Effect of air pollutants on leaves of pigeon pea, a pulse crop of Fabaceae growing in the vicinity of a silicon industry

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Abstract: In urban areas, the crops are undergoing to a serious environmental stress causing by the air pollutants. Leaf is an absorptive part for pollutants. The physical and anatomical characteristics of leaves such as leaf size, leaflet size, size of epidermal cells, number of trichomes, stomata number, size, density, frequency and index are directly influenced by the air pollutants since the stomata and surface contact are the gateways for entry of pollutants into the mesophyll cells. Thus, the study is aimed on leaf characters of pigeon pea (*Cajanus cajan*), a pulse yielding crop of Andhra Pradesh, India growing in the vicinity of a silicon industry and compared with the leaf characters of the species growing at a nearby village. The study revealed slight decrease in size of leaf and leaflet, trichomes frequency, size of the epidermal cells, height of the palisade parenchyma, diameter of the spongy parenchyma, size of stomata in upper epidermis, density of stomata in lower epidermis, stomata frequency in upper epidermis and stomatal index on both sides. But the modifications continued till the maturity of plant and have shown resistance to industrial pollutants.

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Key words: Urban area, industrial pollutants, pulse crop, leaf size, leaflet size, trichomes, stomata, palisade parenchyma, spongy parenchyma

INTRODUCTION:

Crop plants are undergoing to a serious environmental stress by airpollution due to increasing industrialization and urbanization during last few decades. Airborne particulate matter is causing a serious problem to Indian cities. Plants are generally more affected than animals by air pollution, as they constantly take up atmospheric gasses. Of all plant parts, the leaf is the most sensitive part to the air pollutants and several other such external factors. Plants provide an enormous leaf area for impingement, absorption and accumulation of air pollutants (Chauhan and Joshi, 2010). The uptake of pollutants depends on the physical structure of leaves. Epidermal characteristics and air movement across the leaf restricts the initial flux of gasses to the surface. Cuticle wax and leaf hairs are the major areas of impact. Stomata, the absorptive sites of pollutants are directly related to their toxic effects. Stomata number, size, density and frequency indicate the resistance of a leaf to the pollutants. There are several studies concerning the anatomy of vegetative organs under conditions of pollution (Alves et al., 2008; Ahmad et al., 2005; Silva et al., 2005; 2006; Verma et al., 2006; Gostin, I.N.,2009). These studies have shown that under the action of pollutants, plants develop different morphological and anatomic is aimed on leaf anatomical characters of pigeon pea, an important pulse yielding crop of Andhra Pradesh, India. Leaf samples from plants growing in the vicinity of an industry are compared with another sample of leaves collected from plants growing at a nearby village.

Materials and Methods:

Study area:

The present study is conducted in district Kurnool of Andhra Pradesh state in India, which is situated between eastern latitudes of 76 °58’ to 78° 56’and northern latitudes of 14 ° 54’ to 16 ° 14’ latitude. Autumn, winter, spring and summer are the four distinct seasons. The climate of the area is relatively temperate with an average rainfall of about 878 m.m. which is chiefly confined to monsoon months. Temperatures are ranging from 25℃ to 40 ℃.

Study Sites:

Two sites are selected for the study. Site - 1 is in urban area very closer to silicon industry, which releases black suit and smoke into the surroundings.

Site – 2 is nearby to a village nearly 70km. from site-1 where there is no traffic and industries.

Table - 1 showing the size of leaf and a leaflet; thickness of leaflet and Trichomes frequency

S.No.	Size of the leaflet (cms.)	Thickness of the leaflet (mms.)	Size of the leaf (cms.)	Trichomes frequency	
				Upper side	Lower side
1. Leaf collected from polluted field	9.0	3.0	13	23.9	35.3
2. Leaf collected from unpolluted field	9.6	3.0	14.6	26.1	39.9

Table-2 showing the size of epidermal cell, Height of the palisade parenchyma, Diameter of the spongy parenchyma

S.No.	Average size of the epidermal cell (mm.)	Average height of the palisade parenchyma (mm.)	Average diameter of the spongy parenchyma(mm.)
1.Leaf collected from polluted field	29.4	3.7	18.1
2.Leaf collected from unpolluted field	33.6	4.9	18.9

Table-3 showing the size, density, frequency and index of stomata

S.No.	Stomata size (length&width)		Stomata density		Stomata frequency		Stomata index	
	Upper side	Lower side	Upper side	Lower side	Upper side	Lower side	Upper side	Lower side
1.Leaf collected from polluted field	3.2x2.6	4.1x3.9	1.8	3.7	19.987	88.199	0.20	0.22
2. Leaf collected from unpolluted field	3.6x3.1	3.8x3.7	1.4	4.4	39.294	84.451	0.25	0.25

Plant sampling and analysis:

The studies are conducted on pigeon pea (*Cajanus cajan*, (L.)) crop growing under field conditions. For each site, 5 plants are collected. Four leaves from the central part of each plant are collected. Size of the leaf, size and thickness of leaflet are measured. Free hand sections are performed using a razor blade for anatomical analysis. The measurements of the epidermal cells, assimilating parenchyma and Stomata length and width are made by using a graphical scale fixed to the glass of microscope. One section is investigated from each leaf; for each parameter 50 measurements are made. Stomata number/cm., stomata density/cm., stomata frequency/cm. and stomata index for both surfaces are measured. Leaf hairs/cm. are also counted.

Results and Discussion:

In pigeon pea plants growing in the vicinity of a silicon industry, size of the leaf and leaflet is slightly decreased, but not the thickness of leaflet. Frequency of trichomes both in upper and lower epidermis is also slightly decreased (Table-1). Average size of the epidermal cell, height of the palisade parenchyma, diameter of the spongy parenchyma are also decreased (Table-2). Stomata length and width in upper epidermis is decreased, whereas in lower epidermis it is slightly increased. Stomata density is slightly increased in upper epidermis and decreased in lower epidermis. Stomata frequency is considerably decreased in upper epidermis, whereas in lower epidermis it is slightly increased. Stomata index is

decreased both in upper and lower epidermis layers (Table-3).

The relatively high concentrations of pollutants present around the crop field are uptake through the stomata, the principle route for their entry into the mesophyll cells. This pollution stress slightly altered the size and structure of leaflet. This crop is resistant to air pollutant actions and the modifications continued to grow and reach maturity. Various authors underlined the reduction of plant growth, as a consequence of pollution stress (Gupta and Iqba, 2005; Maruthi Sridhar et al., 2005, 2007; Gostin, 2009).

Modification of the frequency and sizes of stomata as a response to the environmental stress is an important manner of controlling the absorption of pollutants by plants (Gostin, 2009). Verma et al. (2006) find a significant decrease of stomatal density and frequency in *Ipomea pes-tigridis* grown under various degrees of environmental stresses. Gostin (2009) reported the decrease in stomatal size in *Lotus corniculatus, Trifolium montanum, T.pratense, and T.repens.*

Gaseous pollutants entering into the leaves via stomata may strongly interact with the surface of mesophyll cells. Leaf anatomy also showed reduction in epidermis, palisade parenchyma and spongy parenchyma cells in polluted leaves as compared to leaves collected from non-polluted plants. This study shown a significant decrease in sizes of epidermal cell and palisade parenchyma whereas the spongy parenchyma shown slight decrease in size. Thus, the structural characteristics indicated a significant potential for resistance to air pollutants released from a silicon industry, this crop may be recommended to the farmers of urban area, after a long investigation for their economic growth.

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