J. Phytol. Res. **14** (2) : 147-150, 2001

INFLUENCE OF PHYTOTOXICITY OF WATER POLLUTANTS ON WILD PLANTS

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Pollution is a world wide problem. The present investigation pertains to the effect of polluted water on the epidermal characterstics of wild flora of Meerut. Leaf samples of plants growing under polluted sites of 'Abu ka Nala' were collected and analysed for the estimation of the variations induced in the epidermal pattern of different plants. 'Abu ka nala' contains sewage, domestic wastes, sugar, paper and textile factory effluents. All species did not response similarly to the effluents, some were relatively tolerant while others were sensitive. The set of observations made during the study, indicate that the extent of changes induced in the epidermal characteristcs may give an idea about the level of water pollution.

Keywords : Abnormal stomata; Effluent; Pollution; Stomatal index.

Introduction

Unscientific and careless urbanisation, industrialisation and agriculturalisation are major threats to biosphere stability. The principle cause of environmental degradation has been the need of the poor, greed of the rich and the careless application of technology. Rapid progress in science and technology has been of great advantage to mankind but it is leaving the environmental pollution as its byproduct[1].

Today, India is among the first ten industrial nations. Various industries are producing a large number of pollutants in the form of solid, liquid or gas. Due to a number of chemical changes, pollutants may be converted to more toxic compounds which accumulate in the food chain more easily. It has been confirmed by various investigations that water pollution has a tremendous effect on the health of man and his pats. The water of 'Abu ka Nala' flowing in Meerut city is highly polluted by industrial pollutants and domestic wastes. Present investigation deals with the morphological changes induced by these effluents on some wild angiosperms.

Materials and Methods

The criteria of the selection of a plant as a specimen in the study was that the plant must either be submerged in the effluent or growing very close to the running effluent. At least ten plants of every species available there, were collected during the months of November and December, 1988 and January, 1989. Although, to find out a plant which may not be under the exposer of some type of pollutant is more or less impossible in the industrialized cities like Meerut. Therefore, the plants suspected to be growing at places which were under least influence of pollutants were collected and used as control for different comparisons.

The plants were identified with the help of different floras. The identifications were confirmed by compairing the herbarium specimen with the vaucher specimen kept in the herbarium of Botany Department, CCS University, Meerut. For the evaluation of the damage done to the wild flora, morphological and growth pattern studies were made in the present investigations. Mature leaves of the plants were fixed in FAA for the purpose of epidermal studies. The peelings of abaxial and adaxial surface of leaves were taken either by gently scrapping the tissues with the help of razor blade or by using 1 : 1 glacial acetic acid and 40 volumes of hydrogen-peroxide. The epidermal peelings were stained in haematoxylene and mounted in 4 percent glycerol. Diagrams were made with the help of camera lucida. The size of stomata was measured in microscope with the help of occulometer and stage micrometer. The growth pattern was explored by measuring the biomass and above ground plant parts.

Other important parameters analysed included, frequency distribution of stomata per mm^2, stomatal anomalies and stomatal index (S.I.). The S.I. is calculated by the following formula[2] :-

$$\text{(Normal Stomata) S.I.} = \frac{S \times 2}{E+(S \times 2)} \times 100 \quad \text{----------(1)}$$

Where, S = Number of stomata/mm^2
E = Number of epidermal cells/mm^2

The stomatal Index of abnormal stomata was calculated by the modified formula number (1)

$$\text{S.I. (Abnormal Stomata)} = \frac{\left[\text{Total no. of Stomata} - \text{No. of stomata both G.C. degenerated}\right] \times 2 - \text{No. of stomata withone G.C. degenerated}}{\text{Total number of guard cell} + \text{Total No. of epidermal cells}} \times 100$$

Results and Discussion

Foliar structures have been used by various workers to study the effect of pollutants on plants. During the present investigations the damage caused by the complex pollutants of "Abu Ka Nala" to the wild flora of Meerut was studied. The changes induced in certain morphological parameters, like epidermal and growth pattern of plants belonging to different species growing near the polluted water, were studied.

