area showed an increased APTI value of 16.9 *J. podagrica.* Based on the APTI values the plant species were categorized as tolerant to air pollution (Table 2). In this study, increase in relative water content were observed in polluted site, similarly increased in relative water content was observed by Sharma et al. (2013). Relative water content is associated with protoplasmic permeability in the cells causes loss of water and dissolved nutrients, resulting in early senescence of leaves (Tiwari 2006). More water content in the leaf in certain plants helps to maintain its physiological balance under stress condition of air pollution, when the transpiration rates are usually high. Higher relative water content favors drought resistance in plants. So, plants having more relative water content might be grown in drought area (Krishnaveni et al. 2013). The plant species investigated for Air Pollution Tolerance Index (APTI), *Jatropha pogadrica* Hook. showed more tolerance to air pollution than similar increase in APTI was observed by Krishnaveni et al. (2013). Thus, based on above studied parameters., *Jatropha podagrica* Hook. are categorized as tolerant species according to their APTI values. Thus, they can be considered as sinks of air pollution.

Table 1: Micro-morphological characteristics of *Jatropha podagrica* from control and polluted sites

Plants name		Number of stomata	Clogging	Stomata pore size length	Stomata pore size breadth	Subsidiary Cells	Stomata Index	Trichome number	Trichome length	Trichome breadth
J. podagrica	C	14.2±1.9[b]	0.16±0.5[b]	9.24±1.4[a]	5.62±0.6[a]	62.8±5.2[a]	0.18±0.036[b]	--------	--------	---------
	P	18.2±2.3[a]	6.4±2.3[a]	8.04±0.9[b]	5.24±0.9[a]	57.7±5.5[b]	0.23±0.024[a]	---------	--------	--------

(Mean ±SD followed by same superscript are not statistically significant between the concentrations when subjected to SPSS package ver. 14.0 according to Tukey's mean range test at 5% level, C= Control, P= Polluted)

Table 2: Chlorophyll a, Chlorophyll b and Total Chlorophyll Contents of Plants of Polluted and Control Areas

Plants names		Chl a	Chl b	TCH	RWC	pH	AA	APTI
J. podagrica	c	0.25±0.03[b]	0.26±0.02[b]	0.77±0.04[b]	70.5±5.62[a]	5.4±1.05[b]	1.56±0.03[a]	14.0±2.63[b]
	p	2.05±0.22[a]	2.01±0.12[a]	4.55±0.23[a]	70.8±5.22[a]	6.8±1.02[a]	0.74±0.02[b]	16.9±2.44[a]

(Mean ±SD followed by same superscript are not statistically significant between the concentrations when subjected to SPSS package ver. 14.0 according to Tukey's mean range test at 5% level C: Control, P: Polluted, Chl a: Chlorophyll a, Chl b: Chlorophyll b, RWC: Relative Water Content, TCH: Total Chlorophyll Content, A: Ascorbic acid Content, APTI: Air Pollution Tolerance Index)

CONCLUSION

The present study concludes that *Jatropha pogadrica* has capacity to tolerate the high air pollution. Therefore, it can be used to mitigate the air pollution.

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