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STUDIES ON EFFECT OF THERMAL POLLUTION ON SOME PLANTS OF KORADI AND KHAPERKHEDA

Piyushkumar R. Sharma and Punita S. Tiwari
Department of botany, Shivaji Science College, Nagpur.
Corresponding author Email address: punitatiwari9@gmail.com

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ABSTRACT:

Increasing industrialization and anthropogenic activities is the main agent of pollutant discharge into the environment and introduce various harmful substances into the atmosphere. It is difficult to estimate the effects of air pollutants because the organisms are exposed to a wide range of uncontrolled variables (parasites, weather conditions, complex mixture of pollutants). On the morphological, anatomical and physiological point of view, the plants from polluted sites present important changes especially regarding their colors, shapes, leaf length, width, stomatal and trichome frequency and chlorophyll content. However, despite of these changes, plants were survived well at the polluted environment of Koradi and Khaperkheda. These results showed the importance of morphological data for precocious diagnosis injury and to determine the sensitivity of different plant species to the action of air pollutants. After this study, we can consider that there is still a serious lack of knowledge of the impact of air quality on vegetation in the industrial urban areas. Overall, the study reveals that all the plant species growing in the polluted environment of the thermal power plant are badly affected by emission. There is a need to set limits on how much of a pollutant is allowed in the air.

Key words: - *Nerium indicum, Cassia siamea, Lantana camara, Thevetia nerifolia, Barleria prionitis, Tephrosia purpurea, Cleome viscosa, Gossypium herbaceum, Zizypus nummularia, Ficus hispida*

INTRODUCTION:

Increasing industrialization and anthropogenic activities is the main agent of pollutant discharge into the environment and introduce various harmful substances into the atmosphere. Many industrial sites and heavy traffic is responsible for production of heavy metals and other toxic compounds that may cause harmful health effects in human or animals and ultimately affect plant life and impact the global environment. There is no mechanical or chemical device, which can completely check the emission of pollutants at the source. Once the pollutants are released to the atmosphere, only the plants are the hope, which can mop up the pollutants by adsorbing and metabolizing them from the atmosphere. Therefore, the plants, role in the air pollution abatement have been increasingly recognized in recent years. Plants act as a air purifiers to minimize pollutant present in the air by developing characteristic responses and symptoms. Thermal pollution is one of the burning and serious environmental problems in big cities of India. As the society develops it lead to more air pollution which is a global problem. Photosynthesis process affected by air pollution and gets inactivated because pollutants had accumulated on surface of leaf and then absorbed on the surface of leaf. Therefore the plants can be called as bio indicators of air pollution. Leaves are sensitive parts of plant to because of abundance of stomata on surface, from which pollutants penetrate into the sensitive tissues of leaves. During summer, excessive chlorophyll produces while in winter chlorophyll production become slow and then stops Chlorophyll absorbs light energy and transfers it to the photosynthetic apparatus chloroplast. Plants play an essential role to clean the pollution in environment. The study describes the choice of eco–friendly plant species and their right placement in the urban environment to overcome the pollution problems. Trees are known as the largest and the most efficient carbon and pollution sinks. Air pollution which actually covers lots of different types of problems they are, health problem, acid rain, domestic and industrial smoke, smog, greenhouse effect, particulates, radionuclide's and ozone layer depletion **(Ahmad et al., 2012).**

I. STUDY AREA

1. KORADI: Koradi Thermal Power Station (KTPS) is located at Koradi near Nagpur, Maharashtra. The power plant is one of the four most important

power plants in Vidarbha and the power surplus region of India. The power station started its operations in 1974. It is one of the nine active power stations under Maharashtra State Power Generation Company Limited (MAHAGENCO), a subsidiary of Government of Maharashtra owned Maharashtra State Electricity Board (MSEB). The plant operates in 8 units . It has a total power generation capacity of 1700 MW. It is located on the northern side of Nagpur and is covers an area of 30,337 km2.

