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RESEARCH ARTICLE

Changes in the micromorphology of two common roadside dicotyledonous plants under the influence of automobile pollution along the National highway- 58

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SUMMARY

This study deals with the impact of auto-emission on stomatal frequency, epidermal cells and stomatal index of two common dicotyledonous roadside plants *i.e- Eucalyptus* spp. and *Mangifera indica* L. Stomatal and epidermal cells frequency and stomatal index show drastic reduction at different distances of high polluted site(HPS), medium polluted site(MPS) and low polluted site(LPS) from National highway- 58. The data collected from these plants show that *Eucalyptus* spp. were slightly tolerant to auto-emission pollution in comparison to *Mangifera indica* L.

Key Words : Auto-emission pollution, Stomatal frequency, Stomatal index, High polluted site(HPS), Medium polluted site(MPS), Low polluted site(LPS)

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Exhaust gases from automobiles contribute significantly to air pollution. The major pollutants emitted from the automobiles are particulate matter, SO_2, NO_X, CO, and unburnt hydrocarbons which affect the stomatal opening, closing or impact on guard cells is more than other organelles since most of the gaseous exchange for all the biochemical processes takes place through these micropores because foliar surface is the direct phase of contact between plant and atmosphere. The amount of air pollutants absorbed primarily on the size and number of stomata in the leaves. It has been suggested that stomatal response may be a key factor in determining the sensitivity of plant species to automobile pollution. Many workers reported reduction in stomatal dimensions and stimulation in the number of stomatal and epidermal cells in plants growing in the vicinity of automobile pollution *viz.*, Salgare and Thorat (1990); Kulshrestha *et al.* (1994); Johari and Sneh Lata (1999); Pal *et al.* (2000); Kazmi *et al.* (2004) .

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MATERIALS AND METHODS

This investigation was carried out on two common roadside dicotyledonous plants *i.e- Eucalyptus* spp. L. and *Mangifera indica* L. along with National highway- 58, to assess the effect of auto-emission on stomatal and epidermal cells frequency and stomatal index. The sampling site Sa taken as highly polluted site (HPS), situated at Modipuram (N.C.R), where the micromorphological parameters were studied adjacent to highway (Sa_1); 50 meter away from highway (Sa_2); and 150 meter away from highway (Sa_3). Two other sites of study are village Bhainsee (Sb) adjacent to N.C.R, which has been taken as medium polluted site (MPS) and village Barla (Sc), a low polluted site (LPS). Controlled conditions have been taken at every site which was 1.5 km away from the highway *i.e-* Sa, Sb and Sc, respectively.

The materials collected from different sites were under investigation and marked 3 months before at the same height above the ground. Leaves are washed with the fresh water and 1 mm^2 specimen were cut and placed in 40 – 80 % HNO_3 in a test tube, heated over flame and gently agitated to separate the epidermis. Decanted the acid, rinsed thoroughly in water for 3-4 times, 1 minute each. Neutralized the final rinse with 0.1 – 1 % NaOH or KOH, and washed again in water and then dehydrated in methanol (Ghouse and Yunus, 1972). Finally rinsed material was taken in xylene and after that mount and counted the number of stomata and epidermal cells separately on adaxial and abaxial surface with the help of camera lucida. The variations induced in epidermal pattern were calculated by using following formulae.

$$\textbf{Stomatal index} = \frac{\textbf{S}}{\textbf{e}+\textbf{S}}\ \textbf{(Salisbury, 1927)}$$

where,

S= Number of stomata microscopic field area^{-1}

e= Number of epidermal cells microscopic field area^{-1}

$$\textbf{Frequency of stomata} = \frac{\textbf{Number of stomata}}{\textbf{Microscopic field area}}$$

$$\textbf{Frequency of epidermal cells} = \frac{\textbf{Number of epidermal cells}}{\textbf{Microscopic field area}}$$

RESULTS AND DISCUSSION

The data taken from all the two plants, which were under investigation at every site show that auto-emission pollutants affect the micromorphology along the National highway. The concentration levels of auto-emission pollutants are different at different distances from highway at every site *i.e*- S_a, $S_{b,}$ and S_C , respectively.

