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Effect of marble dust on plants around Vishwakarma Industrial Area (VKIA) in Jaipur, India

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Abstract

The paper describes the effect of marble dust on plants in and around Vishwakarma Industrial Area (VKIA) Jaipur, Rajasthan (India). Trees species growing in and around VKIA area were selected and various morphological characteristics were studied such as leaf area dry weight ratio (LADWR), Dust retaining capacity (DRC) and Chlorophyll content. In the study the effects of marble dust on selected tree species was observed. LADWR was recorded maximunm 217.90 $cm^2 g^{-1}$ dry wt. in *Polyalthia longifolia* in VKIA and minimum 98.74 $cm^2 g^{-1}$ dry wt. in *Ficus religiosa* in Nindar whereas The DRC was observed maximum 178.51 mg cm^{-2} in *Azadirachta indica* in VKIA as well as minimum recorded 66.41 mg cm^{-2} in *Thevetie pervvianain* in Vidyadher Nagar. However the Total Chlorophyll Content was also determined and it was found maximum in Bougainvillea *i.e.* 2.949 mg g^{-1} (fresh wt.) in VKIA whereas minimum for Nindar *i.e.* 0.784 mg g^{-1} (fresh wt.) in *Ficus religiosa*.

Key words

Anthropogenesis activities, Marble industries, Leaf area dry weight ratio, Dust retaining capacity

Introduction

In the context of environmental pollution abatement, green belt has been defined as mass plantation of pollutant-tolerant trees for mitigating the air pollution by filtering, intercepting and absorbing pollutants in a sustainable manner (Gareth *et al*., 1992; Andy, 1991; Ruth and William, 1994; Sharma and Roy, 1997). Particulate Matter produced during the marble crushing is usually of relatively large size. The chemical composition of the dust tends to be homogenous mixture of oxides of calcium, potassium, aluminum, silica and sodium, which settles into a head mass when it comes in contact with water (Raina *et al.,* 2008). In short, dust pollution affects not only human health but also ecological health of a region (Okita *et al.,* 1996; Pandey *et al.,* 2002, 2004; Srivastava, 2004; Srivasatava *et al.,* 2005). Stone crusher dust, is extremely harmful to human health as well as surrounding vegetation. The dust impairs visibility the particulate dust falling on leaves may cause foliar injuries, reduction in yield, change in photosynthesis and transpiration *etc.* (Raina *et al.,* 2008). Several studies conducted under field condition have revealed that when these particulate matters are deposited on vegetation, the plant growth is adversely effected (Chatter 1991; Gunamani and Arjunan, 1991; Rao, 1991; Sharma and Sharma, 1991; Aslam *et al*., 1992; Mishra *et al.,* 1993; Pandey and Nand, 1995; Chowdhary and Rao, 1996; Somashakar *et. al*., 1999; Kumar *et al.,* 2000). Monitoring of the effects of dust particles on vegetation is very important. Dust emission occurs from many operations in the marble industries *viz*., cutting, buffing, polishing, tile making, loading and transportation therefore it was necessary to study the effect of dust on plants around the Vishwakarma Industrial Area (VKIA) of Jaipur.

Materials and Methods

An extensive study was carried out in VKIA industrial area within 5 km distance in each direction. Vishwakarma Industrial Area was established in the year 1970 in Jaipur city (Rajasthan). The study area (VKIA) is located at 27°59'53"N North latitude and 75°46'39"E East longitudes. It is spread over a total area of 1400 Acres. The region has many well established marble industrial units. Leaves of different selected plants *viz*. *Azadirachta indica* (Neem), *Polyalthia longifolia* (Ashok), *Ficus religiosa* (Pipal), *Bougainvillea* and *Thevetie pervviana* (Pili Kaner) (5 plants samples

Table - 1: Leaf dry weight ratio ($cm^2\ g^{-1}$ dry wt.) of selected tree species and around Vishwakarma Industrial Area (VKIA) Jaipur

