IOSR Journal Of Environmental Science, Toxicology And Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399. Volume 2, Issue 6 (Jan. - Feb. 2013), PP 04-07
www.Iosrjournals.Org

Effect of urban air pollution on epidermal traits of road side tree species, *Pongamia pinnata* (L.) Merr.

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Abstract: *Effect of urban air pollution on roadside tree species Pongamia pinnata(L.) Merr. has been studied with special reference to epidermal characteristics of leaves. The light microscopic studies of this plant indicated marked alteration in epidermal traits, with increased number of stomata and epidermal cells per unit area in leaf samples collected from polluted sites than those from control site. Results revealed that, as compared to the leaves from control, the length and width of guard and epidermal cells reduced considerably in leaves of polluted sites. These changes in epidermal traits could be as indicator of environmental stress and can be recommended in high traffic density area for the early detection of urban air pollution.*
Key words: *Urban air pollution, epidermal cells, stomata.*

I. Introduction

The automobile emissions constitute a major source of environmental pollution in Indian cities. The problem is much more aggravated due to narrow and congested roads, and old poorly maintained vehicles. Petrol and diesel engine driven motor vehicles release a wide variety of pollutants particularly benzene, carbon monoxide, organic compounds, oxides of nitrogen, sulphur dioxide and suspended particulate matters like ultra fine primary particles, smoke, metals (Cd, Co,Cu, Pb, etc.) and inert dust. The ultra fine particles, when released, quickly coagulate into larger particles through reaction with other pollutants like sulphur dioxide, nitrogen oxides, ammonia and volatile organic compounds (Street et al. 1996).

Plant species, particularly trees and shrubs, are important sinks for trapping and absorbing many gases, particulates, aerosols and airborne pollutants (Gajghate and Hassan 1999), thus improving the quality of urban life (Powe and Willis 2004) . Plant species differ in their ability to mitigate traffic pollution due to differences in their leaf surface characteristics such as epicuticular wax, cuticle, epidermis, stomata and trichomies (Neinhuis and Barthlott,1998).

The road side plants play significant role in assimilation and accumulation of pollutants and act as efficient interceptors of airborne pollutants. Studies show that under polluted conditions, plants develop different morphological, physiological and anatomical changes (Inamdar and Chaudhari 1984 , Iqbal 1985, Gupta and Ghouse 1988, Gravano et al. 2003, Novak et al. 2003, Dineva 2004). Recently, adverse effects of urban air pollution on leaf architecture of plants have been studied by various workers (Kulshreshtha et al. 1994a, 1994b, Hirano et al. 1995, Sharma and Roy 1995, Carreras et al. 1996, Aggarwal 2000, Pal et al. 2000, Kaur 2004, Dineva 2006, Rai and Kulshreshtha 2006, Sher and Hussain 2006).

Automobiles are the main source of pollution in urban atmosphere of the Rewa city. This study was undertaken to assess the changes caused by urban air pollution on number and size of stomata and epidermal cells in the leaves of a roadside tree species, *Pongamia pinnata* (L.) Merr.

II. Materials and Methods

Roadside plant species, *Pongamia pinnata* growing at four sites viz; Sirmour crossing, P.K. School, Manas Bhavan and Bypass N.H.-7 of Rewa city, and A.P.S. University campus as control site, was selected for its foliar stomata and epidermal cell traits.

Ten old leaves of different size were plucked carefully from each of at least three plants at each selected site and kept in polythene bags during January 2009 and brought to the laboratory. Phenological observations revealed that *Pongamia pinnata* shed their leaves during the mid of May, and remained leafless for a very short period of 7 to 10 days. The new foliage appeared during the last week of May. The new leaves from the plants of selected sites were collected during the mid of June 2009 in the same manner as for old leaves. The leaf samples collected from control and polluted sites were thoroughly washed with tap water followed by deiodenized water to eliminate all loose dust particles from their surface. Leaf surface characteristics were studied with light microscope. The leaf epidermal peel slides were made by the methods of lasting impressions. In this method, at least one square centimeter on leaf surface was painted by a thick patch of clear nail polish. Allowed the nail polish to dry completely then taped a piece of clear cellophane tape to the dried nail polish patch by carton sealing tape. Gently, peeled out the nail polish patch by pulling a corner of the tape and the finger nail polish along with the leaf peel. This is the leaf impression which was taped on slides and labeled as abaxial and adaxial surface etc. Leaf impression was examined under at least 400 x magnifications by light microscope. Number of stomata and epidermal cells were counted per square millimeter area. Length and width of epidermal cells and stomata guard cells of a leaf were measured in µm with ocular micrometer under high power magnifications with the help of "Stage – Ocular micrometry".

