International Research Journal of Biological Sciences ISSN 2278-3202
Vol. **8(8),** 20-24, August **(2019)** *Int. Res. J. Biological Sci.*

Short Communication

Effect of cement dust on physiology of selected trees at Cement Nagar, Bethamcherla (Mandal), Kurnool district, A.P., India

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Available online at: www.isca.in, www.isca.me
Received 3th December 2018, revised 15th May 2019, accepted 10th July 2019

Abstract

The present learn is carried to find out Air pollution tolerance index standards of twenty plant species growing around Panyam cement factory, Bethamcherla mandal of Kurnool district, A.P., India to recognize the plant species that are forbearing to grown up in cement dust polluted areas. The study revealed an increase in their APTI values in eight species and indicated that these 8 species may be more tolerant to the stress caused by cement dust pollution. The highest percentage increase of APTI is recorded in Ficus benghalensis (94.61), followed by F.religiosa (54.78), Terminalia catappa (46.57), Leucania leucocephala (35.45) and Mangifera indica (32.03). They can also capable to raise water table of the soil by plummeting temperatures of the area due to their increase in population and by covering the soil surface with their huge canopy.

Keywords: Pollution, Cement dust, Air pollution tolerance index, chlorophyll, biological indicators, pollution resistant species etc.

Introduction

Air pollution is one of the severe problems facing today by the world. Due to human activities such as energy usage, agriculture, urbanization and industrialization there was a high demand of infrastructure due to population increase, hazardous substances are distributed widely in ecosystem. Cement industry is one of the 17 most contaminant industries listed by central pollution control board. The main impact of it to the environment is the broadcast of dusts and gases. It also plays a crucial errand in the disparities of the environment and produces air pollution hazards[1].

Research on the impact of solid particulate matter dates back into the 18th century. Research on atmospheric effluence and its bang on plants have focused chiefly on phyto toxic elements such as NO_2, O_3, and SO_2. In the previous years research on the effect of particulate matter all over the world is increasing. Numerous studies are offered in the literature on effects of fine dusts on human health. But it must be renowned that there are only a small number of studies about their effects on plant life. The extent of injure caused by fine dust depositions distressing plants "Physiological processes" where recurrently not considered.

Cement furnace dusts are a complex mixture of elements, including high levels of, zinc, copper, fluoride, lead, magnesium, cadmium, nickel, beryllium and other compounds. The main ingredient of cement is limestone. Several studies underline the depressing effects of cement dusts on the plants in the long run. The studies revealed that cement dusts increases the rate of plants[2]. The particulate dirt falling on the leaves of plants have been found to affect stomatal functioning, photosynthesis, pigment and metabolic constituents, productivity and also cause foliar injuries and reduction in yield[3].

The effect of direct cement dust particles on chlorophyll accumulation in leaves is two-fold. Chlorophyll biosynthesis is a good indicator of plant productivity as it represents the plants potential in food manufacture.

As the plants are universal sinks of CO_2, plantation of species to trap air polluting dust is needed. The improved recital comes from the pollution lenient species[4]. By monitoring plants forbearance towards air pollution, they can be screened and can be considered as biological indicators or monitors of air pollution[5]. Plants retort to air pollution is resoluted by the air pollution tolerance index (APTI) and APTI determines the plants elegance to fight against air pollution[6]. Thus to lessen the pollution, the APTI assessment and recognition of the air pollutant defiant species is desired. Dust pollution causes water distress in habitats.

Thus persuasion of APTI values of plants growing in such areas is advantageous to list out the plants that are suitable to propose to grown up in dust polluted areas, because rising of species that are having immense APTIs are proficient to increase their population magnitude and can also capable to increase water table by plummeting temperatures of the region.

In the present heave, we meant to conclude Air Pollution Tolerance Index (APTI) values for twenty plant species growing around Panyam cement factory, Bethamcherla Mandal of Kurnool district, A.P., India.

Methodology

Study area: The present study is conducted at Panyam cements industry of Cement Nagar in Kurnool district, Andhra Pradesh, India which is positioned in the middle of longitudes of 77.51, latitudes of 15.41. Autumn, winter, spring, and summer are the four distinct seasons' that can be seen here. The surroundings of the region is fairly temperate with an usual rainfall of about 150 cms. This is essentially restricted to monsoon months. Temperature ranges of 28^0C–44^oC. Two sites are chosen for the study. Site-1 is a control area where there are no cement industries that is Rayalaseema University campus, Kurnool. Site-2 is dust polluted region, horrifically nearer to cement industry area, which discharge cement dirt pollutants into the environs.