2. KHAPARKHEDA: Kaparkheda Thermal Power Station is located in Nagpur district in the Indian state of Maharashtra. The power plant is coal based power plants of MAHAGENCO. The coal for the power plant is sourced from Saoner and DumriKhurd mines of Western Coalfields Limited (WCL). Source of water for the power plant is from Pench reservoir through a pond of Koradi Thermal Power Station (KTPS) (Wikipedia).

The following plants were chosen for the current study. Collected plants were bought to laboratory for the study. They were identified by using standard Floras (Ugemuge 1986, Flora of Nagpur District; Singh and Kartikeyan 2000, Flora of Maharashtra State).

NO.	PLANT SPECIES	FAMILY	COMMON NAME
1	*Nerium indicum Linn.*	Apocynaceae	Kaner
2	*Cassia siamea Linn.*	Caesalpiniaceae	Kasood
3	*Lantana camara Linn.*	Verbenaceae	Ghaneri, Raimoni
4	*Thevetia nerifolia Linn.*	Apocynaceae	Pili Kaner
5	*Barleria prionitis Linn.*	Acanthaceae	Kati-Korati
6	*Tephrosia purpurea Linn.*	Papilionaceae	Sharpunkha , Jangli neel
7	*Cleome viscosa Linn.*	Capparidaceae	Pivli Tilvan
8	*Gossypium herbaceum Linn.*	Malvaceae	Cotton, Kapas
9	*Zizypus nummularia*	Rhamnaceae	Ber
10	*Ficus hispida Linn.*	Moraceae	Kat Umbar

Table: 1. List Of Taxa Studied For The Present Investigation

MATERIAL AND METHODS :-

At present this locality shows rare occurrence of fossils specimens. A number of cellulose acetate peal sections were prepared along its transverse, radial longitudinal and tangential longitudinal facets after etching it with hydrofluoric acid.

A. **Morphological study:** The plants were collected from polluted and unpolluted area, were bought to laboratory and the following morphological parameters were recorded and analyzed;

⇒ Structure of stem
⇒ Length, breadth and colour of leaf
⇒ Internodal distance
⇒ Weight of leaf with dust and without ash
⇒ Structure of trichomes

B. Quantitative characters

1. Size of stem: the size of stem was observed with comparing the plants that grow in polluted and unpolluted region.
2. Leaf size: the length and breadth of leaf was calculated by taking a 5 mature leaves from the plant and their length and breadth were calculated and the mean value was recorded.
3. Length of internodes: the length of internodes of the plant was calculated at different regions from the 3rd node in each branch.
4. Weight of leaf: the weight of five to six leaves were measured and mean values was recorded. The leaves were washed, dried and again weighted to record the amount of ash deposited on them.

C. Estimation of chlorophyll pigment: Chlorophylls are the essential components for photosynthesis. They occur in chloroplasts as green pigments in all photosynthetic plant tissues. They are loosely bound to proteins but are readily extracted in organic solvents such as ether or acetone. Leaves were grind to make fine pulp and the addition of 20 ml. of 80% acetone. Centrifuged (5000 rpm) for five minutes. Transferred supernatant to a 100 ml. volumetric flask with 80% acetone. The absorbance of the solution was taken at 645, 663 and 652 nm against the solvent (80% acetone) blank (Schwartz and Von Elbe, 1994).Calculation: It is done as described below;

(1) mg chlorophyll - a/g. = 12.7(A663) - 2.69(A615) × 1 V/1000×W
(2) mg chlorophyll - b/g = 22.9 (A645 - 4.68(A663) ×V/1000×W
(3) mg of total chlorophyll g/tissue = 20.2(A645) + 8.02 (A663) ×V/1000×W

Where, A =Absorbance at specific=Final volume of chlorophyll extract in80% acetone,
W =Fresh weight of tissue extracted