III. Results and Discussion

Observations on number, length and width of epidermal cells of *Pongamia pinnata* growing at polluted sites and control site of Rewa city are presented in table 1. Results indicated marked alteration in epidermal traits, with increased number of epidermal cells per unit area on both the surface of old and new leaves at polluted sites, as compared to control site. This increase in number was observed in the range of 19.86 to 39.87 %. New leaves showed greater increase in number of epidermal cells than those of old leaves. Both new and old leaves exhibited 5.46 to 20.07% reduction in epidermal cell length at polluted sites, except the ventral surface of new leaves where an increase in cell lengths was noticed. Leaf samples collected from polluted sites also showed reduced width of epidermal cells on both the surfaces than those of control samples, except on dorsal surface of old leaves. This reduction in cell width was observed in the range of 2.77 to 27.06 %.

Pongamia pinnata is a hypostomatal species i.e. stomata are found only on ventral surface of the leaves. Table 2 shows average number of stomata, length and width of stomata guard cells of leaf samples collected from polluted and control sites. Results revealed that both old and new leaves had increased number of stomata on their ventral surface at polluted sites. However, this increase was higher in new leaves (32.78%) than older ones (12.54%). In leaves of polluted sites the length of guard cells decreased in the range of 13.6% (old leaves) to 15.62% (new leaves). Mixed results were observed with respect to width of guard cells. Old leaves revealed increase in width of guard cells (18.75%), whereas 8.84% decrease was observed in guard cells width of new leaves. Distorted shapes of stomata were observed on ventral surface of both the leaves at polluted sites.

This study demonstrated marked alteration in foliar surface architecture of *Pongamia pinnata* due to urban air pollution in Rewa city. Increased number of stomata and epidermal cells in leaves of this plant collected from polluted sites supports the findings of other workers. Similar increase in the number of epidermal cells and stomata has been observed in *Jasminum sambac* (kulshreshtha et al. 1980), *Calotropis gigantea* (Ramanathan and Kanabiran 1989), *Azadirachta indica* and *Dalbergia sissoo* (Sharma and Roy 1995), *Azadirachta indica* and *Polyalthia longifolia* (Pal et al. 2000), *Cassia siamea* (Aggarwal 2000), and *Nyctanthese arbortristis, Quisqualis indica* and *Terminalia arjuna* (Rai and Kulshreshtha 2006). The similar results of reduction in size of stomata and epidermal cells at polluted sites as compared to that at reference site is received in studies of the foliar epidermal traits from other works (Trivedi and Singh 1990, Kulshreshtha et at. 1980,1994a, Sharma and Roy 1995, Aggarwal 2000, Kaur 2004, Dineva 2006, Rai and Kulshreshtha 2006). The significant reduction in the size of epidermal cells and stomata resulted due to inhibited cell elongation, leaf area and consequently the increase in cell frequency, as suggested by Rai and Kulshreshtha (2006). This reduction in stomata size could be considered as an adaptive response of this plant to avoid entry of harmful constituents of exhaust which can other wise cause adverse effects (Satyanarayana et al. 1990, Salgare and Thorat 1990). Distorted shapes of stomata observed in *Pongamia pinnata* populations exposed to exhaust pollution might have resulted due to lowering of pH in cytoplasm of guard cells and thus a change in turgor relations of the stomata complex (Kondo et al. 1980) and due to physiological injury within the leaf (Ashenden and Mansfield 1978).

This study illustrates that leaf surface characters, including stomata and epidermal cells, in plant species growing along road sides are considerably modified due to the stress of automobile exhaust emission with high traffic density in urban areas. These changes could be considered as indicator of environmental stress.