Plant species	VKIA	Jhotwara	Vidyadhar nagar	Nindar	Murlipura	Mean
Azadirachta indica	193.33±0.77	190.27±0.48	156.19±1.18	137.96±1.32	157.60±0.87	167.07±0.92
Polyalthia longifolia	217.90±0.71	205.74±0.41	202.32±0.59	172.92±1.96	177.62±1.01	195.30±0.94
Ficus religiosa	156.51±1.69	146.76±1.39	113.05±0.86	98.74±1.18	165.83±1.52	136.17±1.33
Bougainvillea	195.47±0.48	158.95±1.07	158.10±1.83	175.72±0.47	168.48±0.66	171.34±0.90
Thevetie pervviana	129.70±0.82	118.14±0.42	140.18±0.48	92.83±0.53	132.08±0.59	122.58±0.57

Mean ± SE (Standard error), n=3

Table - 2: Dust retaining capacity ($mg\ cm^{-2}$) in selected plant species in and around Vishwakarma Industrial Area (VKIA) Jaipur

Plant species	VKIA	Jhotwara	Vidyadhar nagar	Nindar	Murlipura	Mean
Azadirachta indica	178.51±1.25	124.83±1.10	142.97±1.05	153.88±1.12	128.24±1.33	145.68±1.17
Polyalthia longifolia	165.38±0.20	126.53±0.23	94.93±0.16	74.59±0.77	112.89±0.87	114.86±0.44
Ficus religiosa	149.05±1.11	110.6±1.35	103.89±1.76	81.49±1.03	86.16±1.07	106.23±1.26
Bougainvillea	121.59±2.01	80.06±2.13	119.76±2.02	98.41±2.20	98.61±2.93	103.68±2.25
Thevetie pervviana	93.59±0.55	72.85±0.18	66.41±0.20	66.85±0.41	79.74±0.23	75.88±0.31

Mean ± SE (Standard error), n=3

Table - 3: Total chlorophyll content ($mg\ g^2$ fresh wt.) of selected plant species ($mg\ g^{-1}$ fresh wt.) in and around Vishwakarma Industrial Area (VKIA) Jaipur

Plant species	Chlorophyll a	Chlorophyll b	Total Chlorophyll
Vishwakarma Industrial Area (VKIA)			
Azadirachta indica	1.430±2.11	1.230±2.08	2.660±2.09
Polyalthia longifolia	0.873±1.81	0.458±1.17	1.331±1.49
Ficus religiosa	0.832±1.32	0.172±1.16	1.004±1.24
Bougainvillea	1.765±1.03	1.185±1.81	2.949±1.42
Thevetie pervviana	0.832±1.22	0.172±1.66	1.004±1.44
Jhotwara			
Azadirachta indica	1.34±2.03	0.675±2.71	1.007±2.37
Polyalthia longifolia	0.983±2.33	0.297±2.67	1.280±2.50
Ficus religiosa	0.551±2.46	0.417±2.80	0.969±2.63
Bougainvillea	1.463±2.11	0.939±2.30	2.402±2.20
Thevetie pervviana	0.956±2.91	0.143±2.08	1.099±2.49
Vidyadhar Nagar			
Azadirachta indica	1.360±1.09	0.976±1.04	2.336±1.07
Polyalthia longifolia	0.541±1.47	0.465±1.26	1.006±1.36
Ficus religiosa	0.586±1.13	0.443±1.05	1.029±1.09
Bougainvillea	0.914±1.22	0.887±1.36	1.801±1.29
Thevetie pervviana	0.503±1.30	0.908±1.25	1.410±1.37
Nindar			
Azadirachta indica	0.927±1.37	0.757±1.43	1.684±1.40
Polyalthia longifolia	1.46±1.09	0.119±1.14	1.580±1.12
Ficus religiosa	0.484±1.13	0.229±1.24	0.784±1.18
Bougainvillea	1.460±1.06	0.119±1.11	1.580±1.08
Thevetie pervviana	0.914±2.01	0.887±2.12	1.801±2.06
Murlipura			
Azadirachta indica	0.809±2.66	0.360±2.73	1.170±2.69
Polyalthia longifolia	0.554±2.39	0.463±2.68	1.010±2.53
Ficus religiosa	0.604±2.83	0.287±2.99	0.891±2.91
Bougainvillea	1.390±2.46	1.000±2.15	2.390±2.30
Thevetie pervviana	1.534±2.53	0.578±2.19	2.101±2.36

Mean ± SE (Standard error), n=3

for each location (VKIA, Jhotwara, Vidyadhar Nagar, Nindar, Murlipura) for observing morphological characteristics such as leaf area dry weight ratio (LADWR), Dust retaining capacity (DRC) and Chlorophyll content.

