# Phytomonitoring of Dust Using *Pedilanthus tithymaloides* Poit.

ABSTRACT

*Foliar dust was collected from a common plant Pedilanthus tithymaloides* Poit.*, growing along road dividers and traffic islands. Five sites in the city of Mumbai known to have high suspended particulate matter values in the city were selected. The sites were selected on the basis of vehicular types. The sites were Dr Annie Besant Road , Worli;Linking Road , Khar;Western Express Highway , Andheri; Western Express Highway , Borivali and Lal Bahadur Shastri Road ,Bhandup and foliar dust was estimated throughout the dry season. The five sites showed varied SPM values and foliar dust values in the study. High values of foliar dust were in agreement with the existing conditions along the roadsides in different sites. The site Borivali had high values of foliar dust due to construciton activity along the highway, while Bhandup showed high values due to it being a very busy road with all types of vehicles. The plant Pedilanthus tithymaloides* Poit. can be used as a Phytomonitor of dust in the city.

*Key words: Mumbai, Phytomonitor, Dust, SPM.*

## INTRODUCTION:

Urban vegetation in Mumbai city comprises of gardens, avenue trees and ornamental plants which grow along the road dividers and traffic islands at junction of cross roads. This urban vegetation is largely maintained by Municipal Corporation or corporate sectors in their effort to keep the city green. The city of Mumbai is densely populated and polluted. The pollutants range from $NO_x$, CO and SPM (Joshi and Chauhan, 2008). The city shows high range of SPM levels between 500 $\mu g/m^3$ to 190 $\mu g/m^3$ (MCGM, 2013). The total number of vehicles in Mumbai as on January 2011 is 19,09,804 which includes 54.5 % two wheelers, 31.2 % cars, 3.5 % taxis, 2.8 % heavy vehicles, 7.6 % three wheeler and 0.4 % of other vehicles (MCGM 2010-11), contribute significantly to air pollution. Dust pollution itself comprises 40% of total air pollution problems in India (Lone et al. 2005). In Mumbai, the Maharashtra Pollution Control Board (MPCB) monitors air pollution at 3 sites and Municipal Corporation of Greater Mumbai (MCGM) at 6 sites. All the values are higher than the daily permissible levels of 200 $\mu g/m^3$ in winter and summer season. Maximum SPM was recorded in Feb-13 at Andheri (Table 1). That plants can effectively be used to monitor dust is a well-known fact (Yuns et al., 1985; Joshi, 1990).

Due to heavy vehicular traffic there is a movement of suspended particulate matter in the ambient surrounding, which id deposited on roadside plants. Urban trees have effectively been used in the city in the past for monitoring dust air pollution (Chaphekar S. B., 1980). The use of vegetation to filter out dust, soot and particulates from the atmosphere has been extensively used as a common practice in developing countries. Leaves of plants have been regarded as bio filters as they absorb large quantities of particles from the environment (Central Pollution Control Board, 2007). The dust interception capacity of a plant depends on its surface geometry, phyllotaxy and external

characteristics of its leaf such as hairs, cuticle, length of petioles, height /canopy of trees and the prevailing weather conditions with direction and speed of the wind (Prajapati and Tripathi 2008). In urban environment, pollutants commonly found in dust on the roads can be potentially harmful to roadside vegetation, wildlife and the neighboring human settlements (Bhattacharya et al 2011).

This study is an attempt to explore the potentials of *Pedilanthus tithymaloides* Poit. a commonly grown plant along roadsides, as a Phytomonitor of dust.

Table 1: Suspended Particulate Matter at various sites in µg/$m^3$

| **Sites** | **Worli** | | **Khar** | | **Andheri** | | **Borivali** | | **Bhandup** | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Avg | Max | Avg | Max | Avg | Max | Avg | Max | Avg | Max |
| **Dec-11** | 317 | 420 | 344 | 407 | 389 | 482 | 190 | 209 | 458 | 559 |
| **Jan-12** | 265 | 364 | 232 | 333 | 422 | 553 | 261 | 300 | 419 | 542 |
| **Feb-12** | 255 | 339 | 266 | 364 | 500 | 501 | 264 | 297 | 473 | 567 |
| **Mar-12** | 316 | 1061 | 396 | 1357 | NA | NA | 265 | 303 | 451 | 821 |
| **Apr-12** | 158 | 360 | 227 | 431 | NA | NA | 205 | 235 | 330 | 506 |
| **May-12** | 105 | 158 | 171 | 271 | 194 | 288 | NA | NA | 209 | 269 |
| **Oct-12** | 208 | 320 | 234 | 360 | 214 | 274 | NA | NA | 267 | 332 |
| **Nov-12** | 295 | 356 | 350 | 491 | 299 | 401 | 157 | 167 | 337 | 396 |
| **CPCB STD = 200 µg/$m^3$** | | | | | | | | | | |

Source: Municipal Corporation of Greater Mumbai, (2013).

