RESEARCH ARTICLE

Study of dust deposition on leaves of some plant species in GVISH. Campus of Amravati (MS) India

Irwe RR, Sontakke SG, Sheikh SI and Darade MS*

Department of Botany, Government Vidarbha Institute of Science and Humanities, Amravati (M.S.) , India
*E-mail: marutidarade@gmail.com

Manuscript details:

Received: 12. 07.2017
Accepted: 30.11.2017
Published : 16.12.2017

Editor:
Dr. Arvind Chavhan

Cite this article as:
Irwe RR, Sontakke SG, Sheikh SI and Darade MS (2017) Study of dust deposition on leaves of some plant species in GVISH. Campus of Amravati (MS) India; *International J. of Life Sciences*, 5 (4): 639-643.

ABSTRACT

A survey of fifteen dust polluted plants of different families were carried out in institute campus. The dust holding capacity of leaves, pH of dust wash of leaf surface and amount of total chlorophyll content with respect to dust deposition on leaves are determined. From the surveyed plants the quantity of dust deposition was recorded from the randomly sampled leaves. The maximum dust deposition on leaf surface was recorded in *Ficus benghalensis* and *Pongamia pinnata*. Minimum dust deposition was found on *Spathodea campanulata*. The pH of leaf wash of dust was found maximum on dust polluted leaves as compared to the control. The minimum total chlorophyll content was recorded in dust affected leaves.

Key words: Dust, Leaves, Chlorophyll, pH.

INTRODUCTION

The Government Vidarbha Institute of Science and Humanities is a major institute in Vidarbha region of Maharashtra State in India. The campus of this institute is occupied by many herbs, shrubs and trees. The institute is situated along the state highway. The amount of dust particles presents in the atmosphere causes air pollution. The dust present in the atmosphere is ultimately settle on ground and on vegetation. The dust is fine particle and particulate matter in the atmosphere. Dusts consist of solid matter in a minute and fine state of subdivision so that the particles are small enough to be raised and carried by wind. They may originate from many sources. A large range of industrial processes can produce particulate emissions (Fenelly, 1975). Dust particles emitting from different sources affects plant life in different ways. The plant exposed to heavy dust pollution shows variation according to the density of falling dust particles, the cover formed by deposition of dust particle decrease the pigment of plant leaves. The physical and chemical properties of plant tissue can also be changed by such large dust pollution. The dust deposition causes various effects on life activities of plants.

Plants are indispensable part of ecosystems and their sensitivity to air pollution is more considerable than standards of air pollution (Thomas,

1991). Air pollution has become a serious environment-tal stress to crop plants due to increasing industriali-zation and urbanization during the last few decades (Rajput and Agrawal, 2004). Diverse changes induced by different air pollutants in plants with respect to morphological, anatomical and physiological charac-teristics have been investigated (Rao,1981; Pawar and Dubey,1983; Rao and Dubey, 1988). Considering the role and effect of dust on plants, present work is attempted.

MATERIAL AND METHODS

Study area

The geographical area of state of Maharashtra is around 3,07,713 km^2, among which 61,939 km^2 is surrounded by green and beautiful forests. Amravati district has geographical area to 121,235. km^2, classified by tropical stunted semi-evergreen forests, stunted semi-evergreen shrubs forests, moist deciduous and dry deciduous forests. The Amravati district is situated between 20°32' and 27°46' North latitudes and 76°37' and 78° 27' East longitudes. The survey and study of dust polluted plants were carried out in campus of Government Vidarbha Institute of Science and Humanities, Amravati (M.S.), India.

Collection of sample:

Dust deposited fresh leaves of fifteen plant species like *Pongamia pinnata, Spathodea campanulata, Cassia fistula, Nyctanthus arbortristis, Ficus religiosa, Polyalthia longifolia, Morinda citrifolia, Bougainvillea spectabillis, Annona squamosa, Bahunia variegate, Ficus benghalensis, Plumaria alba, Tabebuia argentea, Butea monosperma, Sapindus mukorossi,* were collected in the month of January to March 2017. Observations of selected plants were carried out for 7 to 8 weeks. The polluted leaves from top, middle and basal region of each plant was considered, collected and used for experimental analysis.