D. Anatomical studies:

Air pollutants enter the plant systems through direct and indirect pathways. The outermost area of a leaf are covered by a layer of epidermal cells which help in moisture retention. Between the epidermal layers are the mesophyll cells which comprise the spongy and palisade parenchyma. The leaf has a vascular bundle which are used to carries water, minerals and carbohydrate in the plant. The Stomata of leaves are controlled by guard cells which can open and close and hence change air spaces in the interior of leaves. Particulate matter enters into leaves through stomata by diffusing into and out of leaves, more also Particulate matter transferred from the atmosphere may be deposited on plant parts and exert some physical or chemical effects which may leads to physiological and anatomical abnormalities in plant. The effects off particulate matter deposited on plant are more likely to be associated with their chemistry than simply with the mass of deposited particles. Effects of particulate matter on plant which also includes reduction in growth, yield, flowering as a result of the changes in physiology and the anatomy of the plant. The deposition of air pollutants on soils and plants can cause alteration of the nutrient content of the soil in the vicinity of the plant, which ultimately changes the soil conditions and hence leads to an indirect effect of air pollutants on vegetation and plants, extensive tissue collapse or necrosis resulting from injury to the spongy or palisade cells in the interior of the leaves. To carry out the anatomical investigations, fresh stems and leaves of the plants were selected. Transverse sections were obtained from the different plant parts used. All the sections were obtained by free hand sectioning. Sections were deposited in watch glasses containing 1% safranin for one minute. The stained sections were dehydrated through alcohol series and mounted on clean slides in DPX or Canada balsam. Photomicrographs of the anatomical sections were taken.

E. Stomatal index :

Stomatal index is the percentage, which the numbers of stomata form to the total number of epidermal cells, each stoma being counted as one cell. Stomatal index is calculated by using the following equation,

$$SI = \frac{S}{E + S} X\ 10$$

Where, SI = Stomatal index,
S = Number of stomata per unit area,
I = Number of epidermal cells in the same unit area (Salisbury, 1927).

RESULTS AND DISCUSSION

Thermal pollution is one of the burning and serious environmental problems in big cities of India. As the society develops it lead to more air pollution which is a global problem. Some natural and human activities introduce gases and particulate which contaminate air as a result of which causes air pollution. The tremendous increase in mobilization of human society has resulted in phenomenal rise in industrial pollution. The industries discharge an appreciable amount of exhaust emission which consists of poisonous gases like carbon monoxide, sulphur-di-oxide, oxides of nitrogen etc. 75% of the air pollution takes place through exhaust gases from automobiles (Bhora and Kumar, 2004). The emissions from the industries cause adverse effects on plants, animals, soil and other environmental constituents. The present study deals with the effect of air pollution in particulars, the vehicular pollution on plants.

In this present study one of the highly polluted industrial areas in Koradi and Khaperkheda were selected. These areas consists of ash dumping ground where the ash collected from this industries was disposed off and further the area around 1km of the power plants where the ash deposition is maximum seen. Plants respond quickly to low concentrations of air pollutants. therefore, plants are considered to be more sensitive to air borne pollutants than the animals and humans as they are constantly exposed to air borne pollutants. Among various plant organs, leaves by virtue of their location, distribution and structure are the main recipients of pollutants and a number of

studies have proved that most obvious effects of air pollution are expressed by foliage than any other part of the plant. Being, the outermost layer, the epidermis is relatively more prone to hazards of air pollutants than another tissue. The significance of stomata in protecting plants against air pollutants has been studied by Mansfield and Majernik (1970), who provided experimental evidence suggesting that stomatal closure helped to protect plants against pollution damage.In the present study 10 plants species belonging to 9 families were selected and their morphological, anatomical and physiological characters were studied. Several studies have been carried out on the micro-morphological effects of air pollutants on plants. These studies have unearthed several interesting findings on the effects of air pollution on plants. These effects include:

Morphological features: The morphological features were varying greatly in polluted plants as compared to unpolluted plants. The shape, size, weight, colour of leaf, structure of stem, internodal distance varies greatly in polluted plants. The maximum changes in morphological feature was found in Cleome viscosa where the intermodal distance was much reduced due to internodal suppression. Further in Barleria prionitis the internodal distance was large as compared to normal plant. Leaves shows large amount of ash deposition which blocks the stomatal aperture of plants. There was not much difference in other characters of plants. (table:4)

