RESEARCH ARTICLE

Dust retaining potential of *Tithonia diversifolia* (Hemsl.) A. Gray

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ABSTRACT

The suspended particulate matter or dust is one of the many pollutants present in the atmosphere. It is a renowned fact that vegetation helps in reducing dust concentrations in environment by acting as sink for air pollutants. Dust fall studies done on a perennial herb Tithonia diversifolia (Hemsl.)A.Gray at 10 different sites selected throughout the industrial area of Tarapur implies that in comparison to Control site readings, all the other sites had considerably high dust fall values throughout the 2 dry seasons i.e. from October 2012 to May -2013. Severely affected months in the entire study period were October, November, December and January. Sampling sites in closer proximities to vehicular and industrial pollution sources showed highest accumulation of foliar dust.

Keywords: *Tithonia diversifolia* (Hemsl.) A. Gray, Tarapur, Dust fall.

INTRODUCTION

Tarapur Industrial Area located at 17.7°N 75.47°E at an average elevation of 456 meters in Palghar Taluka, Thane district of Maharashtra is one of the biggest industrial estates in Maharashtra stretch over 1130 hectares and accommodates around 1100 industrial units of different categories like chemicals, textiles engineering plastic, packing etc. There are about 390 chemical units, which have been identified as one of the major sources of environmental pollution (MPCB, 2012). Three air quality monitoring stations were identified by MPCB in the industrial area of Tarapur namely MIDC office compound, Police Chowky and Sports stadium. Regular monitoring was done from installation of the stations up till the year 2010 but no later data till date is available at the official websites of MPCB and CPCB. In fact, the air monitoring stations of Tarapur are not even included in many current reports and databases of monitoring authorities.

Urban dust is a mixture of heterogeneous particulate matter consisting of heavy metals, tarry deposits and other particles associated with day to

day activities in that area (Das and Bhaumik, 1980). Since the physicochemical properties of dust samples differ from area to area, depending on the type of industrial activity carried out there, their injurious effects on plants and animals also differ.

The area not monitored by agencies regularly, therefore it was necessary to know the environmental disturbances. Plants have been used to monitor dust in nearby city of Mumbai in the past Shetye and Chaphekar (1980). In an environmental survey around the coal depot at Chandasi and Varanasi, Rao (1979) observed the severe injury effect of coal dust deposition on *Mangifera indica* and *Dalbergia sissoo* trees leading to their death within a period of two years.

Chaphekar *et.al*., (1980) used leaves of trees like *Mangifera indica*, *Thespesia populnea* and *Polyalthia longifolia* for the estimation of dust fall in 20 different types of localities of Mumbai city in order to monitor airborne dust settling by gravity. They also observed marked reduction in growth of potted plants of *Commelina benghalensis* transplanted in heavily polluted areas of Mumbai city. Joshi and Joshi (2013) showed that *Hyptis suaveolens* had high dust capturing capacities amongst the ruderal plants in the city of Mumbai..Foliar surface of plants is an important receptor of atmospheric pollutants hence it is very crucial to select suitable plant species for urban environment (Lou et al., 2012).In the current study a known phytomonitor is used to estimate dust fall in the industrial area of Tarapur.

MATERIALS AND METHODS

1. Selection of plant material:

Tithonia diversifolia (Hemsl.)A.Gray an ornamental species from Asteraceae family was chosen for this study. A perennial herb reaching to a height of 1-3 m, it has broad ovate leaves sometimes 3-5 lobed with crenate margin. Leaves and petioles are pubescent and inflorescence is Sunflower like. The seeds were grown in an nursery and transplanted in pots after 4-5 leaf stage.the plant was used by Joshi ,N.C(1990) for monitoring ambient air quality of Mumbai.

2. Study Area:

Tithonia plant sets were monitored for their dust capturing abilities. 4 sets each, with each set consisting of three transplants of *Tithonia* saplings were placed at ten different sites in the year 2012-2013 around the industrial area of Tarapur, Palghar district, Maharashtra, India. The description of experimental sites is given in Table 1.

Table 1: Sites in Tarapur chosen for dust fall studies using *Tithonia diversifolia* from October 2012- May 2013

S.N.	SITE NAME	DESCRIPTION OF SITE
1	Pam –Tembhi (Control)	Village area, away from vehicular and industrial pollution.
2	Tarapur Industrial Manufacturing Association (T.I.M.A.) Road	Next to vehicular traffic road, industrial area.
3	TATA Wires (a)	Next to heavy vehicular traffic road, Industrial area.
4	TATA Wires (b)	Interior of industrial vicinity.
5	Virender processors Road	Next to heavy vehicular traffic road, industrial area.
6	Nahar textiles Road	Alongside vehicular traffic road, industrial area.
7	Duratex Road	Next to moderate vehicular traffic road, industrial area.
8	Nirlon Road	Roadside with less vehicular traffic, industrial area.
9	SG Synthetics Road	Heavy vehicular traffic consisting of all types of vehicles.
10	Boisar Flyover Road	Roadside connecting to railway station and highway, continuous movement of vehicular traffic.

