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RESEARCH ARTICLE

Stomatal analysis in *Cassia occidentalis* l. in response to automobile pollution along Roadsides in Meerut city, India.

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ABSTRACT

Environmental deterioration in India is eminent due to rapid industrialization and intense Urbanization due to industrialization. The poor air quality is one of the most serious environmental problem in the world. Transportation, industrial power generation, toxic substances, gases in the atmosphere have effect on our food supply, health, plant human life and economy. Present study deals with the observation made on the plants on roadside in comparison to plants in controlled area. On roadside plants having heavy auto-exhaust pollution load. Present studies were made on *Cassia occidentalis* taken from Garh road, Railway road, Delhi road and University road. These changes have been worked out on the basis of percentage of reduction in various parameters in tested plants. Due to high concentration of automobile pollution, the number of stomata, stomatal index and stomatal density were reduced and Number of epidermal cells and epidermal density were increased. Variation in stomatal index and stomatal density on the adaxial and abaxial surface has been observed in these plants.

Key Words: Stomatal Density, Stomatal index, epidermal density, Vehicular exhaust pollution.

INTRODUCTION

Our environment is a complex mixture of a number of constituents like air, water, soil, plants and animals, all of which maintain a dynamic inter-relationship and interdependence. The earth is the only planet known in the entire universe capable of supporting life which is due to its unique environment. Any undesirable change in the environment, which may be due to addition of unwanted substances results in atmospheric pollution and disturbs the normal functioning of the whole ecosystem. Zielinska et al. (2004) reported that the composition of emissions from automobiles highly depend on the fuel type, the state of vehicular maintenance and ambient conditions. Sarkar *et al.* (1986) observed the high effects of automobile exhaust pollution on *Clerodendron incerme*, *Solanum torum* and *Calotropis procera* along a road carring dense traffic. And found visible injury, necrosis, chlorosis and reduction in leaf area due to air pollution. Decrease in stomatal frequency and occurrence of aborted stomata were

reported in the leaves of some woody perennials as a result of air pollution (Chattopadhyay, 1996). Similarly, decrease in stomatal index, density and coverage area was observed in *Dahlia* and *Tagetus* (Dhaka, 1999; Prakash *et al.,* 2001); *Helianthus annus* (Goswami, 2002); *Zea mays* (Jeyakumar *et al.*, 2003) and *Mammillaria fragilis* (Joshi *et al.,* 2004) and Miyazawa et al. (2006).

MATERIALS AND METHODS

Leaves were collected from different selected sites and studied. For the study of stomata parameters, the replica technique (conservative facsimile technique) was adoptd (Prakash and Kumar, 1995). In this method, an adhesive such as quick-fix was applied on the surface of the leaf. It was allowed to dry for a few seconds and then a cellotape was placed on the leaf surface. The tape was then pulled off and the impression of leaf epidermis than was obtained under the microscope. Stomatal index was determined as follows.

$$\text{Stomatal density} = \frac{\text{Number of stomata}}{\text{Field area (mm}^{-2})}$$

$$\text{Epidermal density} = \frac{\text{Number of epidermal cell}}{\text{Field area (mm}^{-2})} \times 100$$

$$\text{Stomatal Index} = \frac{S}{E+S} \times 100 \qquad \text{(Salibury, 1927)}$$

where, S = no. of stomata in microscope field area^{-1},
E=no. of epidermal cells microscopic field area^{-1}

RESULTS AND DISCUSSION

The reduction in the number of stomata on adaxial and abaxial surface respectively was 51.8% and 38.8% in *Cassia occidentalis* at Delhi road (Table: 1, 2). The number of epidermal cells however recorded at increase. The number of epidermal cells was higher at high polluted sites. The reduction in stomatal index on adaxial / abaxial surfaces was 54.20% /48.4% in *Cassia occidentalis* at Delhi road (Tables 1, 2).

Stomatal density also recorded a decrease at different polluted sites. In *Cassia occidentalis* the reduction percentage in stomatal density was recorded as 51.8% and 38.8% on adaxial/ abaxial surface at Delhi road and 22.2%and6.6% on adaxial/ abaxial surface at University road (Table 1, 2).

The results were statistically analyzed and interpreted by three way ANOVA. All the data were subjected to statistical analysis to find out Critical Difference at (CD) 5% and 1% level (Fisher 1951), is superscripted with single star (*) and double star (**) respectively.

Effect of pollution on various other parameters of plants growth growing under polluted condition might be attributed to the disturbances caused in habitat due to pollutants emitted by diesel engines of locomotives, deposition of smoke, carbon, dust and gaseous pollutant, etc. present study number of stomata decreases with increase in pollution on roadside. As the number of stomata decreases, consequently the number of epidermal cells increases.