Measurement of dust fall on the leaves :

Ten mature leaves of each sampled plants were collected in a separate polythene bags. Leaves were collected at the height of three to four meters from all the sites. The measurement of dust fall was carried out by the method of Dry technique described by Das and Pattanayak (1997). In this technique at first the intact leaf was weighted (in mg) and then dust particulates from leaf surfaces were gently collected with the help of camel hair brush and the weight of leaf was measured again. The amount of dust deposition in mg/ cm^2 was calculated as per the following formula.

$$\text{Dust content } (mg/cm^2) = \frac{\text{Weight of intact leaf - initial weight of leaf}}{\text{Total surface area of leaf } (cm^2)}$$

Estimation of dust holding capacity :

The leaves of dust polluted plants were selected about three meters from the ground level. The sample of leaves were plucked off randomly from aerial part of the plant . Five samples of leaves were taken and average of it is considered. The leaves were brought in the laboratory and washed with distilled water. Suspension of dust were collected in petridish. The distilled water is then filtered using preweighed filter paper and dust is collected. the weight of dust is noted after evaporation of moisture. The same weight is used to calculate dust holding capacity with the help of formula

$$\text{Dust holding Capacity } (gm / m^2) \text{ /month)} = \frac{\text{Total weight of dust}}{\text{Total leaf area}} \; X \; \frac{30}{\text{No. of days of exposure}}$$

Determination of pH of dust :

A pinch of dust collected from both the surface of leaves were taken and added in that 5 ml distilled water. The mixture is homogenized in a glass beaker. A broad range pH paper indicator is taken and dipped in the dust - water suspension. The colour change of paper is matched with colour scale on a pH paper booklet. The pH values of each sample were compared and noted.

Measurement of total chlorophyll :

The chlorophyll pigment of dust polluted leaves were estimated following the method of Arnon (1949). The fully expanded and dust deposited leaves from differ-ent sites of the Institutes campus were collected in the polythene bags and brought to the laboratory. The leaves were washed out thoroughly with distilled water. Three replicates were used for each plant. 01 gram leaf tissues of sampled material was grinded, homogenized and extracted thrice in chilled 80% acetone (v/v). It was then centrifused at 5000 rpm for five minutes and supernatant is made to 100 ml by adding 80 % acetone and the optical density was measured at 645nm and 663nm on a spectrophoto-meter. The concentration of the chlorophyll pigments was calculated using the following formula and the

results are expressed in mg/g fresh weight.

Chlorophyll a = [(12.7 X OD at 663) - (2.69 X OD at 645)] X dilution factor

Chlorophyll b = [(22.9 X OD at 645) - (4.68 X OD at 663)] X dilution factor

Total chlorophyll = [(20.2 X OD at 645) - (8.02 X OD at 663)] X dilution.

RESULT AND DISCUSSION

Monitoring of air pollution by higher groups of plants is a recent development in the field of environmental sciences. Monitoring of dust pollution by forage crops, taking morphological characters into considerations has earlier been worked out by many workers (Mishra *et al.* 1995 , Quadir, *et al.* 1997). The dust deposition on both the surface of leaves of different plants of different families were studied . Total fifteen plants were sampled (Table 1) . The amount of deposition of dust found varied with respect to the size and texture of leaves.

The leaves of members of different families were surveyed and collected from institute campus and observations were recorded. The various parameters of dust polluted leaves were recorded (Table 2) e.g. Dust holding capacity mg / cm^2 of leaf surface, pH of leaf surface dust wash and total chlorophyll content mg/g of fresh leaves etc. A considerable variation regarding the results were found at different air polluted locations of the campus. From the observations recorded, it is clear that, the maximum dust holding capacity is found in *Ficus benghalensis* and *Pongamia pinnata* respectively. It may be due to the large surface area, texture of leaf surface for holding the maximum dust particles. Such type of observations was noted by another worker in *Muntingia calabora* in which he found maximum dust deposition on leaves having rough nature and presence of minute hairs on surface of leaves. The minimum dust deposition was found on leaf surface of *Spathodea campanulata* and *Butea monosperma.*

The minimum dust deposition was found in *Acacia arabica* due to its minute, pinnate and smooth surface of leaves (Naik and Somasheker et.al 2006). The average of dust holding capacity of different dust polluted leaves were found to be 0.12 with standard error 0.07. The standard deviation and sample variance were found to be 0.28 and 0.08 respectively in studied plants sample. Supe and Gowande, et al. (2013) carried out the work on effects of dust fall on vegetation, according to their study dust pollution is important issue of ambient air.