Sampling of plants and their analysis for physiological studies: Twenty plants are selected for the study and their leaves are collected from both the sites. Five replicates of the samples are gathered from study localities and brought to the laboratory for analysis. Fresh weight of both the leaf samples is taken immediately. These samples are stored in refrigerator for other study.

Determination of Air Pollution Tolerance Index (APTI): APTI is determined by using the method and formula described by Singh and Rao[7].

APTI = A (T + P) + R/ 10., A = Ascorbic Acid content (mg/g)., T = Total Chlorophyll (mg/g)., P = P^H of leaf extract., R = Relative Water Content of leaves (%).

Ascorbic acid assessment: Ascorbic Acid (AA) content is analyzed by using titration method described by Anne Marie Helmenstine[8]. 20ml of the sample solution is Pippetted into a 250ml of conical flask and then 150ml of distilled water and 1ml of starch indicator solution is added. The sample is titrated with 0.005mol/L Iodine solution. The end point of the titration is recognized as the first permanent trace of a dark blue-black color due to the starch-iodine complex. Repeated the titration with further sample solution until obtained concordant result. We determined the number of moles of ascorbic acid reacting by using the following equation of the titration:

Ascorbic Acid + I2 → 2I- + de hydro ascorbic acid.

The concentration of ascorbic acid is calculated in the sample of leaf in mg/100ml.

Total Chlorophyll Content (TCh): This carried out according to the method described by Arnon[9]. 3g of fresh leaves were blended and then extracted with 10ml. of 80% acetone and left for 15 minutes for thorough extraction. The liquid portion was decanted into another test tube and centrifuged at 2,500rpm for 3 minutes. The supernatant was then collected and the absorbance taken at 645nm and 663nm using a spectrophotometer. The formula given by Maclachlan and Yentsch[10] is used to estimate the concentration of chlorophyll 'a' and chlorophyll 'b' (mg/g – fresh leaf).

Chlorophyll a = 12.7 x $O.D_{663}$ - 2.69 x $O.D_{645}$.
Chlorophyll b = 22.9 x $O.D_{645}$ – 4.68 x $O.D_{663}$.
Chlorophyll a/b = Total amount of chlorophyll a / Total amount of chlorophyll b
Total chlorophyll content a+b = 8.02 x $O.D_{663}$ + 20.2 x $O.D_{645}$.

Leaf extract P^H: As described in Agbaire and Esief[11], 5gms of fresh leaves are homogenized in 10ml. of de-ionized water. This is filtered and P^H of the leaf extract is determined after calibrating pH meter with buffer solution of pH4.

Relative Water Content (RWC): By using the method described by Singh, 1997[12], the RWC of leaves is determined and it is calculated with the formula **RWC** = FW – DW / TW – DW x 100.

FW = Fresh Weight, DW = Dry Weight, TW = Turgid Weight

Fresh weight of the leaves is recorded by weighing the fresh leaves. The leaves are dried in an oven at 70^0C for overnight and then taken the dry weight. The leaves are immersed in water overnight, blotted dry and then weighed to obtain the turgid weight.

Figure-1: Google map showing Panyam cements and Mineral industries of Bethamcherla Mandal, Kurnool district, A.P., India.

Results and discussion

The values of analysis for all parameters carried out on 20 plant species collected from two selected sites for the study of Kurnool district are shown in the Table. Figure-2 showing the graphical representation of Air pollution tolerance index of samples collected from site I and site II.

In the following 11 plants Air pollution tolerance index (APTI) is high in unpolluted area and it is decreased in polluted area. i. *Albizia odoratissimma – 14.53 and 11.11;* ii. *Annona squamosa* - 16.05 and 12.9; iii. *Cordia dichotoma* – 24.95 and 23.1; iv. *Derris indica–18.84 and 13.13;* v. *Ficus mollisima* – 15.07 and 13.5; vi. *Ficus recemosa*–23.03 and 18.4; vii. *Holoptelea integrifolia* – 13.81 and 10.2; viii. *Moringa oleifera* – 15.46 and 13.8; ix. *Polyalthia longifolia* – 16.16 and 15.3; x. *Syzygium cumini*–14.32 and 12.3; xi. *Tamarindus indica – 29.09 and 13.79;*

In the following 8 plants APTI is less in unpolluted area and it is increased in polluted area. i. *Azadirachta indica – 10.37 and 12.29;* ii. *Eucalyptus obliqua* – 9.68 and 10.8; iii. *Ficus benghalensis* – 13.49 and 40.3; iv. *Ficus religiosa* – 15.57 and 24.1; v. *Leucaena leucocephala* – 11.96 and 16.2; vi. *Mangifera indica* – 9.77 and 12.9; vii. *Sapindus emarginatus -10.7 and 10.42:* viii. *Terminalia catappa* – 12.28 and 18;