## MATERIALS AND METHODS:

This study was conducted in Mumbai, the commercial capital of India. This has a total population exceeding 14 million and is located on the west coast of India. Five sites were selected for the study (Table 2 and Fig.1). Leaves of *Pedilanthus tithymaloides* Poit., growing along road dividers were collected in zipper pouches. From each site four dusty leaves at random were collected and brought to the laboratory. The leaves were washed with 25 ml of water and filtered through Whatmann paper No 1. These filter papers were weighed before and after filtrations. Once washed the leaves were traced on graph paper to determine leaf area in $cm^2$. This difference in weights is the amount of dust captured by plants and expressed as $gm/m^2$ (Joshi N. C., 1990). Foliar dust was determined from all five sites from Dec-11 to Mar-12.

Air quality data for suspended particulate matter levels for these sites was obtained from Municipal Corporation of Greater Mumbai, Santacruz (Table 1).

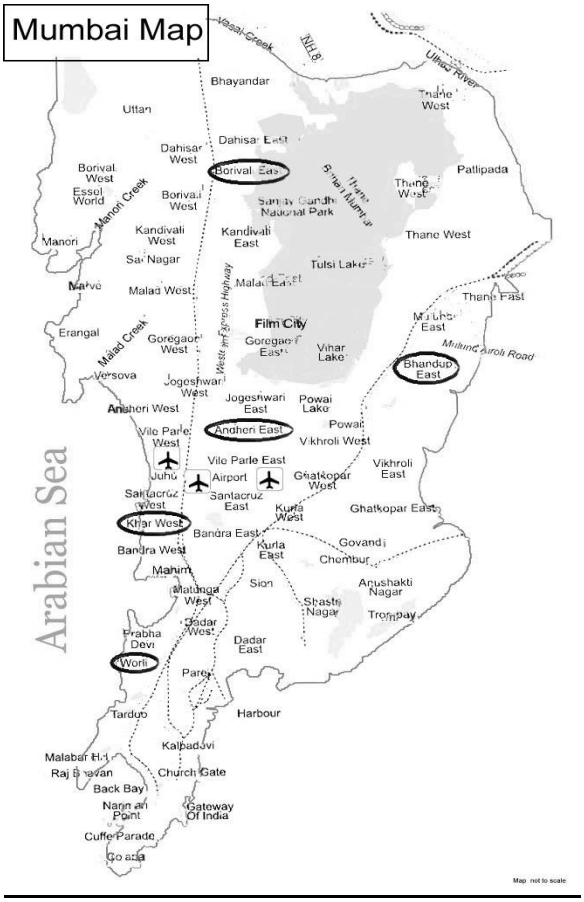


Fig 1: Study sites on Map of Mumbai

**Statistical Methodology**: Statistical analysis was done using SPSS by Box and Whisker Plot method. Also Correlation between dusts captured on leaves of *Pedilanthus tithymaloides* and SPM levels in Air was done.

Table 2: Description of selected Sites

| Site No. | Study Area for Phytomonitoring | Types of Vehicles |
|---|---|---|
| 1 | Dr Annie Besant Road, Worli | Main road, facing the sea-moderate to heavy traffic, all types except three wheelers. |
| 2 | Linking Road, Khar | Main road, Moderate to heavy traffic, all types of vehicles, construction activity, including three wheelers. |
| 3 | Western Express Highway, Andheri | Main road ,Heavy traffic, construction activity, all type of vehicles |
| 4 | Western Express Highway, Borivali | Main road, heavy Traffic, all types of vehicles but more of heavy vehicles. |
| 5 | Lal Bahadur Shastri Road, Bhandup | Major arterial road passing through an industrial area .Heavy vehicular traffic. |

## RESULTS AND DISCUSSION:

The results of foliar dust collected on *Pedilanthus* in the dry season are represented in Table 3.

Table 3: Dust fall on the leaves of *P. tithymaloides* Poit in gm/m$^2$ at different sites

| ***Pedilanthus tithymaloides*** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **SITES** | **Dec-11** | **Jan-12** | **Feb-12** | **Mar-12** | **Apr-12** | **May-12** | **Oct-12** | **Nov-12** |
| 1 | 7.26 | 17.98 | 26 | 26.91 | 15.36 | 24.62 | 23.14 | 28.05 |
| 2 | 16.92 | 25.36 | 19.02 | 26.08 | 11.2 | 37.14 | 17.48 | 20.48 |
| 3 | 23.9 | 31.67 | 34.12 | 30.23 | 28.96 | 21.71 | 27.18 | 28.19 |
| 4 | 20.52 | 23 | 21.32 | 41.85 | 40.5 | 45 | 21.74 | 28.9 |
| 5 | 20.24 | 32.49 | 33.78 | 26.9 | 37.28 | 45.81 | 41.38 | 39.11 |

**Dr Annie Besant Road, Worli**: This site showed a gradual increase in foliar dust values from Dec-11 to Mar-12 whereas the values decreased in Apr-12 followed by an increase in May-12. In winter (Oct-Nov 2012), dust values were quiet high ranging between 20-30 gm/m$^2$. The highest value for dust was 28.05 gm/m$^2$ in Nov-12 and the least was in Dec-11, 7.26 gm/m$^2$ (Fig 2).