3. Dust Collection Method:

Foliar dust was collected from leaves present at 3rd and 4th internodes of *Tithonia* plants after an exposure period of 10 days. Dust from the leaves of each plant sample was washed with water using spray bottles and foliar dust was collected in plastic beakers. These beakers were then sealed and labeled. Washed leaves were blotted dry and traced on graph paper to give the total leaf area in cm^2. The collected water sample was brought back to laboratory to perform gravitational dust fall analysis. Dust was carefully collected on pre-weighed Whatman's filter paper (pore size 110mm). The filter paper was then oven dried at 70°C and later weighed to calculate the dust fall.

This technique was repeated after every 10 days of exposure of plant to suspended particulate matter and readings were noted for 10th day, 20th day and 30th day respectively. Later, an average of these three readings was taken in order to quantify the dust retaining ability of the plant. Dust fall was measured in gm/m^2 as suggested by Chaphekar *et al*. (1980). Dust fall estimation was carried out in the 2 dry seasons from October 2012 to May 2013.

4. Statistical analysis:

To determine the significance between samples, a "Student's t-test" was carried out at $p<0.05$ level of significance. Box and Whiskers plot along with Histograms were used for data analysis.

RESULTS AND DISCUSSIONS

Dust fall values from October 2012 to May 2013 at 10 sites selected for this study is represented in (Table 2). A comparative study was carried out for dust fall on plants kept at all experimental sites with control plant set readings. In comparison to the control all the study sites showed significantly higher dust fall (Table 2 and Fig. 1).

The period from October to November showed high dust fall values which abruptly decreased in the month of December. This was followed by a sudden increase in dust fall in January. A gradual decrease in dust fall was observed from the month of February to April with a slight increase at some sites in the month of May. Death of plants was also recorded at some sites

Table 2: Dust fall (gm/m^2) of *Tithonia diversifolia* kept at different sites in Tarapur industrial area from October 2012- May 2013. (Mean of 3 readings± S.E)

NO.	SITE NAME	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
1	Control	0.51 ±0.02	0.68 ±0.15	0.63 ±0.03	1.07 ±0.21	1.04 ±0.27	0.64 ±0.03	0.44 ±0.01	0.36 ±0.01
2	T.I.M.A. Road	*5.57 ±0.12	7.45 ±0.07	NIL	NIL	*4.88 ±0.08	*3.59 ±0.11	*4.66 ±0.78	*4.15 ±0.35
3	TATA Wires (a)	*6.54 ±0.68	*8.12 ±0.89	NIL	NIL	*5.12 ±0.31	*4.96 ±0.64	*4.51 ±0.47	*3.05 ±0.31
4	TATA Wires (b)	*2.65 ±0.3	*3.36 ±0.28	*5.57 ±0.21	NIL	*4.91 ±0.09	*2.92 ±0.52	1.07 ±0.25	*2.20 ±0.3
5	Virender processors Road	*6.36 ±0.16	*7.69 ±0.29	*6.50 ±0.81	*6.61 ±0.55	*5.22 ±0.2	*5.14 ±0.26	*4.24 ±0.74	*5.01 ±0.47
6	Nahar textiles Road	*6.96 ±0.21	6.47 ±0.22	*5.8 ±0.31	*5.42 ±0.14	*5.01 ±0.24	*4.26 ±0.1	*5.07 ±0.83	*3.92 ±0.19
7	Duratex Road	*3 ±0.24	*5.12 ±0.39	*4.71 ±0.17	*4.88 ±0.37	*5.03 ±0.27	*4.27 ±0.19	*2.3 ±0.11	*3.88 ±0.36
8	Nirlon Road	*2.35 ±0.16	*2.6 ±0.15	*3.69 ±0.17	*3.17 ±0.21	*3.1 ±0.07	*2.59 ±0.09	*2.12 ±0.07	*2.28 ±0.22
9	SG synthetics Road	*5.76 ±0.39	*6.03 ±0.32	*5.27 ±0.29	5.97 ±0.17	*5.28 ±0.28	*4.13 ±0.22	*3.63 ±0.11	*3.96 ±0.26
10	Boisar flyover Road	*7.48 ±0.18	*8.73 ±0.75	NIL	*10.95 ±0.72	*10.32 ±0.80	*6.3 ±0.55	*5.51 ±0.55	*5.64 ±0.28

