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EFFECT OF AIR POLLUTION ON THREE PLANT SPECIES GROWING AROUND CHAVARA INDUSTRIAL AREA, KOLLAM, KERALA

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Effect of air pollution from KMML industry, Chavara on three plant species viz. *Nerium odorum* Soland, *Thespesia populnea* Cav. and *Samanea saman* (Japq.) Merr.has been studied with special referance to their histo-morphological and biochemical characteristics. Average single leaf area showed a significant increase in the polluted samples of *T. populnea* and *S.saman* where as no significant variation was observed in *N. odorum.* Trichome density, fibre length and vessel diameter decreased to significant levels in all the polluted samples . A significant increase in stomatal density was noticed in all the polluted samples. Reduction in biochemical parameters viz.total chlorophyll (24.9 - 35.3%), protein(6.6 - 11.1%) and leaf extract pH(1.3 - 3.8%) was observed in all the polluted samples where as an increase in ascorbic acid (5-13%) and relative water content (3.7 - 8.7%) was observed in all polluted samples. Among the three species *S.saman* was found to be the most pollution tolerant taxa based on the APTI value.

Keywords : Air pollution; Air pollution tolerance index; Biochemistry; Histo-morphology.

The plants growing in polluted environment often show symptoms of various injuries, general debility and premature ageing. The extent of plant injury due to pollution may vary from species to species depending on their tolerance to pollution. Evaluation of plant species for histo-morphological and biochemical changes in response to air pollution and for their tolerance is important to assess the impact of air pollution on vegetation and to findout efficient species for cleaning up of atmospheric pollutants. The effect of air pollution on different anatomical traits have been studided by several workers in India and aborad[1-6]. Biochemical and physiological impacts of major pollutants have also been studied[7-10]. As such studies are scanty in Kerala, the present work was carried out to investigate the effects of air pollutants, emanating from Kerala Minerals and Metals Ltd. industrial complex, on histo-morphological and biochemical characteristics of *Nerium odorum, Thespesia populnea* and *Samanea saman.*

Kerala Minerals and Metals Ltd (KMML) industrial complex is situated at Chavara, Kollam District. It is one of the biggest industries in Kerala. It has two plants, the mineral separation plant and the Titanium dioxide pigment plant. The coastal belt of Kerala, stretching from Neendakara to Kayamkulam is enriched with valuable mineral, ilmenite. Ilmenite is separated and purified at the mineral separation plant. The purified ilmenite is converted into TiO_2 at the pigment plant.The hazardous and particulate matters coming out of the industry pose serios threat to the near by inhabitants and vegetation.

Three plant species namely *Nerium odorum* Soland, *Thespesia populnea* Cav. and *Samanea saman* (Japq.) Merr. were selected for the present study. Twig samples in three replicates of each selected plant species, growing around chavara industrial area, were collected randomly as polluted samples. Twigs of the same size and age of selected species growing in unpolluted area near S.N. College Junction served as control. Average single leaf area, trichome density and stomatal density were recorded from the fresh samples. Woods were macerated to obtain fibre and vessel elements. These elements were measured and analysed statistically. Samples were sectioned (15 - 20 µm thickness) and stained with safranin for microscopic examination. Relative water content, leaf extract pH, total chlorophyll, protein and ascorbic acid were estimated from the leaves. Total chlorophyll was analysed following the method byArnon[11], protein by Bradford[12] and ascorbic acid by Sadasivam and Manickam[13]. Air pollution tolerance index (APTI) was calculated by following the formula proposed by Singh and Rao[14].

The results obtained from the study are summarised in Tables 1-2. The observations recorded on

Table I. Leaf area, epidermal traits and xylary elements in three plants species growing in the polluted and control sites.

Plant species	Parameters	Control site Mean ±S D	Polluted site Mean ±SD
Nerium odorum	Leaf area (cm^2)	16±1.8	15±1.6^{NS}
	Trichome density	24.32 ±2.6	19.2±1.8**
	Stomatal density	38±7.14	49±4.25**
	Fibre length (µm)	494±28.6	426.13±2.3*
	Vessel length (µm)	128±18.3	124±13.8^{NS}
	Vessel diameter (µm)	44±4.1	35±6.12**
Thespesia populnea	Leaf area (cm^2)	83±14.3	96±17.5**
	Trichome density	12.45±1.3	10±0.98**
	Stomatal density	48±8.14	60±7.02**
	Fibre length (µm)	638.7±34.6	592±28.6*
	Vessel length (µm)	186.5±37.2	170.3±30.1^{NS}
	Vessel diameter (µm)	53±8.9	60±9.02**
Samanea saman	Leaf area (cm^2)	528±36.6	609±29.4**
	Trichome density	16.7±1.41	14.1±0.8*
	Stomatal density	46±7.29	58±9.18**
	Fibre length (µm)	672±28.69	647±13.1**
	Vessel length (µm)	234.2±25.3	236.9±18.7^{NS}
	Vessel diameter (µm)	52±2.9	40±3.01**