Microscopic observations of leaf epidermal peels of different species infrequently show many stomatal abnormalities on both the surface except in *Cannabis sativa* and *Portulaca quadrifolia* (Fig. 1). These abnormalities include the presence of stomata with single guard cell (Fig. 1/3, 9, 13), stomata with one guard cell degenerated clogging (Fig. 1/1,6) stomatal clogging (Fig. 1/1,13) and contiguous stomata (Fig. 1/5, 8). These abnormalities are frequently present in *Alternanthera sassilis, Amaranthus spinosus, Amaranthus viridis, Blumea lacerata* etc. Whereas, infrequent in others e.g. *Chenopodium ambrossoides, Rumex dentatus* etc. Abnormal stomata in polluted plants have also been observed by Godzik and Sassen[3] and Kumar[4]. Degeneration of one and both guard cells, due to cement, dust pollution is also reported by Rajachidambaram and Krishnamurty[5]. Abnormal guard cells are reported by Bhirvamurty and Kumar[6] in *Calotropis gigantia*. The stomatal abnormalities may be due to the disturbances in the biological reactions of plant cells. Some plant reactions can be seen in the form of stomatal abnormalities (Fig. 3).

The discharge of sewage, domestic wastes, industrial and agricultural effluents contain simple nutrients to highly toxic chemicals like nitrates, selanium, cadmium, mercury, chlorinated hydrocarbons[7]. High concentration of heavy metals disturb physiology of plant cells. Some plant reactions can be visualized in the form of morphological variations in the organ. Foliar epidermis is one of such tissue which may respond quickly to different environmental pollutants and mutagens[8].

The polluted water could induce changes in epidermal pattern of both adaxial and abaxial leaf epidermis of the plants growing either a little submerged or in close vicinity to it. Present studies clearly indicate that 48.64 percent species increased the frequency of stomata on adaxial and abaxial surface of the plants growing near the running effluent. Higher stomatal frequency on the upper surface of the leaves from polluted area was also noticed in *Pantago lanceolata* by Wagoner[9]. Bhirvamuty *et al.*[10] reported an increased frequency of stomata on the adaxial surface of the leaves of *Cassia tora* and *Pergularia daemia*.

The stomatal index varied in the specimens collected in different months [Fig. 2(A)]. In general, it was found to be increased in 43.24 and 40.54 per cent species on abaxial and adaxial surface, respectively. The stomatal index decreased in 48.6 and 56.76 per cent species on these surface. A decrease in the stomatal index caused by pollutants was also observed by Bhirvamurty and Kumar[6]. The stomatal value in polluted population is an adaptation to decrease the amount of poisonous gases getting into leaf tissue[11]. The effect of pollutants on the size of the stomata was different in