The plant material (1g fresh weight) was extracted in 80% (v/v) aqueous acetone. The extract was centrifuged at 2000 rpm. The absorbance of the clear solution noted at 645 and 663 nm using a spectrophotometer. The chlorophyll content of the leaves was estimated by (Arnon, 1949).

Leaves were taken from each plant species from road side area and washed with 50 ml distilled water in a pre weighed Petri plate and this water was kept in filled plate over hot plate. After complete evaporation of water the petri plates was cooled in desiccators and the final weight was taken to measure amount of dust in petri plate. The leaf area was measured with the help of graph paper in cm^2 and the Dust Retaining Capacity was calculated (Agarwal, 2005).

Leaf area measurement was worked out by graph paper and its outline was drawn. Then the leaf area was calculated by counting the number of bigger and smaller squares. These samples were put in paper bags and dried in a thermostatically controlled oven at 80°C for 48 hr. Weight of dry leaves was taken with the help of electronic balance and the ratio was calculated as per (Agarwal, 2005).

Results and Discussion

In the present study the pollution effects on the performance of selected tree species was observed and shows in Table 1. Leaf area dry weight ratio in *Azadirachta indica* was recorded maximum in Vishwakarma Industrial area *i.e.*193.33 cm^2 g^{-1} dry wt. and minimum in Nindar *i.e.* 137.96 cm^2 g^{-1} dry wt. with mean 167.07 cm^2 g^{-1} dry wt. while Leaf Area Dry Weight Ratio of *Polyalthia longifolia* was found maximum in Vishwakarma Industrial Area *i.e.* 217.90 cm^2 g^{-1} dry wt. and minimum in Nindar *i.e.*172.92 cm^2 g^{-1} dry wt. with mean 195.30 cm^2 g^{-1} dry wt. whereas leaf area dry weight ratio of *Ficus religiosa* was recorded maximum in Vishwakarma Industrial area *i.e.* 156.51 cm^2 g^{-1} dry wt. and minimum in Nindar *i.e.* 98.74 cm^2 g^{-1} dry wt. with mean 136.17 cm^2 g^{-1} dry wt. However, for *Bougainvillea* leaf area dry weight ratio was recorded maximum in Vishwakarma Industrial Area *i.e.* 195.47 cm^2 g^{-1} dry wt and minimum in Nindar *i.e.*175.72 cm^2 g^{-1} dry wt. with mean 171.34 cm^2 g^{-1} dry wt. The Leaf Area Dry Weight Ratio of *Thevetie pervviana* was found maximum in Vidyadhar Nagar *i.e.* 140.18 cm^2 g^{-1} dry wt. and minimum in Nindar *i.e.* 92.83 cm^2 g^{-1} dry wt. with mean 122.58 cm^2 g^{-1} dry wt. Pigment concentration has been reported to decrease in the plants growing near the stone crushers (Somashekar *et al.,* 1999; Singh, 2000) and Cement factory (Gunamani and Arjunan, 1991). Dust emission occurs from many operations in the stone quarrying and processing *viz*., drilling or blasting from deposit beds, loading and transportation of rocks at crushers, open conveyors, primary, secondary and tertiary crushing of stones, screening, transporting rock by belt conveyors, storage and loading of the crushed materials *etc.*