Stomatal frequency of *Eucalyptus* spp. on their adaxial surface show maximum reduction at HPS *i.e*- 9.78%, 6.07%, 3.96% followed by 6.87%, 4.04%, 2.12% at MPS, and 5.38%, 2.89%, 1.57% at LPS, respectively, whereas in case of *Mangifera indica* , stomata were found absent at their adaxial

Table 1: Impact of auto-emission on stomatal frequency per mm^2

Sites plants		Sa				Sb				Sc			
		C	Sa3	Sa2	Sa1	C	Sb3	Sb2	Sb1	C	Sc3	Sc2	Sc1
Eucalyptus spp. (Saffeda)	ADAXIAL	260.83	250.50†	245.00*	235.33**	259.67	254.17†	249.17†	241.833*	254.00	250.00†	246.67†	240.33†
		±9.51	±9.25	±9.15	±8.86	±9.60	±9.51	±9.39	±9.23	±9.57	±9.40	±9.30	±9.23
	ABAXIAL	340.50	332.33†	325.17†	319.00*	340.83	336.17†	330.17†	322.67†	340.50	337.33	332.00†	328.33†
		±9.93	±9.71	±9.57	±9.38	±10.29	±10.23	±10.07	±9.86	±10.28	±10.24	±10.08	±9.99
Mangifera indica (Mango)	ADAXIAL	-	-	-	-	-	-	-	-	-	-	-	-
	ABAXIAL	805.00	749.00**	724.17**	710.67**	808.33	777.50*	743.17**	726.50**	815.00	801.50†	765.17**	745.00**
		±13.82	±13.52	±13.35	±12.74	±14.81	±14.21	±14.19	±13.62	±14.93	±14.42	±14.29	±12.77

Table 2 : Impact of auto-emission on epidermal cells per mm^2

Sites plants		Sa				Sb				Sc			
		C	Sa3	Sa2	Sa1	C	Sb3	Sb2	Sb1	C	Sc3	Sc2	Sc1
Eucalyptus spp. (Saffeda)	ADAXIAL	2514.19	2475.17	2435.67	2395.67	2518.17	2500.33	2468.50	2425.17	2524.67	2514.50	2488.67	2453.83
		±27.95	±24.04	±22.17	±22.10	±28.93	±26.14	±24.19	±22.85	±29.52	±28.22	±26.41	±23.15
	ABAXIAL	2037.83	2021.50	1992.50	1972.83	2040.33	2027.17	2002.33	1980.50	2048.00	2040.67	2020.50	2010.67
		±19.45	±18.79	±18.40	±17.58	±20.22	±19.72	±19.39	±18.84	±20.35	±20.17	±19.72	±19.13
Mangifera indica (Mango)	ADAXIAL	7005.50	6705.50	6415.50	6120.17	7036.67	6885.33	6670.17	6374.50	7118.17	6983.00	6865.00	6560.50
		±46.67	±44.22	±41.32	±40.66	±47.68	±45.23	±43.26	±41.57	±48.01	±45.90	±43.58	±42.33
	ABAXIAL	4150.67	3985.00	3890.50	3840.50	4085.67	4005.50	3900.00	3825.50	4150.50	4120.33	4005.67	3915.67
		±37.27	±35.66	±34.76	±32.52	±38.18	±36.69	±34.91	±34.28	±36.69	±36.51	±35.58	±33.72

Table 3: Impact of auto-emission on stomatal index per mm^2

Sites plants		Sa				Sb				Sc			
		C	Sa3	Sa2	Sa1	C	Sb3	Sb2	Sb1	C	Sc3	Sc2	Sc1
Eucalyptus spp. (Saffeda)	ADAXIAL	9.40	9.19	9.14	8.94	9.35	9.23	9.17	9.08	9.14	9.04	9.02	8.92
	ABAXIAL	14.32	14.12	14.03	13.92	14.31	14.22	14.16	14.01	14.26	14.19	14.15	14.04
Mangifera indica (Mango)	ADAXIAL	-	-	-	-	-	-	-	-	-	-	-	-
	ABAXIAL	16.24	15.82	15.69	15.62	16.52	16.26	16.01	15.96	16.41	16.28	16.04	15.98

-Value are in mean (n = 30), ± S.D. , * and ** Indicate significance of value at P= 0.05 and 0.01, respectively, † – Non significant surface. The maximum reduction of stomatal frequency were found at abaxial surface of *Mangifera indica* at HPS *i.e*- 11.72%, 10.04%, 6.96%, followed by 10.12%, 8.06%, 3.81% at MPS and 8.59%, 6.11%, 1.66% at LPS, respectively, followed by *Eucalyptus* spp. as 6.31%, 4.50%, 2.40% at HPS; 5.33%, 3.13%, 1.37% at MPS and 3.57%, 2.50%, 0.93% at LPS , respectively.