In the following plant APTI is almost equal in unpolluted and polluted areas. i. *Albizia lebbeck* - 11.66 and 11.9;

The evaluated APTI for the studied plants at control site and polluted site are in the range of 9.69 - 29.09 and 10.2 - 40.3 respectively. In 11 of the studied plant species APTI's are decreased at polluted site indicating that they are undergoing to the pollution stress. Eight of the species has shown an increase in their APTI's, where as in one plant there is no much change as stated in the results. Therefore, the result indicates that these 9 species may be more tolerable to the stress caused by cement dust pollution.

Percentage increases of the studied plants resulted highest increase for *F.benghalensis* (94.61) followed by *F.religiosa* (54.78), *T.catappa* (46.57), *L. leucocephala* (35.45), *M. indica* (32.03), *A. indica* (18.51), *E.obliqua* (11.57), *S. emarginatus*(10.42) and *A.lebbeck* (2.05).

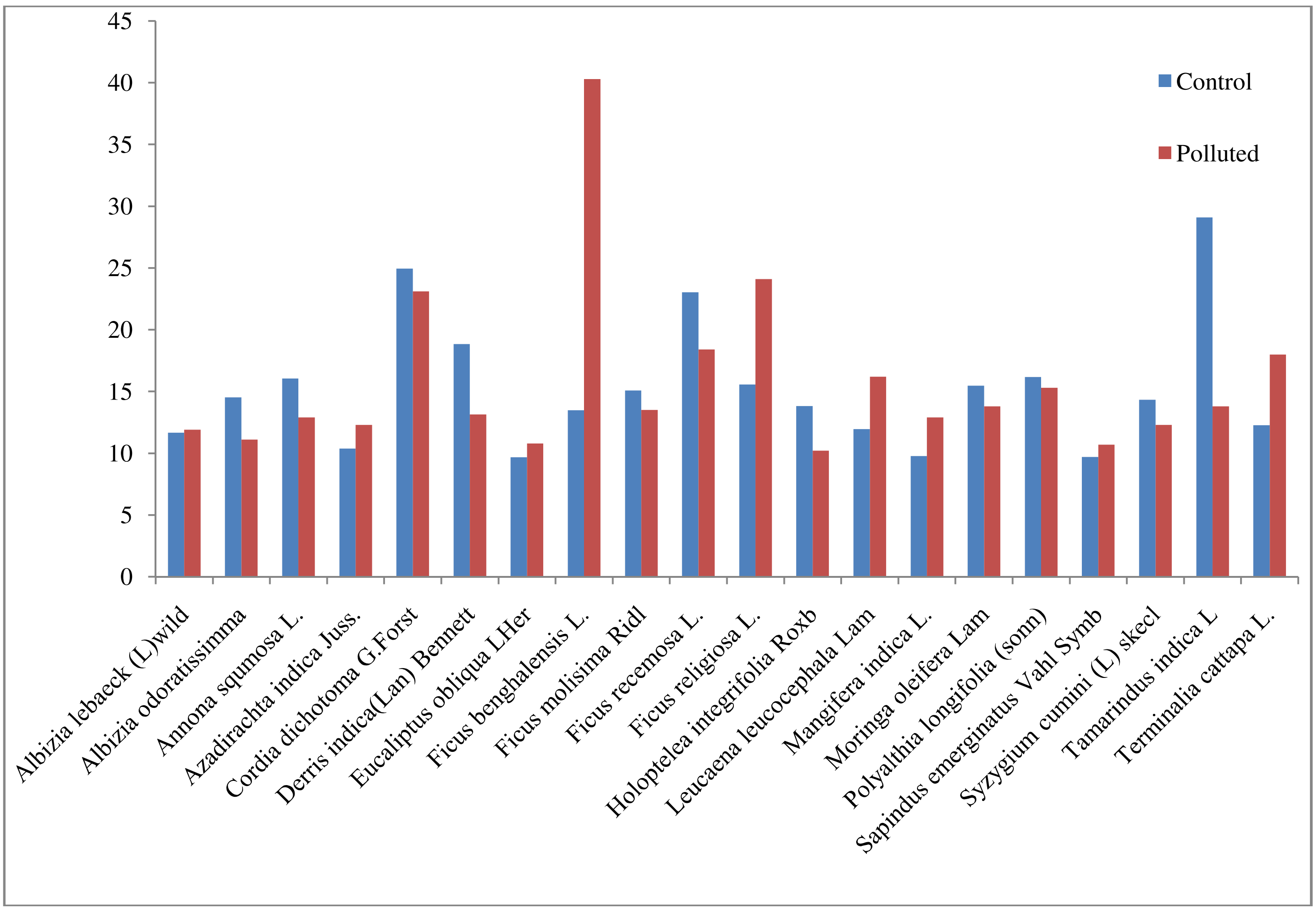

Figure-2: The graphical representation of Air pollution tolerance index of samples collected from site I and site II.