NIL= no reading since plants died

*= significant at $p<0.05$

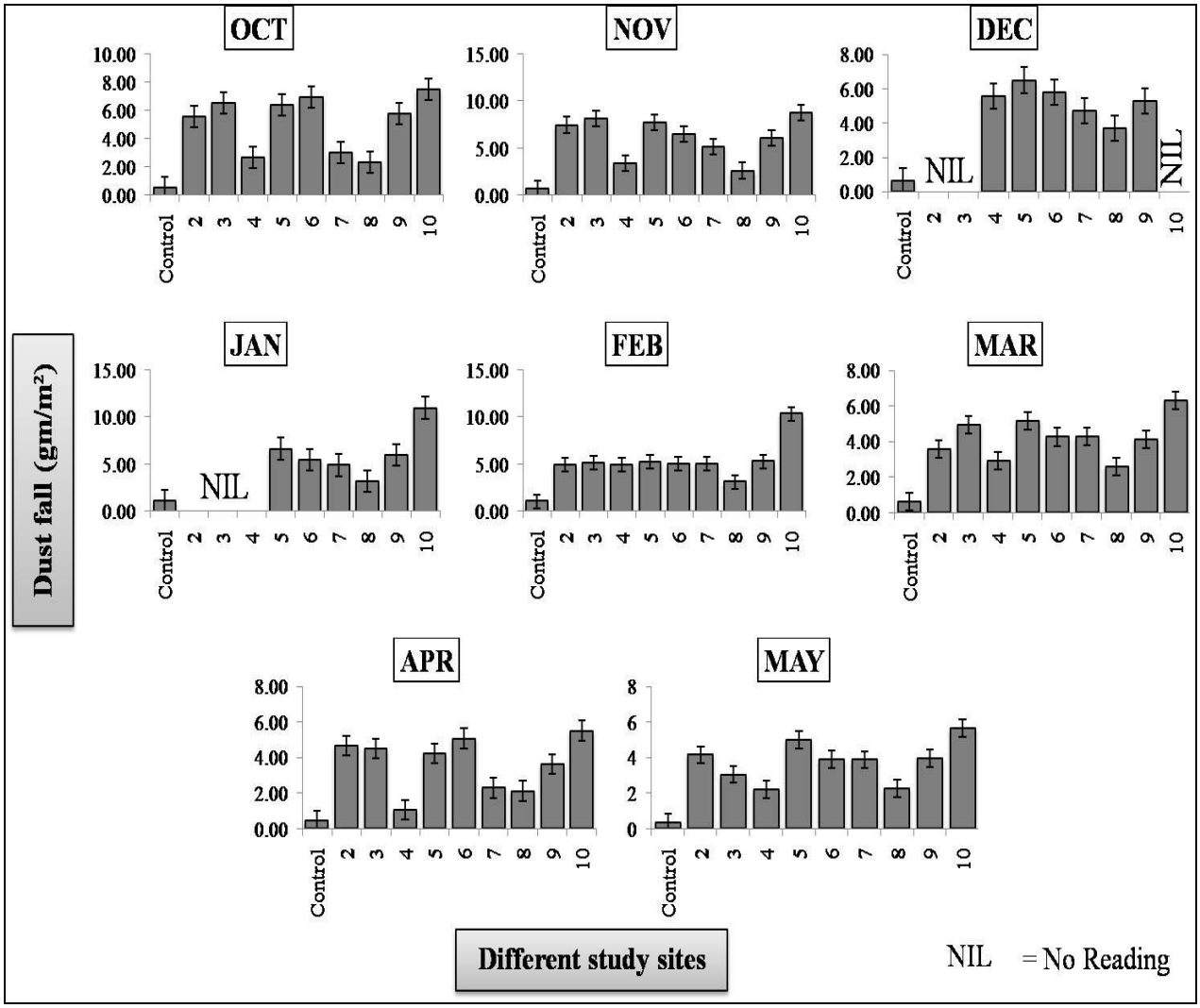

Fig.1: Dust fall (gm/m^2) of *Tithonia diversifolia* kept at different sites in Tarapur industrial area from October 2012- May 2013. (Mean of 3 readings± S.E)

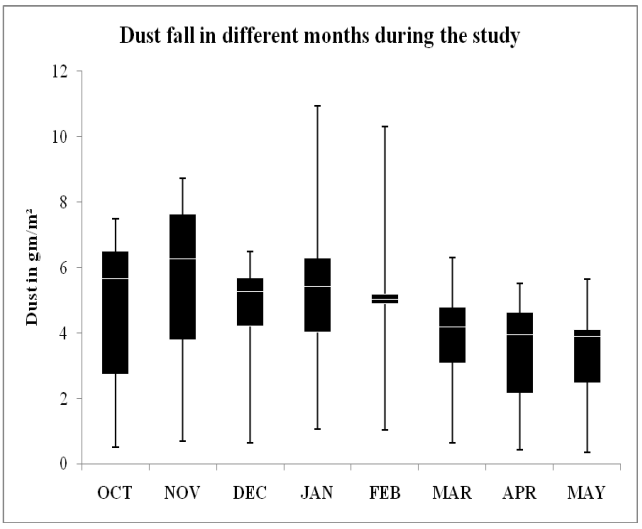

Fig. 2: Box plot of foliar dust fall in different months on *Tithonia* (2012-2013).