Mangifera indica shows drastic reduction in epidermal cells at their adaxial surface as 12.64%, 8.42%, 4.28% at HPS; 9.41%, 5.21%, 2.15% at MPS; 7.83%, 3.56%, 1.90% at LPS, followed by *Eucalyptus* spp. as 4.71%, 3.12%,1.55% at HPS; 3.69%, 1.97%, 0.71% at MPS; and 2.81%, 1.43%, 0.40% at LPS, respectively. At the abaxial surface of *Mangifera indica*, reduction of epidermal cells was 7.47%, 6.27%, 3.99% at HPS; 6.37%, 4.54%, 1.96% at MPS; and 5.65%, 3.48%, 0.72% at LPS; followed by *Eucalyptus* spp. as 3.19%, 2.22%, 0.80% at HPS; 2.93%, 1.86%, 0.64% at MPS; and 2.65%, 1.34%, .36% at LPS, respectively.

Stomatal index of *Eucalyptus sps* at their adaxial surface show reductions as 4.89%, 2.77%, 2.23% at HPS; 2.89%, 1.93%, 1.28% at MPS; and 2.41%, 1.31%, 1.09% at LPS. *Mangifera indica* at their abaxial surface show maximum reduction of stomatal index as 3.82%, 3.39%, 2.59% at HPS; 3.39%, 3.09%, 1.57% at MPS; and 2.62%, 2.25%, 0.79% at LPS ; followed by *Eucalyptus* spp. as 2.79%, 2.03%, 1.40% at HPS; 2.10%, 1.05%, .63% at MPS; and 1.54%, .77%, .49% at LPS, respectively.

In general, *Eucalyptus* spp. shows low variation in its micromorphology in comparison to *Mangifera indica*, under the influence of auto-emission pollutants at different polluted sites. The present studies on the plants growing along the National highway – 58, indicate that auto-emission brought appreciable changes in the number of stomata and epidermal cells per mm^2. Stomata are the main portals for gaseous exchange but this exchange get hampered due to air pollutants following the same diffusion pathway as CO_2. The pollutants dissolve in cells and give rise to different ions, thereby causing peculiar changes in the micromorphological attributes of leaf. Reduction in the epidermal and stomatal frequency (xerophytic features) was probably because the plants were subjected to automobile pollutants as well as increased wind velocity so that the exposed area to atmosphere, on which the pollutants deposite and enter the plant body can be minimized. Similar results were presented by Salgare and Thorat (1990) on some trees. A decrease in stomatal frequency from polluted habitats suggests an adaptation that may keep out gases pollutants that may otherwise get into the leaf and cause tissue damage and physiological disturbance.

Kulshrestha *et al*. (1994) made a comparative study of the cuticular and epidermal features of *Syzigium cumini* L. and *Lantana camara* L. growing close to diesel generator set and a controlled site.They observed highly significant differences in stomatal opening. In another study Kulshrestha *et al*. (1994) investigated the effect of automobile exhaust pollutants on leaf surface of *Nerium indicum* L. and noted significant differences, apart from others, in epidermal cells and stomatal features in control and polluted populations.

In the present study *Eucalyptus* spp. and *Mangifera indica* L. followed the same pattern of changes in their micromorphology due to stress conditions. The stomatal and epidermal frequency declined in plants growing in close vicinity of National highway, decline being more in stomatal frequency than that of epidermal cells resulting in the significant fall in stomatal index. Perhaps, lesser stomata decreased gases exchange between environment and plants, thus protecting it from toxic inhalation. Observations revealed the difference level of sensitivity of plants to auto-emission in terms of micro- morphological parameters.

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