Table-1:

Name of the plant	Family	P^H value		RWC value		Chlorophyll		Ascorbic acid		APTI		% Increase /Decrease
		C	P	C	P	C	P	C	P	C	P	in APTI
Albizia lebbeck (L)wild	Fabaceae	6.7	6.8	65.72	76.5	0.29	0.74	7.24	5.65	12.0	11.9	2.05
*Albizia odoratissimma (*L.f) Benth.	Fabaceae	6.4	6.0	85.39	73.7	0.7	0.63	8.43	5.65	15.0	11.11	23.53
Annona squmosa L.	Annonaceae	6.3	6.0	91.64	86.4	0.48	0.39	10.1	6.7	16.0	12.9	19.62
Azadirachta indica Juss.	Fabaceae	6.2	7.4	79.86	75.7	0.72	0.91	3.43	5.65	10.0	12.29	18.51
Cordia dichotoma G.Forst	Boraginaceae	7.3	6.8	91.09	84.2	0.58	0.49	20.1	20.1	25.0	23.1	7.41
*Derris indica (*Lan) Bennett	Fabaceae	6.9	7.9	84.17	91.6	0.39	0.6	14.4	4.64	19.0	13.13	30.3
Eucaliptus oblique LHer	Myrtaceae	5.1	5.4	73.21	89	0.45	0.5	4.26	3.43	9.7	10.8	11.57
Ficus benghalensis L.	Moraceae	7.4	7.5	92.94	92.2	0.85	0.61	5.1	38.5	13.0	25.3	94.61
Ficus molisima Ridl	Moraceae	7.8	7.4	96.51	94.2	0.73	0.7	6.35	5.1	15.0	13.5	10.41
Ficus recemosa L.	Moraceae	7.1	7.2	91.3	80.6	1.24	0.67	16.7	3.25	23.0	18.4	20.1
Ficus religiosa L.	Moraceae	7.6	6.8	95.18	87.8	0.8	0.78	7.24	20.1	16.0	24.1	54.78
Holoptelea integrifolia Roxb	Ulmaceae	7.1	7.0	98.02	75.7	0.76	0.74	5.1	3.44	14.0	10.2	26.14
Leucaena leucocephala Lam	Fabaceae	6.3	6.2	94.77	92.5	0.23	0.56	3.8	11.21	12.0	16.2	35.45
Mangifera indica L.	Anacardiaceae	5.9	6.1	63.3	97.9	0.45	0.45	5.41	4.81	9.8	12.9	32.03
Moringa oleifera Lam	Moringaceae	5.8	5.9	86.31	90.1	0.25	0.28	11.2	7.79	15.0	13.8	10.77
Polyalthia longifolia (sonn)	Annonaceae	6.3	6.0	95.7	98.8	0.19	0.72	10.1	8.16	16.0	15.3	5.32
Sapindus emerginatus Vahl Symb	Sapindaceae	6.2	7.1	70.32	55.1	0.52	0.71	3.94	6.76	9.7	10.7	10.42
Syzygium cumini (L) skecl	Myrtaceae	6.2	6.2	92.05	91.8	1.86	1.43	6.35	4.1	14.0	12.3	14.1
Tamarindus indica L	Fabaceae	3.4	5.9	77.9	80.3	0.2	0.36	62.6	9.19	29.0	13.79	52.59
Terminalia cattapa L.	Combretaceae	5.3	6.0	87.2	84.0	0.63	1.58	5.9	12.6	12.0	18.0	46.57

Conclusion

Since the APTI is increased and percentage increase of APTI is also high in *F.benghalensis*, *F.religiosa*, *T.catappa*, *L. leucocephala* and *M. indica*, these plants are highly suggestible to develop the green belts and to raise the water tables around the cement industries.

Acknowledgements

We are thankful to our Vice-chancellor, Registrar and Principal for their co-operation to conduct this work in department laboratory of Rayalaseema University, Kurnool -7, A.P., India.

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