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EFFECTS OF CEMENT DUST ON THE CHLOROPHYLL CONTENTS, STOMATAL CLOGGING, AND BIOMASS OF SOME SELECTED PLANTS

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Effects of cement dust emaniting from an adjacent cement factory on anatomical and physiological aspects of *Citrus medica, Mangifera indica, Ficus religiosa, Eriobotrya japonica, Albizia lebbeck, Psidium guagava, Jasminum grandiflorum, Ligustrums lucidum. Ipomoea carnea, Canabis sativa* and *Malva sylvestris* were investigated during March, 1985. In polluted plants leaf area and biomass was lower. Chlorophyll "a" was effected, chlorophyll "b" was higher while stomata were clogged and moisture content were lower. The plants in the polluted environment apparently looked unhealthy.

Key words: Cement dust, Stomatal clogging, Biomass, Pollutions on selected plants.

Introduction

As a result of progressive increasing of population and industrialization the developing countries including Pakistan are now experiencing the problems of environmental deterioration. In Pakistan air pollution due to textile industry and vehicle exhaust has been reported [2-4] and its effects on roadside plants has been reported [1] growth and germination of some species is severely inhibited by the effluents from paper and soap industries [9-10]. Cement pollutions also interfere with the growth of plant by reducing soil moisture and organic matter increasing salinity and lowering calcium carbonate content, [11] Cement factory emissions also includes various gases [5] and their effects on plants has been reported [12]. The effects of gaseous pollutions on vegetation, therefore needs detailed investigation. With these objectives in mind the present study was conducted to determine the effects of particulate commission from a cement factory on some selected plants in the polluted area.

Materials and Methods

This study was conducted in an area polluted by cement factory, Wah (Rawalpindi district) during March, 1985. Colony and factory area was designated as polluted. Non-polluted area was located at a distance of 2.5 km from the factory in an opposite direction to the predominent winds. Notes on the general appearance of plants were recorded on the spot. The results based on four collections made at one week interval. The results were analyzed using t-test [6]. Following plants were collected for the present investigation.

1. Perennial evergreen trees: *Citrus medica* L. *Mangifera indica* L; *Ficus religiosa* L., *Eriobotrya japonica* (Thunb) Lind.
2. Perennial Deciduous trees: *Albizia lebbeck* (L) Bth.; *Psidium guagava* L.
3. Evergreen shrub: *Jasminum grandiflorum* Linn., *Ligustrum lucidum* Ait. f.
4. Deciduous shrub: *Ipomoea carnea* jacq.
5. Annual herbs: *Canabis sativa* L.; *Malva sylvestris* L.

Effect on leaf area, biomass and moisture contents. Five plants were randomly selected for each of the above listed species within the polluted and non-polluted areas. Twenty leaves were then randomly plucked from each plant. Leaf-area was calculated by graph paper method. Fresh weight was determined. The leaves then oven dried at 65^{O} for 72 hr. for dry weight determination. Moisture contents calculated on dry weight basis [6].

Determination of cement dust deposition. Cement dust was either scrapped from the leaf surface and/or washed in water or alcohol. The solvents were then evaporated to dryness and residue weighed. The deposition was expressed as mg/cm^2 of the leaf area.

Effect on stomatal clogging. Epidermal layers peeled off the fresh leaves were observed under microscope using 10x40 magnification. One hundred stomata were scored in 10 randomly selected fresh leaves of each species. The open and clogged stomata were counted. Stomata were defined clogged when any visible trace of particulate pollutant was partially or completely clogging the stomata.

Effect of chlorophyll contents. Chlorophyll contents of polluted and non-polluted plant was determined using the method of Harbone [8]. Chlorophyll *a* and *b* were measured by direct determination of absorbence at 663 and 645 nm in 1 cm cells using spectronic-20. The concentrations were then calculated using the formulae given

[8]. The chlorophyll concentration of mg/g were changed to mg/cm^2 of the leaf area. For every plant there were 10 determinations.

Penetration of cement dust into plant tissues. Polluted and non-polluted leaves were stored in preservative. Generally, fresh material was prefered. Free hand anatomical sections of leaf were prepared and observed under microscope using 10x40 magnification. The epidermal and sub-epidermal tissues were observed for the presence of any particulate pollutants.