Table : 1 List of plants sampled for dust deposition on leaf surface

S.N.	Family of the Plant	Name of the Plant
1	Annonaceae	*Polyalthia longifolia (L.) (Sonne).Thas.*
2	Annonaceae	*Annona squamosal L.*
3	Apocynaceae	*Plumeria alba L.*
4	Bignoniaceae	*Spathodea campanulata L.*
5	Bignoniaceae	*Tabebuia argentea L.*
6	Fabaceae	*Pongamia pinnata (L.) Pierre*
7	Fabaceae	*Cassia fistula L.*
8	Moraceae	*Ficus religiosa L.*
9	Moraceae	*Ficus benghalensis L.*
10	Nyctaginaceae	*Bougainvillea spectabiolis L.*
11	Nyctaginaceae	*Nyctanthus arbor-tristis L.*
12	Papilionaceae	*Bauhinia verigeta L.*
13	Papilionaceae	*Butea monosperma (L.) taub*
14	Rubiaceae	*Morinda citrifolia L.*
15	Sapindaceae	*Sapindus mukorossi L*

Table 2 : Estimation of DHC , pH and total Chlorophyll of dust deposited leaves

S.N.	Name of the plant	DHC (mg/cm² leaf surface)		pH (leaf wash)		Total chlorophyll (mg/g fresh leaves)	
		Control	Polluted	Control	Polluted	Control	Polluted
1	*Annona squamosa L.*	00	0.0003	8.5	9.2	0.42	0.39
2	*Bahunia variegate L.*	00	0.016	4.4	4.5	0.36	0.31
3	*Bogainvillea spectabilis L.*	00	0.003	3.4	4.1	0.34	0.25
4	*Butea monosperma (L). taub*	00	0.001	6.6	7.2	0.54	0.42
5	*Cassia fistula L.*	00	0.05	5.6	5.9	0.29	0.26
6	*Ficus benghalensis L .*	00	0.836	6.1	6.5	0.29	0.67
7	*Ficus religiosa L.*	00	0.04	5.4	6.5	0.22	0.14
8	*Morinda citrifolia L.*	00	0.014	7.6	8.1	0.64	0.55
9	*Nyctanthus arbor tristis L.*	00	0.02	6.1	6.4	0.31	0.29
10	*Plumaria alba L.*	00	0.004	8	9	0.5	0.45
11	*Polyalthia longifolia (L).(sonne). thas*	00	0.024	6.4	7.1	0.34	0.29
12	*Pongamia pinnata (L).Pierre*	00	0.77	5.6	6.1	0.44	0.35
13	*Sapindus mukorossi L.*	00	0.029	6.9	7.1	0.6	0.55
14	*Spathodia companulata L.*	00	0.001	3.4	3.9	0.39	0.25
15	*Tabovia argontea L.*	00	0.0022	6.5	6.9	0.28	0.21
	S.E.	00	0.07	0.39	0.41	0.03	0.04
	S.D.	00	0.28	1.49	1.57	0.12	0.15

DHC = Dust Holding Capacity

The pH of surface dust deposited on the leaf surface were found maximum as compared to the control plants that were sparingly deposited by dust where amount of dust was very less in the campus area and that were very less deposited by dust particles. The standard error found to be 0.03 and deviation of the samples by 0.12 respectively. The change in the pH value may be due to moisture content held by deposited dust.

The Maximum concentration of chlorophyll pigment found in the polluted plant in *Ficus benghalensis* and minimum was recorded in *Ficus religiosa*. The reduction in chlorophyll concentration in the polluted leaves could be due to chloroplast damage inhibition of chlorophyll synthesis. The dust particle affects plant leaves and ultimately affecting the photosynthesis and respiration. Dust can cause the leaf injury stomata damage, premature senescence and can decrease photosynthetic activity, disturb membrane permeability and reduce growth and yield in sensitive plant species. (Agrawal et al. 2006, Tiwari et al. 2006). Of the fifteen plants studied *Cassia fistula* were found more resistant to dust pollution followed by *Nyctanthes arbortristis.* The decrease in chlorophyll content was observed in *Ficus religiosa.*

The capacity of leaves as dust receptors depends upon epidermal and cuticular features of leaves, surface geometry, phyllotaxy, type of canopy, leaf pubescence etc. The dust deposition not only depend upon the size and area of leaf surfaces but also the nature of leaf surfaces, thickness of leaf, orientation etc. which play an important role in the concentration of dust deposition and chlorophyll content. The photosynthetic pigment are the most likely to be damaged by air pollution. It may be because of the age of the leaf period of senescence, sensitivity of the plant species, biotic and abiotic condition and position of plant at the cross roads, suggest that high level of automobile pollution decreases chlorophyll content in higher plant near roadside (Gami and Patel, 2015).