In the present study it was observed that dust retaining capacity of *Azadirachta indica* was recorded maximum in Vishwakarma industrial area *i.e.* 178.51 mg cm^{-2} and minimum in Jhotwara *i.e.* 124.83 mg cm^{-2} with mean value of 145.68 mg cm^{-2} (Table 2). The dust retaining capacity of *Polyalthia longifolia* was observed maximum in Vishwakarma industrial area *i.e.* 165.38 mg cm^{-2} and minimum in Nindar *i.e.* 74.59 mg cm^{-2} with mean value of 114.86 mg cm^{-2}. The dust retaining capacity of *Ficus religiosa* in present study was observed maximum 149.05 mg cm^{-2} in Vishwakarma industrial area and minimum 81.49 mg cm^{-2} in Nindar with mean value of 106.23 mg cm^{-2}. In the present study in Bougainvillea the dust retaining capacity was observed maximum in Vishwakarma industrial area *i.e.* 121.57 mg cm^{-2} and minimum in Jhotwara *i.e.* 80.06 mg cm^{-2} with mean value of 103.68 mg cm^{-2} while in *Thevetie pervviana* maximum dust retaining capacity was reported in Vishwakarma industrial area *i.e.* 93.59 mg cm^{-2} and minimum in Vidhyadar Nagar *i.e.* 66.41 mg cm^{-2}.

The study shows that dust retaining capacity in *Azadirachta indica, Polyalthia longifolia and Ficus religiosa* were higher than other plants *i.e. Bougainvillea and Thevetie pervviana*. To retain the foreign particle on plant surface or on leaves, two factors *i.e.* leaf surface and size of the leaf are important (Prajapati and Tripathi, 2008). If leaf surface is glossy there is less dust retaining capacity but leaves having rough surface retain high dust. Dust interception capacity of plants depends on their surface geometry, phyllotaxy, leaf external characteristics (Such as hairs, cuticle *etc.*) and height and canopy of trees (Nowak, 1994).

It was observed that in *Azadirachta indica* total chlorophyll content was maximum for Vishwakarma industrial area (2.660 mg g^{-1}) whereas minimum for Jhotwara (1.007 mg g^{-1}) (Table 3). In *Bougainvillea* total chlorophyll content was found maximum for Vishwakarma industrial area (2.949 mg g^{-1}) and minimum for Nindar (1.580 mg g^{-1}). In *Polyalthia longifolia, Ficus religiosa* and *Thevetie pervviana* total chlorophyll content was found maximum for Vishwakarma industrial area (1.331 mg g^{-1}), Vidhyadhar nagar (1.029 mg g^{-1}) and Murlipura (2.101 mg g^{-1}) respectively whereas minimum for Vidyadhar nagar (1.006 mg g^{-1}), Nindar (0.784 mg g^{-1}) and Vishwakarma industrial area (1.004 mg g^{-1}) respectively. Thus the results of the present study revealed that the chlorophyll content was found high in *Azadirachta indica* and *Bougainvillea* which shows that these two species were more tolerant to pollutants. Chlorophyll content may differ in different period of time under different conditions of pollution stress and different meteorological conditions. Similarly Joshi *et al.* (1993) reported that higher chlorophyll content in plants might favour tolerance to pollutants.

Our study reveals that evaluation of anticipated performance of plants might be very useful in the selection of appropriate tree species for urban green belts in the area. Sensitive species are early indicators of pollution, and the tolerant species help in reducing the over all pollution load. The results of this study indicated a decline in chlorophyll content in trees growing in industrial area.

The reduction in chlorophyll content is due to degradation of chlorophyll into phaeophytin by the loss of magnesium ions. Chlorophyll content may differ in different period of time under different conditions of pollution stress and different meteorological conditions. Thus it is concluded that in the study area there is need to develop green belt for the betterment of environment and human being.

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References

Agarwal, S.K.: Environmental monitoring. A.P.H Publishing Corporation. 204-205 (2005).

Arnon, D.I.: Copper enzyme in isolated chloroplasts, ploy phenoloxidase in *Beta vulgaris*. *Plant Physiol.,* **24**, 1-15 (1949).

Aslam, M., A.K. Minocha, P.D. Kalra and R.S. Srivastava: Fugitive dust emission from stone crushers. *Ind. J. Environ. Hlth*., **34**, 187-191 (1992).

Andy, C.: Dictionary of environmental and development. Earth Scan Publications Ltd., London (1991).

Chatter, H.: Effect of Cement dust on the enzymatic activity in the levels of Triticum aestivum. *Acta Ecologica*., **13**, 113-119 (1991).

Chowdhary, U. and T.V.R. Rao: Effect of cement dust on the enzymatic activity in the levels of *Triticum aestivum*. *Acta Ecologica*, **13**, 113-119 (1996).