Anatomical features: The stems of pollution affected plants have shown less amount of xylem with narrow vessels but with more of selerenchyma fibers. The collenchymas in Cleome viscose stem appears to be broader in pollution affected plants. It shows clearly, the tendency to develop more mechanical tissues over xylem in plants growing in polluted sites over the plants of non-polluted sites. Another significant alternation is the reduction in size of the cortical and pith cells similar to petiole in those stem from plants of polluted sites (Fig E). Interestingly the pith and cortical cells of Cleome viscosa and Lantana camara show deposition of ash particles in pollution affected plants (FigD). The leaf anatomy shows many differences in the structure of palisade and spongy tissues. The palisade and spongy tissues in Cleome viscosa ,Teprosia purpurea, Lantana camara, Barleria prionitis And Cassia siamea were more developed but deformed as compared to normal plants. The epidermal cells of Cleome viscosa, Tephrosia purpurea, Lantana camara, Barleria prionitis and Cassia siamea shows deposition of ash particles in polluted plants. From the results in the present study, there is clear that air pollutants from the industry exercised a definite effect on plant anatomy. It is also apparent that the vascular bundles are more affected than other tissues. In other words, the vascular bundles are more sensitive to pollutants. The different tissues of the same plant differ in their response to the same pollutants in a given concentration.

Physiological features: The chlorophyll content of a plant is depending on the total area of plant which is a growth measuring parameter of plant. The chlorophyll and phenol are important metabolites of plant. Fly ash nourished soil provides nutrients to different parts of the plants and the metabolism progresses in proper way and the metabolites concentration getting appropriate. Fly ash contains several nutrients including S, B, Ca, Mg, Fe, Cu, Zn, Mn, and P, which are beneficial for plant growth. The soil nourishing effect of fly ash is because of higher pH could be due to the presence of Ca, Na, Mg and OH- and calcium oxide, a major constituent of fly- ash and forms calcium hydroxide with water and thus contributes to higher pH (Devarajan et al., 1994). The chlorophyll content was increased in polluted plants as compared to unpolluted plants. In plants Cleome viscosa ,Teprosia purpurea , Lantana camara, Barleria prionitis And Cassia siamea the chlorophyll content was very high as compared to unpolluted plants(gGraph:3).The frequency of stomata was more in polluted plants like Gossypium herbaceum, Teprosia purpurea, Cleome viscose and Thevetia nerifolia as compared to unpolluted plants. Similarly, the frequency of trichomes was more in polluted plants as compared to unpolluted plants. The higher chlorophyll in fly ash containing soil is due to the presence of high N, K and Mg which are present in fly ash resulting in higher content of chlorophyll a (Rai et al., 2002). The higher content of chlorophyll b in fly sh effected plants due to higher P content in fly ash present in soil (Canjura et al., 1991).Fly ash is resources and not wastes. The Major characteristics that make the suitability as a bio- fertilizer because it is a mix of macronutrients such as nitrate, phosphate and potassium and micronutrients such as Mg, S, Bo, Fe, Mn and Zn come from the fly ash.Therefore, plants quickly respond to air pollutants and this is brought out by the modifications of various traits in them. Hence they can be used as the biological

indicators of air pollution. The present study on ten species on plants clearly establishes that the experimental sites chosen in this study is highly polluted.

CONCLUSIONS

It is difficult to estimate the effects of air pollutants because the organisms are exposed to a wide range of uncontrolled variables (parasites, weather conditions, complex mixture of pollutants). On the morphological, anatomical and physiological point of view, the plants from polluted sites present important changes especially regarding their colors, shapes, leaf length, width, stomatal and trichome frequency and chlorophyll content. However, despite of these changes, plants were survived well at the polluted environment of Koradi and Khaperkheda. These results showed the importance of morphological data for precocious diagnosis injury and to determine the sensitivity of different plant species to the action of air pollutants. After this study, we can consider that there is still a serious lack of knowledge of the impact of air quality on vegetation in the industrial urban areas. Overall, the study reveals that all the plant species growing in the polluted environment of the thermal power plant are badly affected by emission. There is a need to set limits on how much of a pollutant is allowed in the air. The exchange of experience and information from the developed countries on this aspect of pollution impact on plants might be useful. Our goal must be to have clean air for flora and fauna. We should take necessary steps to get rid of the ever increasing pollution.