Table 1: 1 Stomatal Response in terms of no. of stomata, no. of epidermal cells, epidermal density (mm^{-2}), stomatal density(mm^{-2}) and stomatal index on adaxial surface in *Cassia occidentalis* plant.

Attribute	Different Study Sites					Statistical Value	
	Control	Delhi Road	Garh Road	Railway Road	University Road	CD 5%	CD 1%
No. of epidermal cells	21.75 ± 1.7078	32.5 ± 6.4549	29.0 ± 2.0816	27.0 ± 4.7609	25.25 ± 5.3774		
No. of stomata	13.5 ± 1.0	6.5 ± 0.5773	7.25 ± 0.5	8.5 ± 1.9148	10.5 ± 0.5773		
Epidermal density (mm^{-2})	308.0736 ± 24.1901	442.6345* ± 67.806	417.847* ± 29.485	382.4362* ± 67.435	357.6487 ± 76.167	70.6348	168.3624
Stomatal density (mm^{-2})	191.2181 ± 14.164	92.0679** ± 8.177	102.6912* ± 7.082	120.396* ± 27.122	148.7252* ± 8.177	41.3588	98.5814
Stomatal index	38.3261 ± 2.326	17.5155** ± 3.539	19.7923** ± 2.135	24.1384* ± 5.194	29.8355* ± 4.468	6.7919	16.1889

Values are mean ± Standard Error.
Values are statistically significant at * <CD5% and ** <CD1%

Table. 2: Stomatal response in terms of no. of epidermal cells, no. of stomata, epidermal density (mm^{-2}), stomatal density (mm^{-2}) and stomatal index on abaxial surface in *Cassia occidentalis* plant.

Attribute	Different Study Sites					Statistical Value	
	Control	Delhi Road	Garh Road	Railway Road	University Road	CD 5%	CD 1%
No. of epidermal Cells	41.5 ± 1.2909	62.25 ± 0.9574	60.25 ± 1.258	45.5 ± 1.290	43.75 ± 0.957		
No. of stomata	22.5 ± 2.6457	13.75 ± 0.5	17.75 ± 0.9574	18.25 ± 0.5	21.0 ± 2.4494		
Epidermal density (mm^{-2})	587.8186 ± 18.2860	881.7280** ± 13.5612	853.3994** ± 17.8230	644.4759* ± 18.2860	619.6883 ± 13.5612	53.395	127.27
Stomatal density (mm^{-2})	318.6968 ± 37.4752	194.759* ± 7.0821	251.4164 ± 13.5612	258.4985 ± 7.0821	297.4504 ± 34.6953	109.427	260.821
Stomatal Index	35.0695 ± 2.3912	18.0880** ± 0.36486	22.7560* ± 1.16207	28.6368 ± 1.07618	32.3651 ± 2.5813	6.982	16.642

Values are mean ± Standard Error.
Values are statistically significant at * <CD5% and ** <CD1%

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, injuries the tissue and causes death (Chattopadhyay, 1996); Marie et al. (2008); Prakash et al. (2008). Gaseous pollutant enters the leaves through stomata following the same diffusion pathway as CO_2.

Stomatal opening is checked by the entry of gases in leaf. The pollutants after entering the leaf dissolve in the apoplastic water to produce mainly sulphite and bisulphite ions as (SO_3^{-2}, HSO_3^-) which are toxic at high concentrations but at low concentrations are effectively detoxified by plants to sulphate ions which then work as sulphur source for the plant. Kulshreshtha et al. (2005); Salisbury (1927, 2006 a); Sun star.com (2009).

Urban areas are characterized by higher concentration of SO_2, hence the plants in these areas cannot be detoxified rapidly and adapt themselves by following some line of defense against SO_2 stress. It may include stomotal closure and reduction in number of stomata was observed at all sites, so stomatal index and stomatal Density was also reduced accordingly.

The effect was more severe on adaxial surface than on abaxial surface. This might be due to direct exposure of the adaxial surface to the pollutant. As the number of stomata decreases, consequently number of epidermal cells increases. This resulted in increase in epidermal density.

Present paper shows an overview that high concentration of pollutants was observed at Delhi road and low at University and moderate at Garh road and Railway road in comparison to control site. The adverse effects of air pollution on plants were greater in the area receiving higher pollution load and vice-versa. Due to higher level of dust on upper surface of plant, stomatal process and food synthesis in leaves were highly affected. According to the study it can be concluded that Delhi road was most polluted site followed by Garh road, Railway road, and University road in comparison to control. It can be concluded that the high level of pollution in busy roadsites hampers the plant growth and development to an extent that the plant is disturbed.

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