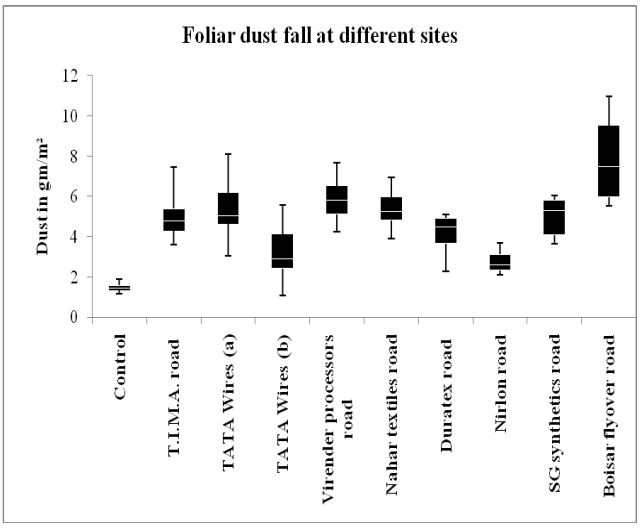

Fig. 3: Box plots of foliar dust fall at different sites during the study period on *Tithonia* (2012-2013).

during the month of December and January (Table 2 and Fig 1).

The Box and Whisker's plot suggest that the average dust fall values were higher in the months of November and October while lowest in the months of April and May (Fig 2). When compared to all the other study sites, the month of January (10.95 gm/m^2) and February (10.32 gm/m^2) however showed an increase in the dust fall values at Site – Boisar Flyover Road (Table 2).

Site – Boisar Flyover Road showed significantly high dust fall of 10.95 gm/m^2 in the month of January and 10.32 gm/m^2 in February. Dust fall value of 8.12 gm/m^2 was recorded at Site- Tata Wires a) and 7.69 gm/m^2 was noted at Site- Virender processors Road in the month of November.
In the entire study, Site -Tata Wires b) had lowest dust fall value of 1.07gm/m^2 followed by Site- Nirlon road with a dust fall of 2.12gm/m^2 and Site – Duratex Road which showed a significantly low dust fall of 2.3 gm/m^2 in the month of April (Table 2).

CONCLUSIONS

Site – Boisar Flyover Road, Site- Virender processors Road and Site- Tata wires a) were comparatively dustier sites in the entire study period (Fig.3). This might be due to location of these sampling sites in close proximity to the vehicular traffic and industrial area where there is continuous emission of particulates into the surrounding air which later settles on the foliar surfaces of nearby vegetation.

Site -Tata Wires b), Site- Nirlon road and Site – Duratex Road on the other hand showed significantly low dust fall values as these sites are located at farthest ends of Tarapur industrial area where vehicular movement is comparatively less (Table 2 and Fig 3).

Box plot analysis of the overall study of different months revealed that the month of November and October had high proportion of average dust fall followed by the month of January (Fig. 2). Severely affected months in the entire study period were October, November, December and January. Whereas the months of February, March, April and May were less dustier. Hence on the basis of dust fall analysis it can be concluded that winter months were dustier as compared to the summer months.

High dust accumulation is observed in winter due to wet surface of leaves, gentle breeze and foggy conditions which prevent particle dispersion. Whereas high wind speed in summer may be the reason for lower dust accumulation (Das and Prasad, 2010).

At some sites namely Tata Wires b), Virender processors Road, Duratex Road, Nirlon road SG synthetics road and Boisar Flyover Road, a slight increase in dust fall was recorded in the month of May (Table 2). This may be due to presence of trichomes on laminar surface of *T. diversifolia* that retained dust even in May month when dust storm is a common phenomenon in pre-monsoon period.

Exposure of plants to accumulation of dust particulates may alter the plant growth without causing any physical damage to the plant but can cause a major problem in their production (Chaurasia et.al. 2013). Continuous dust deposition on foliar surface may clog stomatal pore consequently hindering with gaseous exchange. Santosh and Tripathi (2008) found that dust deposition affects photosynthesis, stomatal functioning and productivity and was one of the stresses that provoke severe damage in photosynthetic apparatus.

Hence it is essential to study dust retaining behavior of plants so that plants with good dust capturing ability can be placed around the polluted areas in order to absorb suspended particulates (dust) from air to some extent. Thus, from the above dust fall study and due to presence of trichomes, it can be accomplished that *Tithonia diversifolia* (Hemsl.) A. Gray proves to be a potential dust capturer and can be planted in and around industrial area as a sink to dust pollution.

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