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Sr.No.	PLANT SPECIES	Polluted site		Unpolluted site	
		With ash	Without ash	With ash	Without ash
1	*Nerium indicum Linn.*	1.094g	0.801g	0.998g	0.924g
2	*Cassia siamea Linn.*	0.15g	0.13g	0.25g	0.25g
3	*Lantana camara Linn.*	0.572g	0.560g	0.472g	0.471g
4	*Thevetia nerifolia Linn.*	0.228g	0.190g	0.159g	0.159g
5	*Barleria prionitis Linn.*	0.098g	0.093g	0.087g	0.086g
6	*Tephrosia purpurea Linn.*	0.056g	0.048g	0.061g	0.061g
7	*Cleome viscosa Linn.*	0.022g	0.016g	0.065g	0.065g
8	*Gossypium herbaceum Linn.*	0.786g	0.782g	0.862g	0.862g
9	*Zizypus nummularia Linn.*	0.368g	0.345g	0.445g	0.445g
10	*Ficus hispida Linn.*	6.06g	4.201g	5.25g	5.25g

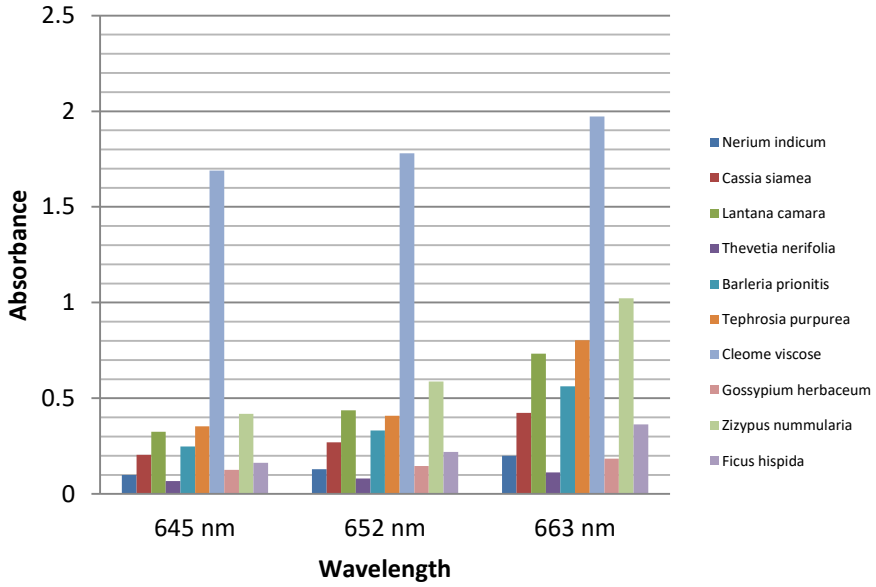
Table: 2. Weight of Leaf

Sr.No.	PLANT SPECIES	Colour of leaf		Shape of leaf	
		polluted	unpolluted	polluted	unpolluted
1	*Nerium indicum* Linn.	Green	Dark green	Lanceolate	Lanceolate
2	*Cassia siamea* Linn.	Light green	Dark green	Elliptical	Elliptical
3	*Lantana camara* Linn.	Yellowish green	Green	Ovate deformed	Ovate
4	*Thevetia nerifolia* Linn.	Pale green	Dark green	Lanceolate	Lanceolate
5	*Barleria prionitis* Linn.	Light green	Dark green	Deformed	Elliptical lanceolate
6	*Tephrosia purpurea* Linn.	Whitish green	Dark green	Elliptical deformed	Palmately compound
7	*Cleome viscosa* Linn.	Dark green	Light green	Deformed	Palmately compound
8	*Gossypium herbaceum* Linn.	Green	Green	Deformed	
9	*Zizypus nummularia* Linn.	Green	Dark green	Obovate	obovate
10	*Ficus hispida* Linn.	Light green	Green	Elliptical	Elliptical