Results

Effect on leaf-area, biomass and moisture contents. The leaf-areas of all the tested species were reduced in the polluted environment (Table 1). The perennial species were more affected than the annuals.

Mangifera, Albizia, Ipomoea and *Ligustrum* were severely arrested in their leaf development. The fresh and dry masses of the species, except for fresh weight of *Jasminum* and *Ipomoea,* and dry masses of *Citrus, Mangifera* and *Eriobotrya,* were significantly reduced in the polluted area (Table 1). *Albizia, Psidium, Canabis* and *Malva* were affected more than the other species.

Moisture contents of evergreen trees like *Citrus, Ficus, Mangifera* and *Eriobotrya* decreased while those of shrubby and herbaceous species increased in the polluted environment (Table 1). *Mangifera* and *Eriobotrya* had large leaves and therefore more effected.

Cement dust deposition. There was a significant deposition of cement dust on the leaves in polluted plants (Table 2). The average deposit (mg/cm^2) was very high for *Citrus, Mangifera* and *Eriobotrya* and least for annual species.

Effect on stomatal clogging. All the species had significant clogging of stomata. However, the percentage of clogged stomata was high in *Albizia, Psidium, Ipomoae, Eriobotrya* and *Mangifera* than the remaining species (Table 2).

Effect on chlorophyll contents. Chlorophyll *a* of the polluted and non-polluted was not significantly different from each other except *Psidium* which showed reduction whereas *Albizia, Mangifera* and *Jasminum* exhibited an increase over the non-affected plants (Table 3). Chlorophyll *b* of all the polluted plants was significantly higher than the non-polluted plants.

Penetration of cement particles into tissue. The anatomical study showed that the penetration of cement was superficial as no particle was found in the sub-epidermal tissues. The cement particles were confined to the stomatal opening only.

Discussions

Cement dust generally develops a layer in the polluted area but gradually thins by the wind with the increasing distance from the source. These air pollutants effect plants in many ways. Although, vegetation was not analyzed in the present study, yet differences in plant cover were apparant in the polluted and non-polluted sites. The effected species generally gave unhealthy look. The small leaf-area and reduced biomass was due to poor growth. The chlorophyll *a* contents were not much affected whereas chlorophyll *b* increased in the polluted plants. This shows that more chlorophyll *b* is required to compensate for the reduced leaf area that causes over all reduction of photosynthetic product. The deposition of cement dust over the leaf reduces the availability of light. Clogging of stomata

TABLE 1. LEAF AREA (cm^2) AND BIOMASS (mg) OF LEAVES OF PLANTS IN THE CEMENT POLLUTED AND NON-POLUTTED HABITAT. EACH VALUE IS A MEAN OF 20 RANDOMLY SELECTED LEAVES.

Species	Leaf area (cm^2)			Fresh weight (mg)			Dry weight			Moisture contents (%)		
	Non-Polluted	Polluted	% of Non-Polluted	Non-Polluted	Polluted	% of Non-Polluted	Non-Polluted	Polluted	% of Non-Polluted	Non-Polluted	Polluted	% of Non-Polluted
1. *Citrus medica*	48.28	32.90	68.14*	1000	880	88.00*	250	330	132.00*	300.00	166.66	55.56**
2. *Mangifera indica*	61.62	38.96	63.23*	2650	2289	86.38*	1130	1433	126.81*	134.51	59.73	44.41**
3. *Eriobotrya japonica*	105.14	77.40	73.62*	4560	3911	85.77*	2015	1800	89.33	226.30	117.30	51.83**
4. *Ficus religiosa*	121.26	92.43	76.23*	3490	2720	77.94*	1260	1100	87.70*	176.98	147.27	83.21**
5. *Albizia lebbeck*	11.61	6.45	55.56**	200	105	52.50**	145	50	34.48**	37.93	110.00	290.00**
6. *Psidium guagava*	47.73	34.83	72.97*	1540	810	52.60**	890	340	38.20**	73.03	138.23	189.28**
7. *Jasminum grandiflorum*	12.26	8.39	68.43*	250	230	92.00	100	70	70.00*	150.00	228.57	152.38**
8. *Ligustrum lucidum*	14.84	8.39	56.54*	535	450	84.11*	125	95	76.00*	328.00	373.68	113.93*
9. *Ipomoae carnea*	98.04	59.34	60.53*	1810	1620	89.50	399	320	80.20*	353.63	406.25	114.88*
10. *Canabis sativa*	18.58	15.16	81.59*	395	320	81.01*	167	74	44.31**	136.52	332.43	243.50**
11. *Malva sylvestris*	12.58	10.97	87.20*	308	213	69.16*	155	95	61.29*	98.71	124.21	125.83*