Gunamani, T. and M.C. Arjunan: Studies on the cement dust induced abnormalities in some timber yielding plants. *Botle. Club*., **8**, 87-96 (1991).

Gareth, J., R. Alan, F. Jean and H. Graham: Environmental science. Harper perennial (Division of Harper Collins publishers). p. 564 (1992).

Joshi, O.P., K. Pawar and D.K. Wagela: Air quality monitoring of Indore city with special reference to SO_2 and tree barks pH. *J. Environ. Biol*., **14**, 157-162 (1993).

Kumar, R.R., N. Shadaksharasamy and G. Srinivas: Impacts of granite quarrying on environment in Banglore district with reference to socio-economic status of workers. *Pollut. Res.*, **19**, 51- 54 (2000).

Mishra, J., V. Pandey, S.N. Sing, N. Singh, M. Yunus and K.J. Ahmed: Growth response of *Lycopersicum esculentum* to cement dust treatment. *J. Environ. Sci. Hlth*., **28**, 1774-1780 (1993).

Nowark, D.J.: Air pollution removal by Chicago's urban forest. *In*: Chicago's urban forest ecosystem: Results of the Chicago urban forest climate project (*Eds*.: E.G. McPherson, D.J. Nowark, R.A. Rowntree). USDA forest service general technical report NE-186. pp. 63-81 (1994).

Okita, T., H. Hara and N. Fukuzaki: Measurements of atmospheric SO_2 and SO42- and determination of the wet scavenging coefficient of Sulfate aerosols for the winter monsoon season over the Sea of Japan. *Atmospheric Environment*, **30**, 3733-3739 (1996).

Pandey, D.D. and S. Nand: Effect of stone crushers dust pollution on grain characteristic of Maize. *Environ. Ecol.*, **13**, 901-903 (1995).

Pandey, J.S., R. Khan and S. Devotta: Health risk assessment for air pollution management in India: A case study of Delhi city. BAQ-2004, 6-8 December, Agra, India. www.Cleanairnet.org/caiasia/1412/propertyvalue-16289. html (2004).

Pandey, J.S., S. Khan, V. Joseph and R. Kumar: Aerosol scavenging: Model application and sensitivity analysis in the Indian context. *Environ. Monit. Assess.*, **74**, 105-116 (2002).

Prajapati, S.K. and B.D. Tripathi: Anticipated performance Index of some tree species considered for green belt development in and around an urban area: A case Study of Varanasi city, India. *J. Environ. Manage*., **88**, 1343-1349 (2008).

Raina, A.K., V. Rathore and A. Sharma: Effect of stone crusher dust on leaves Melia azadarach linn. and Dalbergia sissoo roxb. in Jammu (J and K). *Natural Environ. Pollut. Technol.*, **7**, 279-282 (2008).

Rao, S.: Effect of cement dust on stomatal structure. *Ecol. Environ. Conserv.*, **1**, 7-9 (1991).

Ruth, A.E. and R.E. William: The encyclopedia of the environment. The rene dubor centre for human environments, Houghton Miffin Company, USA (1994).

Sharma, C.P. and V. Sharma: Effect of cement dust pollution on enzyme activity in some tree species growing around associated cement companies Ltd. *Acta Ecologica*., **13**, 99-120 (1991).

Sharma, S.C. and R.K. Roy: Green belt-an effective means of mitigating industrial pollution. *Ind. J. Environ. Protect.*, **17**, 724-727 (1997).

Singh, R.B.: Impact of stone crusher dust pollution on tomato (*Lycopersicum Esculantum*) in the Sonbhadra District of U.P. *J. Environ. Pollut.*, **7**, 235-239 (2000).

Somashekar, R.K., R. Ravi and A.M. Ramesh: Impact of granite mining on some plant species around quarries and crusher of Bangalore district. *Pollution Research*, **18**, 445-451 (1999).

Srivastava, A.: Source apportionment of ambient VOCs in Mumbai city. *Atmospheric Environment*, **38**, 6829-6843 (2004).

Srivastava, A., A.E. Joseph, S. Patil, A. More R.C. Dixit and M. Prakash: Air toxics in ambient air of Delhi. *Atmospheric Environment*, **39**, 59-71 (2005).