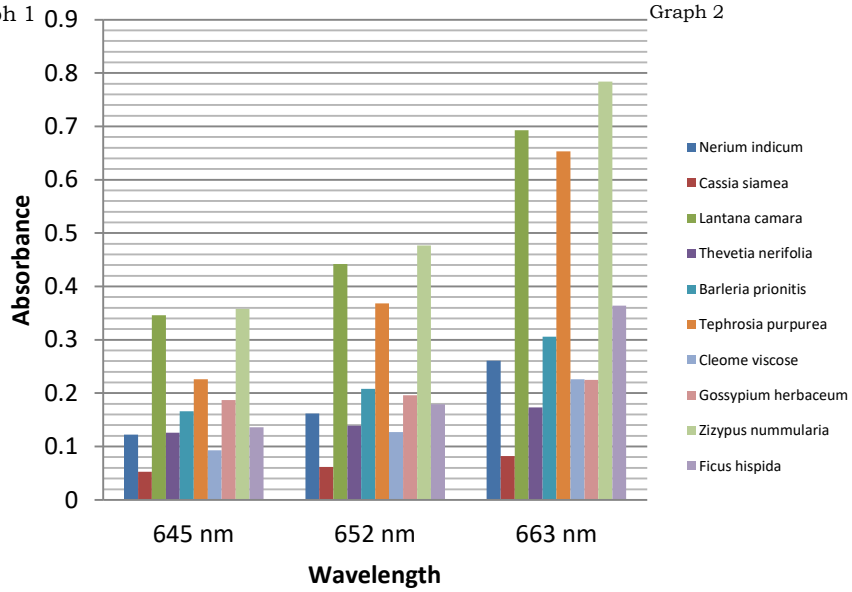
Table: 3. Colour And Shape Of Leaf

Sr.No.	PLANT SPECIES	Size of leaf (l x b cm)		Internodal distance (in cm)	
		polluted	unpolluted	polluted	unpolluted
1	*Nerium indicum* Linn.	8 x 4 cm	13 x 4 cm	3 cm	5 cm
2	*Cassia siamea* Linn.	8 x 3 cm	6.8 x 3 cm	8 cm	12 cm
3	*Lantana camara* Linn.	9 x 4 cm	7 x 3.6 cm	9 cm	7 cm
4	*Thevetia nerifolia* Linn.	7.4 x 3 cm	8 x 6.2 cm	7 cm	6.5 cm
5	*Barleria prionitis* Linn.	3 x 3 cm	5.2 x 4 cm	16.8 cm	8.5 cm
6	*Tephrosia purpurea* Linn.	2 x 1.6 cm	1.3 x 4 cm	4 cm	3.02 cm
7	*Cleome viscosa* Linn.	2 x 1 cm	5 x 3.8 cm	2 cm	4.4 cm
8	*Gossypium herbaceum* Linn.	6.8 x 9 cm	7.65 x 12 cm	4.2 cm	7 cm
9	*Zizypus nummularia* Linn.	7 x 4 cm	5 x 12.8 cm	4 cm	6.5 cm
10	*Ficus hispida* Linn.	35.2 x 10 cm	28 x17.2 cm	5 cm	9 cm