* and ** : Significantly different from non-polluted at P = 0.05 and 0.01, respectively.

TABLE 2. CEMENT DUST DEPOSIT (mg/cm²) ON LEAVES AND STOMATAL CLOGGING (%) IN PLANTS IN THE POLLUTED AND NON-POLLUTED SITES. EACH VALUE IS A MEAN OF 20 LEAVES.

Species	Cement dust (mg/cm²)			Stomatal clogging (%)		
	Non-polluted	Polluted	% of Non-polluted	Non-polluted	Polluted	% of Non-polluted
1. *Citrus medica*	0.21	7.29	3471.43**	31	42	135.48*
2. *Mangifera indica*	0.82	10.27	1252.44**	37	80	216.22**
3. *Ficus religiosa*	0.36	1.62	450.00**	31	61	196.77**
4. *Eriobotrya japonica*	0.24	4.52	1883.33**	31	83	267.74**
5. *Albizia lebbeck*	1.12	4.65	415.18**	15	65	433.33**
6. *Psidium guagava*	0.57	4.02	705.25**	24	59	245.83**
7. *Jasminum grandiflorum*	1.22	3.58	293.44**	20	82	410.00**
8. *Ligustrum lucidum*	1.01	4.17	412.87**	35	50	142.86*
9. *Ipomoae carnea*	0.27	1.01	374.07*	28	65	232.14**
10. *Canabis sativa*	0.97	1.78	183.51**	25	54	216.00**
11. *Malva sylvestris*	0.40	1.28	320.00*	31	56	180.65*

* and ** : Significantly different from non-polluted at P = 0.05 and 0.01, respectively.

TABLE 3. EFFECT OF CEMENT DUST POLLUTION ON THE CHLOROPHYLL CONTENTS OF PLANTS. EVERY VALUE IS A MEAN OF 10 REPLICATES.

Species	Chlorophyll *a* (μg/cm²)			Chlorophyll *b* (μg/cm²)		
	Non-polluted	Polluted	% of Non-polluted	Non-polluted	Polluted	% of Non-polluted
1. *Citrus medica*	26.92	30.09	111.78	165.90	242.55	146.20*
2. *Mangifera indica*	26.29	38.24	145.45*	130.15	205.59	157.96*
3. *Ficus religiosa*	12.29	14.17	115.30	66.13	86.77	131.21*
4. *Eriobotrya japonica*	13.03	15.76	116.42	76.28	103.62	135.84*
5. *Albizia lebbeck*	139.53	186.04	133.33*	690.78	1235.66	178.88*
6. *Psidium guagava*	38.13	26.13	68.53*	168.02	229.40	136.53*
7. *Jasminum grandiflorum*	120.72	166.87	138.23*	654.16	955.89	146.12*
8. *Ligustrum lucidum*	177.22	185.94	104.92	542.45	949.94	175.12*
9. *Canabis sativa*	160.93	185.05	114.99	637.52	723.79	113.53

* : Significantly different from non-polluted at P = 0.05.

further complicates the physiological processes of plant [7].

The present findings suggest that cement dust reduces the leaf area, biomass and shows deposition over the leaf area to affect the growth of the plants. Although many aspects such as differences in the phytosociology of plants, chemical constituents, soil characters and phenological behaviour need further exploration, yet, it is clear that the cement dust pollution is an operative ecological factor causing deterioration of the quality of our environment. The findings stimulate the needs for broad perspective while evaluating the effects of uncontrolled emission of cement dust.

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