Acknowledgement

The authors are thankful to Prof. Ugam K. Chauhan, Head, School of Environmental Biology, A.P.S. University, Rewa (M.P) for providing laboratory facilities.

References

[1] Aggarwal, P. 2000. The effect of auto-exhaust pollution on leaf surface of *Cassia siamea* (L.), a road side tree. Acta Ecologica 22 : 101-106.

[2] Ashenden, T.W. and Mansfield, T.A. 1978. Extreme pollution sensitivity of grasses when SO_2 and NO_2 are present in atmosphere together. Nature 273: 142-143.

[3] Carreras, H.A., Canas, M.S. and Pagnate, M.L. 1996. Differences in responses to urban air pollutants by *Ligustrum lucidum* Ait. F. tricolor (Rehd.). Environmental Pollution 2: 211-218.

[4] Dineva, S. 2004. Comparative studies of the leaf morphology and structure of white ash *Fraxinus americana* L. and London plane tree *Platanus acerifolia* willd. growing in polluted area. Dendrobiology 52: 3-8.

[5] Dineva, S. 2006. Development of leaf blades of *Acer platanoides* in industrially contaminated environment. Dendrobiology 55: 25-32.

[6] Gajghate, D.G. and Hassan, M.Z. 1999. Ambient lead levels in urban areas. Bull. Environmental Contamination and Toxicology 62: 403-408.

[7] Gravano, E., Gilnlietti, V., Desotgiu, R., Bussotti, F., Grossoni, P., Gerosa, G. and Tani, C. 2003. Foliar response of an *Ailanthus altissima* clone in two sites with different levels of ozone-pollution. Environmental Pollution 121 (1): 137-146.

[8] Gupta, M.C. and Ghouse, A.K.M. 1988. Effects of coal smoke pollutants from different sources in the growth, chlorophyll content, stem anatomy and cuticular traits of *Euphorbia hirta* L. Environmental Pollution 47: 221-230.

[9] Hirano, T., Kiyota, M. and Aiga, I. 1995. Physical effects of dust on leaf physiology of cucumber and kidney bean plants. Environmental Pollution 89: 255-261.

[10] Inamdar, J.A. and Chaudhari, G.S. 1984. Effect of environmental pollutants on leaf epidermis and leaf architecture of *Peristrophe bicalyculata*. Journal of plant Anatomy and Morphology 1: 1-8.

[11] Iqbal, M.Z. 1985. Cuticular and anatomical studies of white clover leaves from clean and air-polluted areas. Pollution Research 4: 59-61.

[12] Kaur, S. 2004. Stomatal responses of lemon (*Citrus medica*) to exhaust emissions from vehicles using different types of fuel. Pollution Research 23 (3): 451-454.

[13] Kondo, N., Maruta, I. and Sugahara, K. 1980. Research report from the National Institute for Environmental Studies, Yatabe, Japan 11: 127-136.

[14] Kulshreshtha, K., Yunus, M., Dwivedi, A.K. and Ahmad, K.J. 1980. Effect of air pollution on the epidermal traits of *Jasminum sambac* Ait. New Botanist 7: 193-197.

[15] Kulshreshtha, K., Farooqui, A., Srivastava, K., Singh, S.N., Ahmad, K.J. and Behl, H.M. 1994a. Effect of diesel pollution on cuticular and epidermal features of *Lantana camara* Linn. and *Syzygium cumini* Linn. (Skeels). Journal of Environmental Science and Health 29 (2): 301-308.

[16] Kulshreshtha, K., Srivastava, K. and Ahmad, K.J. 1994b. Effect of automobile exhaust pollution on leaf surface structure of *Calotropis procera* L. and *Nerium indicum* L. Feddes Repertorium 105: 185-189.

[17] Neinhuis, C. and Barthlott, W. 1998. Seasonal changes of leaf surface contamination in beech, oak and ginkgo in relation to leaf micromorphology and wettability. New Phytologist 138: 91-98.

[18] Novak, K., Skelly, J., Schaub, M., Kraeuchi, V., Hug, C., Landlot, W. and Bleuler, P. 2003. Ozone air pollution and foliar injury on native plants of Switzerland. Environmental Pollution 125 (1): 41-52.