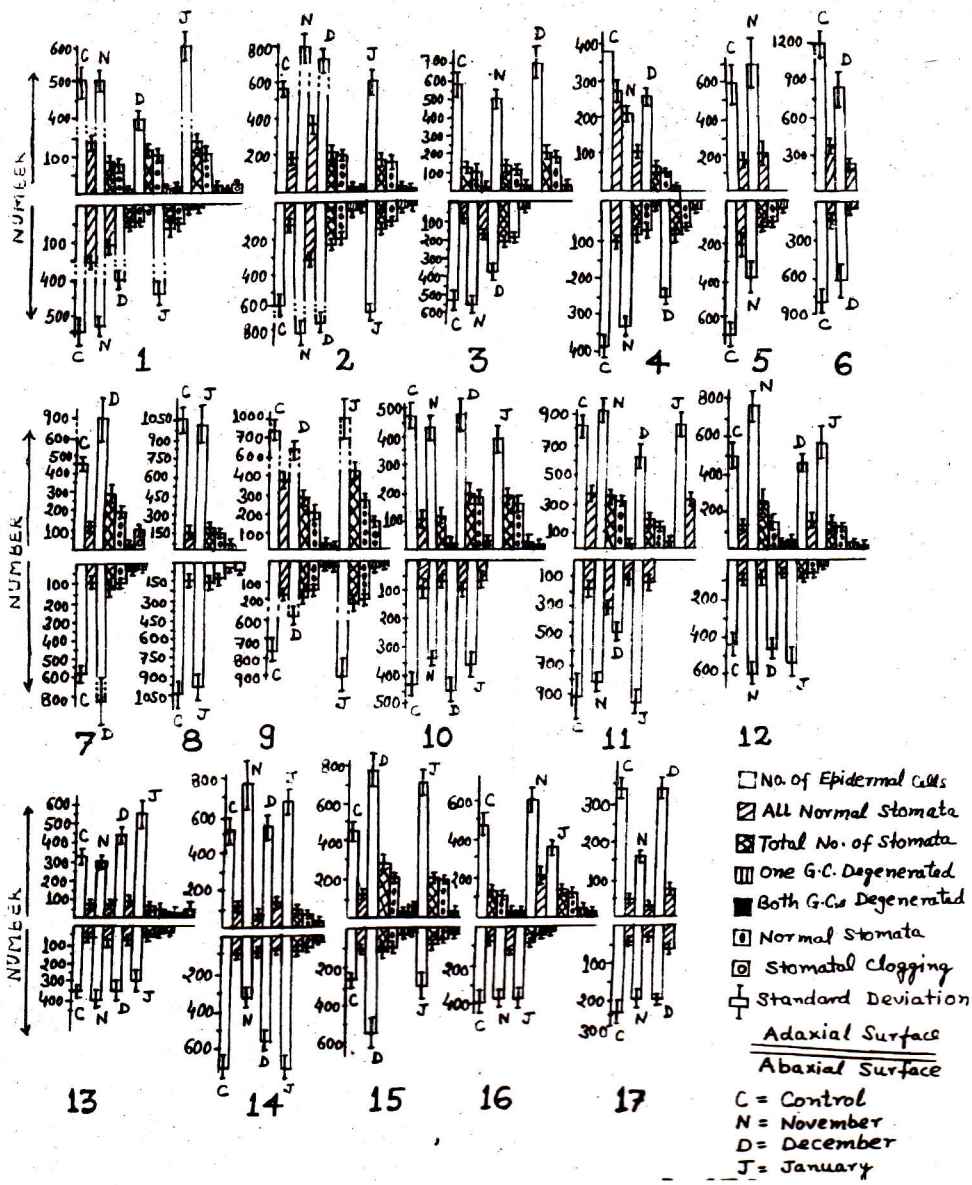

Fig. 1,2A and 2B. Frequency disribution of stomata/mm² in the wild angiospermic plants collected from " Abu Ka Nala", Meerut.

1. *Alternanthera sassilis*; 2. *Amaranthus spinosus*; 3. *Amaranthus viridis*; 4. *Blumea lacerata*; 5. *Chenopodium ambrossoides*; 6. *Cannabis sativa*; 7. *Chenopodium album*; 8. *Croton bomplandianum*; 9. *Eclipta alba*; 10. *Jussea sufroticosa*; 11. *Parthenium hysterophorus*; 12. *Polygonum glabrum*; 13. *Ranunculas sclerotes*. 14. *Rumax dentatus*; 15. *Solanum nigrum*; 16. *Veronica anagalis*; 17. *Portulaca quadrifolia*.

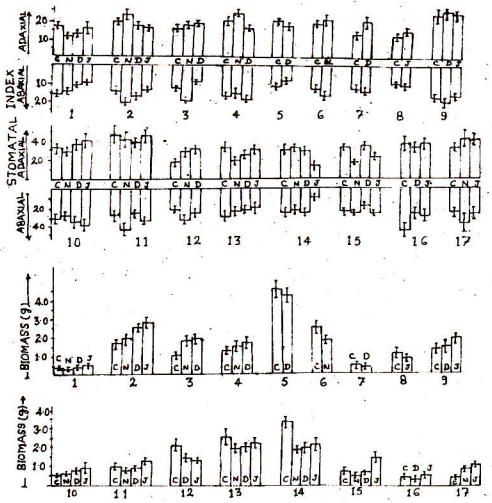

Fig. 2(A). Stomatal Index, (B) Biomass

different species[12-14]. Some of the species show higher number of stomata, which confirms the reports of Yunus and Ahmad[15].

The effect of polluted water on the biomass of the plants has been analysed and picturised in Fig. 2 B. Plants exhibited different responses for increase or decrease in the biomass of the plants as compared to the control. Differential response of the plants on the biomass accumulation may be due to a change in the type and concentration of the effluents and also the rate of absorption and accumulation of these products in the plant body.

It is clear from the above studies that most of the species responsed to the polluted water however a few were with similar in respect to various parameters. This may be due to their resistance to that particular type of the pollution. The induction of various anomalies depend upon the type and concentration of the effluents. Present work points out towards the fact that the morphological parameters can serve as indicators for the degree of damage done to the flora verses the extent of pollution in that area. Month wise variation in the epidermal response may be due to a change in the quality of the effluents i.e. due to different amount of effluent supply in different months.

Acknowledgements

Thanks are due to Dr. A. K. Srivastava, Professor of Botany, C.C.S. University, Meerut for his guidence and encouragement.

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