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Leaf cuticular features as indicators of air pollution

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Abstract:

Various cuticular features like stomatal density, stomatal index, stomatal size, and type show different responses to polluted environment compared to control environment. In the present investigation four plant species in urban area were studied. These were from relatively polluted and unpolluted area of Aurangabad. The reduction in the growth parameters, the size of epidermal cell and stomata were reduced and cuticle damage was also observed. The stomatal density and stomatal index were also noticed to be slightly less in polluted areas.

Key words: cuticle, polluted, stomata, stomatal density, stomatal index and unpolluted.

Introduction:

The impact of air pollution on plants often varies with differences in function of stomata, stomatal size, stomatal index and the extent of stomatal openings. Stomatal behavior determines the extent of absorption of pollutants by plants while the pollutants in turn influence stomatal behavior. The rate of absorption of air pollutants by the plants depends on pollutant concentration gradient from exterior to interior of leaf and on the stomatal conductance which play an important role in determining the impact of pollution on plants.

Beside this a large number of trees and shrubs have been identified and used as dust filters to check the rising urban dust pollution level. (Lorenzini *et.al.,* 2006). The dust affected plant produced lesser number of fruits as compared to the unaffected one. Unlike the inhabitation of shoot, length and area of leaflets and intermodal elongation due to pollution are observed by Indhirabai *et. al.,* (1989). s

Hill and Thomas (1933) reported that SO_2 decreased the yield of alfalfa. Chamberlain (1934) observed that dirt, smoke and the gases of large city were fatal to conifers.

Solberg and Adams (1956) reported that, fluoride and SO_2 destroyed the spongy mesophyll and the lower epidermis of plants.

It is quite evident from the various investigations that, possibility of utilizing leaf cuticular and morphological features as indicators of environmental pollution.

Materials and Methods:

For stomatal studies the technique followed was as described by Ahmad (1972). The cuticle was either peeled or scraped off with a safety blade from the upper and lower epidermis. The cuticle was separated by macerating the foliar material with 10-30% of slightly warmed nitric acid, the cuticle was separated, thoroughly washed with water, neutralized with dilute ammonium hydroxide, again washed with water, stained with 1% aq. safranin and mounted with glycerin and then the numbers of stomata were counted in the given field (1um). These slides were used to study cuticular features such as stomatal density, stomatal index, stomatal size etc. Floral productivity and leaf size were also studied in the plants of relatively unpolluted and polluted habitats. The experimental details are summarized as below:

1) **Stomatal size-** Length and breadth of stomata was calculated from the peeled leaf surface of both upper and lower surface of the leaf.

2) **Stomatal ratio**- The length was divided by the breadth of both upper and lower epidermis.

3) **Area of stomata**- It was calculated by multiplying length and breadth.

4) **Stomatal index (S.I.) -** Number of stomata and epidermal cell were counted in the peelings and S.I. calculated by the formula of Salisbury (1927)

S.I. = S/E+S X 100

Where, S=Number of stomata, E=Number of epidermal cells.

Results:

Stomatal density calculated in *Azadirachta indica* was 16.11 at control site while at polluted site it was 13.33. In *Mangifera indica* it was 6.11 at control site, while at polluted site it was 5.00. In *Polyalthia longifolia* it was 6.94 at control site, while at polluted site it was 5.55, and in *Dalbergia sissoo* it was 5.00 at control site and 4.16 at polluted site.

Stomatal index calculated in *Azadirachta indica* at control site was 14.28, while at polluted site it was 14.11. In *Mangifera indica* it was 20.00 at control site, while at polluted site it was 16.07, and in *Polyalthia longifolia* and *Dalbergia sissoo* it was 16.16, 20.00 at control site and 12.05 and 18.75 at polluted sites respectively.