[19] Pal, A., Kulshreshtha, K., Ahmad, K.J. and Yunus, M. 2000. Changes in leaf surface structures of two avenue tree species caused by auto exhaust pollution. Journal of Environmental Biology 21 (1): 15-21.

[20] Powe, N.A. and Willis, K.G. 2004. Mortality and morbidity benefits of air pollution absorption attributed to woodland in Britain. Journal of Environmental Management 70: 119-128.

[21] Rai, A. and Kulshreshtha, K. 2006. Effect of particulates generated from automobile emission on some common plants. Journal of food, Agriculture and Environment 4(1): 253-259.

[22] Ramanathan, M. and Kanabiran, B. 1989. Effects of soil dust pollution on foliar epidermis of *Calotropis gigantea* (L.) R.Br. and *Ipomea carnea* Jac. (Abstract). Journal of Indian Botanical society 67: 100.

[23] Salgare, S.A. and Thorat, V.B. 1990. Effect of auto exhaust pollution at Andheri (West), Bombay on the micromorphology of some trees. Journal of Ecobiology 2(4): 267-272.

[24] Satyanarayana, G., Pushpalatha, K. and Charya, U.H.A. 1990. Dust loading and leaf morphological trait changes of plants growing in automobile polluted area. Advances in Plant Sciences 3(1): 125-130.

[25] Sharma, M. and Roy, A.N. 1995. Effect of automobile exhaust on the leaf epidermal features of *Azadirachta indica* and *Dalbergia sissoo*. Int. Journal of Mendel 12 (1-4): 18-19.

[26] Sher, Z. and Hussain, F. 2006. Effect of automobile traffic on some cultivated trees along road side in Peshawar. Pakistan Journal of Plant Science 12(1): 47-54.

[27] Street, R.A., Duckham, S.C. and Hewitt, C.N. 1996. Laboratory and field studies of biogenic volatile organic compound emission from Sitka spruce (*Picea sitchensis* Bong.) in the United kingdom. Journal of Geophysics Research Atmospheres 101: 22799-22806.

[28] Trivedi, M.L. and Singh, R.S. 1990. Effect of air pollution on epidermal structures of *Croton bonplandianum* Baill. New Botanist 17 (3-4): 225-229.

Table 1: Average number (per mm^2), Length (μm) and width (μm) of epidermal cells in leaves of *Pongamia pinnata* growing at polluted and control sites.

Epidermal cells	Nature of leaves	Leaf surface	Polluted sites	Control site	DFC (%)
Number	Old leaves	Dorsal	927.74±3.24	599.67±2.50	(+)35.36
		Ventral	950.08±3.50	761.33±3.05	(+)19.86
	New leaves	Dorsal	1112.17±3.86	761.33±2.98	(+)31.54
		Ventral	1091.58±3.78	656.33±2.85	(+)39.87
Length (μm)	Old leaves	Dorsal	35.98±0.14	40.01±0.12	(-)10.27
		Ventral	33.57±0.15	42.00±0.13	(-)20.07
	New leaves	Dorsal	32.33±0.15	34.20±0.14	(-)5.46
		Ventral	32.06±0.14	23.40±0.11	(+)26.56
Width (μm)	Old leaves	Dorsal	24.03±0.09	23.4±0.07	(+)2.62
		Ventral	21.15±0.08	29.0±0.06	(-)27.06
	New leaves	Dorsal	22.07±0.08	22.70±0.07	(-)2.77
		Ventral	20.57±0.06	23.40±0.05	(-)12.09

DFC = Difference from control

Table 2: Average number of stomata (per mm^2), Length and width of guard cells (μm) on ventral surface of leaves of *Pongamia pinnata* growing at polluted and control sites.

Stomata characteristics	Nature of leaves	Polluted sides	Control side	DFC (%)
Number	Old leaves	134.16±1.42	117.73±1.30	+12.54
	New leaves	122.49±1.20	82.33±1.08	+32.78
Length (μm)	Old leaves	20.45±0.09	23.67±0.07	-13.60
	New leaves	21.44±0.08	25.50±0.07	-15.92
Width (μm)	Old leaves	9.60±0.03	7.80±0.03	+18.75
	New leaves	8.66±0.02	9.50±0.02	-8.84

DFC = Difference from control