** = Significant at 1% level; * = Significant at 5% level; NS = Non-significant.

the extent of average single leaf area, trichome density, stomatal density, fibre length, vessel diameter, total chlorophyll, protein, ascorbic acid and relative water content have clearly indicated that pollutants emitted from the KMML industry exercised a decisive influence on these parameters. There was a marked increase in average single leaf area in the polluted samples of *T. populnea* and *S.saman* as recorded by Srivastava *et al.*[15] and Dhir *et al.*[16]. However, no significant difference in leaf area was observed in the polluted and control samples of *N. odorum*. The trichome density showed a significant increase in the polluted samples of all species. A significant reduction in vessel diameter was recorded in the polluted samples of *Chenopodium*[1], *Polygonum*[17] and *Lagerstroemia* and *Alstonia*[18]. Similar observation was made in *N.odorum* and *S.saman*. In case of *T.populnea*, the vessel diameter increased significantly compared to control samples as noticed by Khan *et al.*[19]. A significant decrease in fibre length under the infuence of air pollution was reported earlier in certain weeds[1,2]. The present data substantiate these reports. A reduction in stomatal density was recorded as an influence of air pollutants in *Callistemon citrinus*[20]. In contrary a two fold increase in stomatal frequency was recorded in polluted samples by Pal *et al.*[21]. In the present study the stomatal density also increased significantly in all polluted samples. Possibly this may be one of the

Table 2. Biochemical parameters in the leaves of three species growing in control and polluted sites.

S.No.	Parameters	Plant species	Control	Polluted	% Variation
1.	Total chlorophyll	*N.odorum*	1.5	0.97	35.3
	(mg/g fresh wt.)	*T. populnea*	2.15	1.48	31.2
		S. saman	2.09	1.57	24.9
2.	Protein	*N.odorum*	15.38	14.36	6.6
	(mg/g fresh wt.)	*T. populnea*	13.42	12.15	9.5
		S. saman	16.2	14.4	11.1
3.	Ascorbic acid	*N.odorum*	7.8	8.2	-5.1
	(mg/g fresh wt.)	*T.populnea*	8.0	8.35	-4.3
		S. saman	8.2	9.34	-13.9
4.	Relative water content	*N.odorum*	81.0	84.0	-3.7
	(%)	*T. populnea*	71.0	74.0	-4.2
		S. saman	80.0	87.0	-8.7
5.	Leaf extract pH	*N.odorum*	7.9	7.6	3.8
		T.populnea	7.8	7.7	1.3
		S. saman	8.3	8	3.6

adaptive features to reduce the damage caused by pollution.

Chlorophyll content decreased in all the samples collected from polluted sites. *N.odorum* exhibited the maximum reduction of 35.3%, followed by *T.populnea* (31.2%) and *S.saman* (24.9%). Air pollutants like SPM, SO_2 and NO_2 entered the tissue through the stomata and caused partial denaturation of chloroplast and decreased pigment content in the cells of polluted samples as stated by Rao and Leblanc[22] and Tripathi and Gautam[10].

The amount of protein decreased in all the polluted samples. The reduction in protein content could be attributed to denaturation of the existing proteins as well as to a reduced protein synthesis[7,10,23].

All species showed increased ascorbic acid content under pollution stress. Ascorbic acid being a strong reductant, protects chloroplast against SO_2 induced H_2O_2, O_2 and OH accumulation and thus, protects the enzymes of the CO_2 fixation cycle and chlorophyll from inactivation[24]. The present data also support this statement. The ascorbic acid was maximum in *S.saman* (13.9mg/g fresh wt.) which showed least per cent variation of total chlorophyll (24.9%). Thus, plants maintaining high ascorbic acid level under pollution stress can be considered as tolerant to air pollution. The leaf extract pH was maximum (8.0) in *S.saman* and minimum (7.6) in *N.odorum* growing in the polluted site. Leaf extract pH on the higher side gives tolerance to plants against pollution[25]. The relative water content was maximum in *S.saman* (87%) and minimum in *T. populnea* (74%). Low relative water content causes loss of water and dissolved nutrients, resulting in early scenescense of leaf[26]. It is likely, therefore, that plants with high relative water content under polluted condition may be tolerant to pollutants.

APTI value was maximum for *S.saman* (17.6) followed by *N.odorum* (15.43) and *T. populnea* (14.86). The plants with high APTI value can serve as tolerant species, such plants can effectively be used as pollution scavengers[14,27]. The results from the study reveal that *S.saman* is the most pollution tolerant taxa and can serve as sink to air pollution.

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