The study indicates that the total chlorophyll in control plants was always higher than that of the plants grown in dust polluted atmosphere. The reduction in yield may be attributed to the reduction in the photosynthetic pigments and the deposition of dust which leads to the clogging of stomata that interferes with gaseous exchange. The decrease in total chlorophyll content in unit fresh weight of polluted leaves might be due to chloroplast damage by incorporation of dust particulates into leaf tissue.

Similar observations have also been made by Singh and Rao (1978).

Pandey and Kumar (1996) are of opinion that alkaline condition caused by solubilization of dust in to cell sap might be the cause of chlorophyll degradation. Increased dust deposition and subsequent reduction in chlorophyll may be positively correlated with reduced photosynthetic efficiency.

CONCLUSION

The protection of healthy environment is an important issue. The Rapid deforestation and loss of vegetation helps to damage healthy environment as well as natural resources. The vegetation and forests are very important to balance the ecosystem. It is revealed that the exposure to particulate deposition may alter plant growth and their production even though there may or may not be any marked physical damage to the plant.

Conflicts of interest: The authors stated that no conflicts of interest.

REFERENCES

Agrawal M, Singh B, Agrawal SB, Bell JNB and Marshall F (2006) The effect of air pollution on yield and quality of mungbean grown in periurban areas of Varanasi. *In: Water Air Soil Pollut.169:239–254.*

Arnon DI (1949) Copper enzyme in isolated chloroplasts, ployphenoloxidase in Beta vulgaris. *In : Plant Physiol., 24, 1-15 (1949).*

Bendre AM Practical botany, Rastogy publication, Merrut, India. First edition 2007-2008, pp 69-71.

Fennelly PF (1975) Primary and secondary particulates as pollutants. *In: J. Air Pollut. Contr. Assoc., 25, 697-704.*

Gami AH and Patel NK (2015) Comparing study of marble dust fall and examine chlorophyll content in various seasons of vegetation of Danta taluka. *In: International research Journal of chemistry (IRJC) ISSN 2321- 2845 (ONLINE, 2321- 3299 .*

Mishra PN, Mishra AK, Williams AJ, Dugays D and Banerjee SK (1995) Biological reclamation of fly ash forest plantations. *In: Env. Ecol. 13 : 11-13.*

Naik DP, Ushamalini and Somashekar RR (2006) Dust pollution monitoring in stone Quarry area-A case study narasapura ko- lar district, Karnataka. *In: J. of Industrial pollution control 22(2) pp 357 360).*

Pandey DD and Kumar S (1996) Impact of cement dust pollution on biomass, chloph roll, nutrients and grain characters of wheat. *In: Environ & Ecology. 14: 872-875.*

Pawar K and Dubey PS (1983) Effect of atmospheric pollutant on the morphology and pigment content in proceeding of sixth world congress on air quality. *In: Paris 2:501–50.*

Qadir N, Quereshi RH and Ahamad N (1997) Reclamation of saline sodic soil by gysono and leptochlora fusca. *In: Geoderma. 74 : 204 -217.*

Rajput M and Agrawal M (2004) Physiological and yield responses of pea plants to ambient air pollution. *In: Indian J. Plant Physiol. 9:9–14.*

Rao DN (1981) Phytomonitoring of air pollution.: *In Osmania University, Hyderabad, WHO workshop on biological indicator and indices of Environmental Pollution: pp. 1–8.*

Rao MV and Dubey PS (1988) Plant response against SO_2 in field conditions. *In: Asian Environ.10:1–9.*

Singh SN and Rao DN (1978) Possibilities of using chlorophyll and potassium contents in plant to direct cement dust pollution. *In: Indian .J. Environ* 20 : 10 -13.

Supe NG and Gawande MS (2013) Effect of dustfall on vegetation. *In: International Journal of Science and Research (IJSR) ISSN(online): 2319-7064.*

Thomas H (1991) Accumulation and consumption of solutes in swards of *Lolium perenne* during drought and after rewatering. *In: New Phytol. 118:35–48.*

Tiwari S, Agrawal M and Marshall FM (2006) Evaluation of ambient air pollution impact on carrot plants at a sub urban site using open top chambers. *In: Environ. Monit. Assess. 119:15–30.*