Table: 4. Size And Internodal Distance Of Leaf

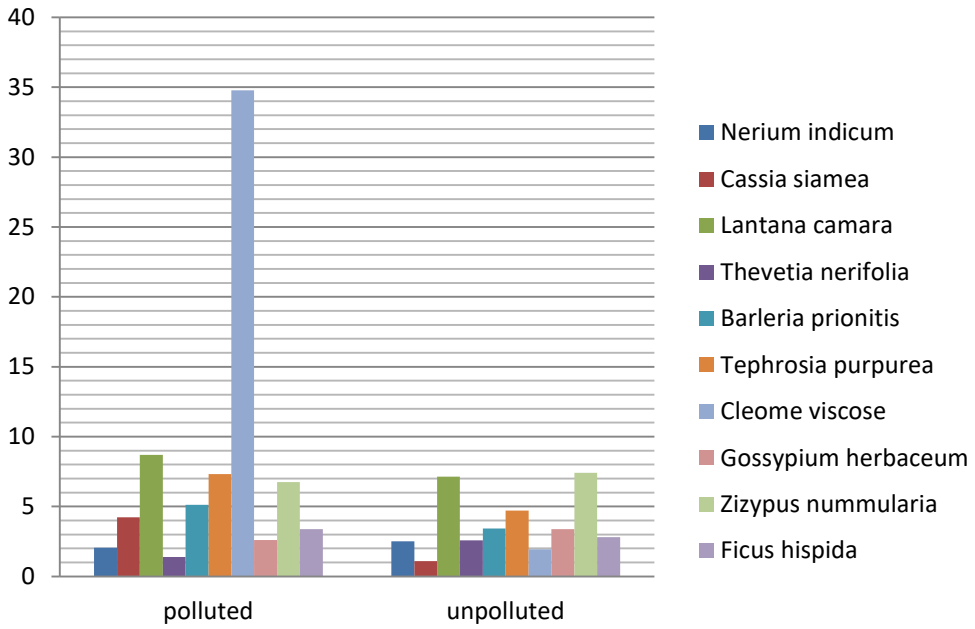


Graph 1



Graph 2

Graph 1: Chlorophyll Content Of Polluted Plants
Graph 2: Chlorophyll Content Of Unpolluted Plants



Graph 3: Total Chlorophyll Content Of Plants

Fig A : Changes In Morphological Characters (Cleome viscosa)