Discussion:

Polluted environmental conditions had adverse effect on the growth of plant, reduction in biomass and the rate of photosynthesis in plant. In some leaves of plant species stomatal conductnce was significantly reduced at the polluted site confirming to some reports (Field *et.al*., 1995, Kull. *et.al*., 1996) and can cause low photosynthetic rate (Farage.*et.al.,* 1991). Chlorophyll 'b' was more severely affected than chlorophyll 'a' as noticed earlier in various woody and nonwoody plants (Joshi.*et.al.,*1993) SO_2 (Esmat, 1993 Ali, 1998) and O3 (Khan and Khan,1994) inhibit chlorophyll biosynthesis. stomatal index of

both epidermal layers increased with plant age at the unpolluted site. Length and width of stomata on both epidermis of leaf were significantly reduced in polluted environment.

The dust loading on leaves may reduce plant growth (Bender *et.al*., 2002).Through its effect on leaf gas exchange (Ernst, 1982) occlude stomata (Hirano *et.al.*, 1995), reduce photosynthetically active radiations and increase the leaf temperature (Naidoo and Chirkoot, 2004). The particles enter the leaf through stomatal openings and their toxicity may disturb the physiological activity of plats (Farmer, 1993). The inhibition implant growth, rate of photosynthesis, late flowering and the total hormonal imbalance may be due to the efficiency of nutrients in the polluted plants. (Farooqui *et.al*., 1995). It has been reported earlier that under stress conditions plants produce more wax than control. (Hollenbach et.al., 1997)

The structure and morphology of epicuticular waxes is a reliable indicator of plant health (Neinhuis and Barthlott, 1988) and to a great extent regulate the resistance to pollution stress. Sauter and Pambor (1989) observed increased degradation of epicuticular wax in spruce and fir due to deposition of road dust. In the dust treated plants characteristic wrinkles appeared and sinuous nature of epidermal cells and distinct cell boundaries were completely lost on the cuticle.

Conclusion:

Present research shows that air pollution inhibits plant growth, Stomatal density and stomatal index decreased in polluted areas. Therefore it is concluded that, these features can be used as indicators of air pollution in city area. It is suggested that such patterns in the plants of polluted areas can be significant in determining the degree of pollution and preventive measures can be taken to reduce the level of air pollution in the polluted area.

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Table-1: Table showing values of stomatal density at control and polluted sites.

Tree species	Stomatal density(mm^2)	
	University area (Control zone)	Chikalthana MIDC (Polluted zone)
Azadirachta indica	16.11	13.33
Mangifera indica	6.11	5.00
Polyalthia longifolia	6.94	5.55
Dalbergia sissoo	5.00	4.16

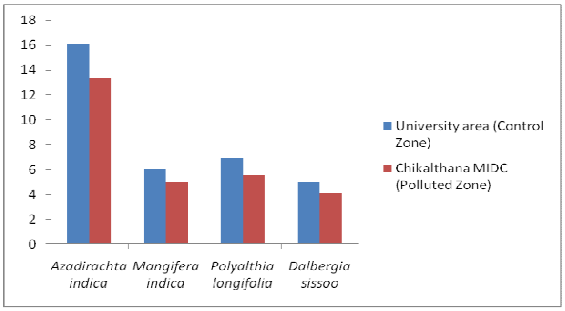

Fig-1: Graph showing values of stomatal density at control and polluted sites.

Table-2: Table showing values of stomatal index at control and polluted sites.

Tree species	Stomatal index	
	University area (Control zone)	Chikalthana MIDC (Polluted zone)
Azadirachta indica	14.28	14.11
Mangifera indica	20.00	16.07
Polyalthia longifolia	16.66	12.05
Dalbergia sissoo	20.00	18.75

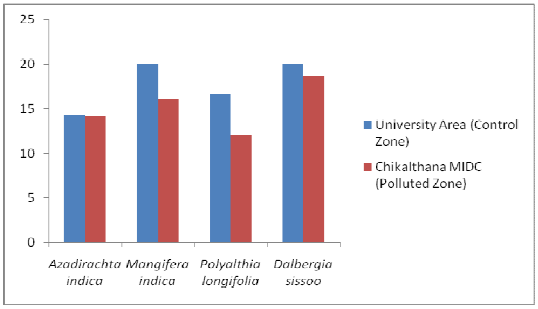

Fig-2: Graph showing values of stomatal index at control and polluted sites.