Fig B : Deposition Of Flying Ash On Leaf Surface Of Ficus hispida

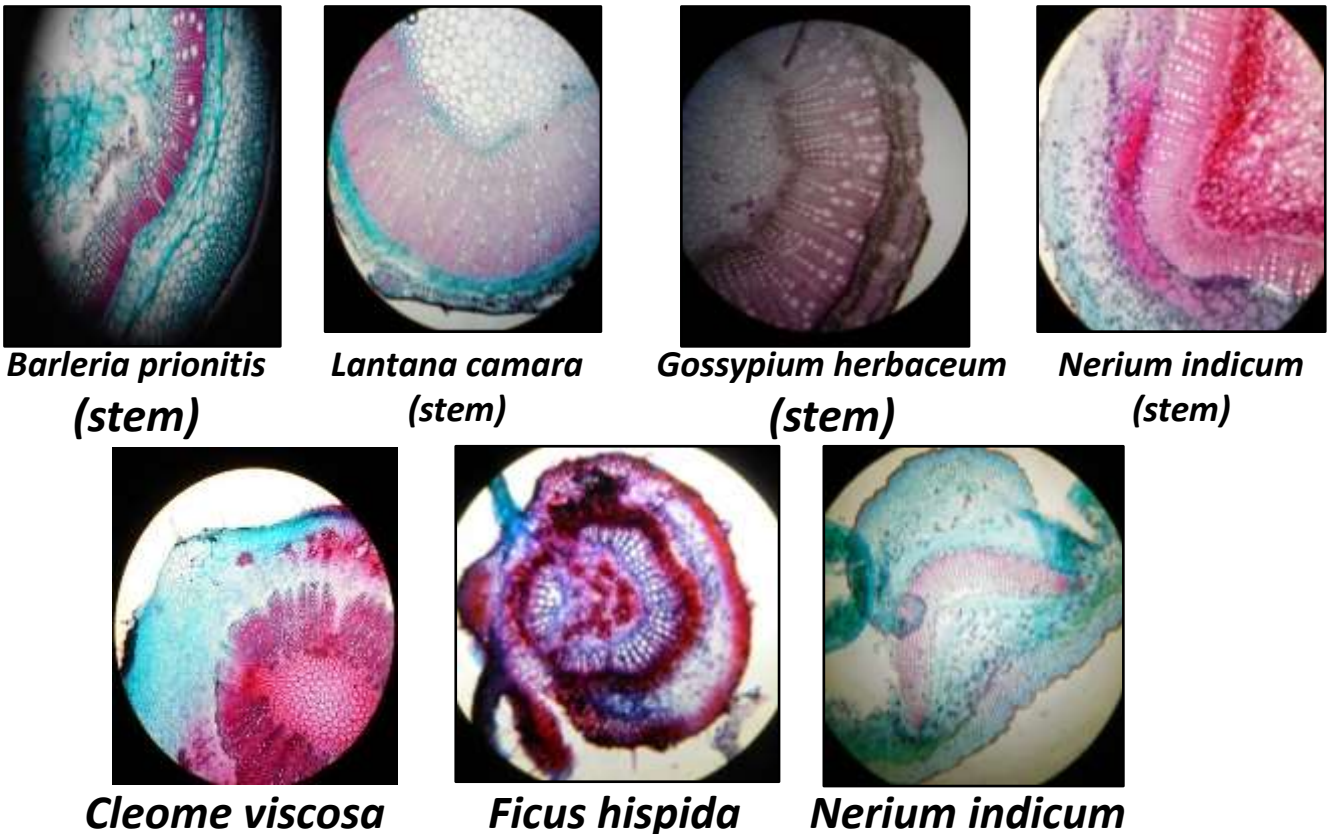


Fig C : anatomical studies of plants (polluted)

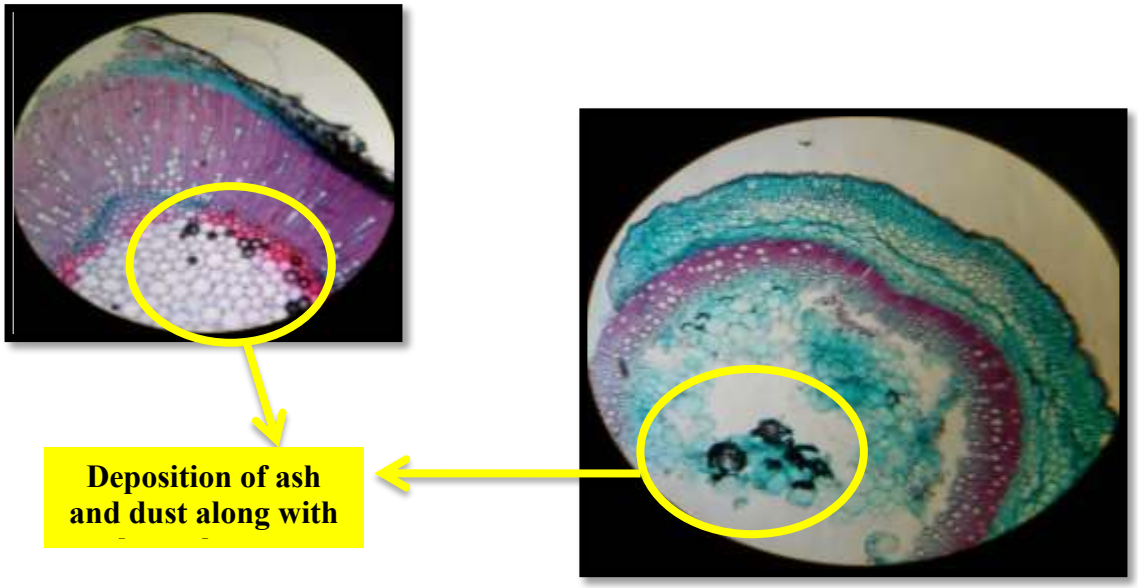


Fig D: anatomical studies of plants with deposition of flying ash particles