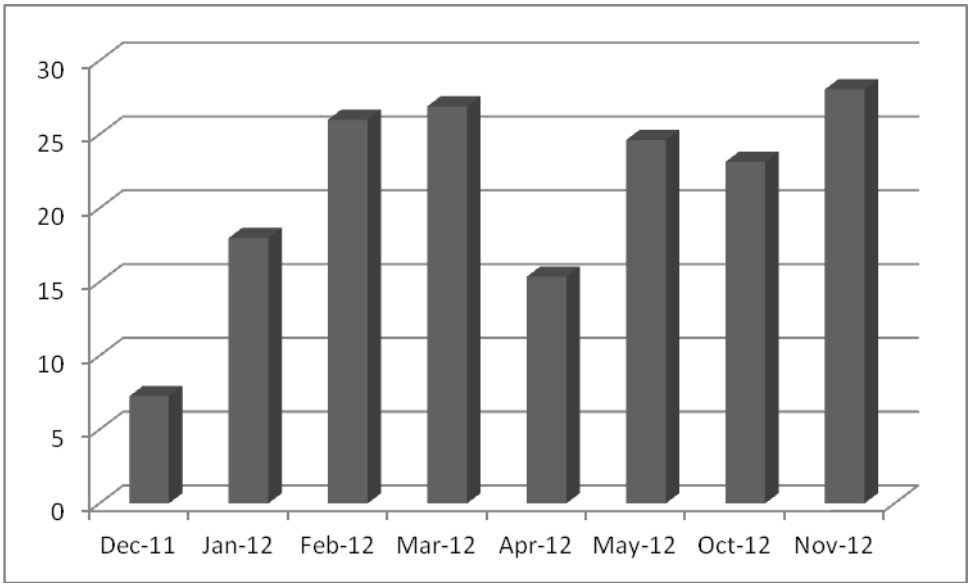


Fig 2: Dust fall on the leaves of *P. tithymaloides* Poit at Worli in gm/m$^2$

**Linking Road, Khar**: Dust fall recorded in May-12, showed the maximum value of 37.14 gm/m$^2$ followed by, 26.08 gm/m$^2$ March-12 and Jan-12, showed marginally less, 25.36 gm/m$^2$ (Fig 3).

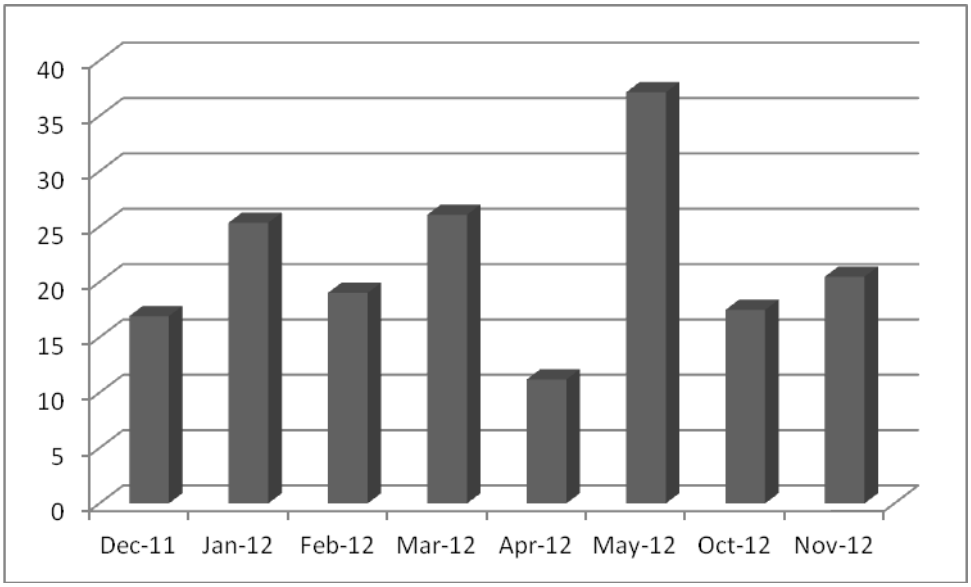


Fig 3: Dust fall on the leaves of *P. tithymaloides* Poit at Khar in gm/m$^2$

**Western Express Highway, Andheri**: Foliar dust recorded was maximum in Feb-12, 34.12 gm/m$^2$, followed by 31.67 gm/m$^2$ in Jan-12. May-12 was least dusty month (Fig 4).

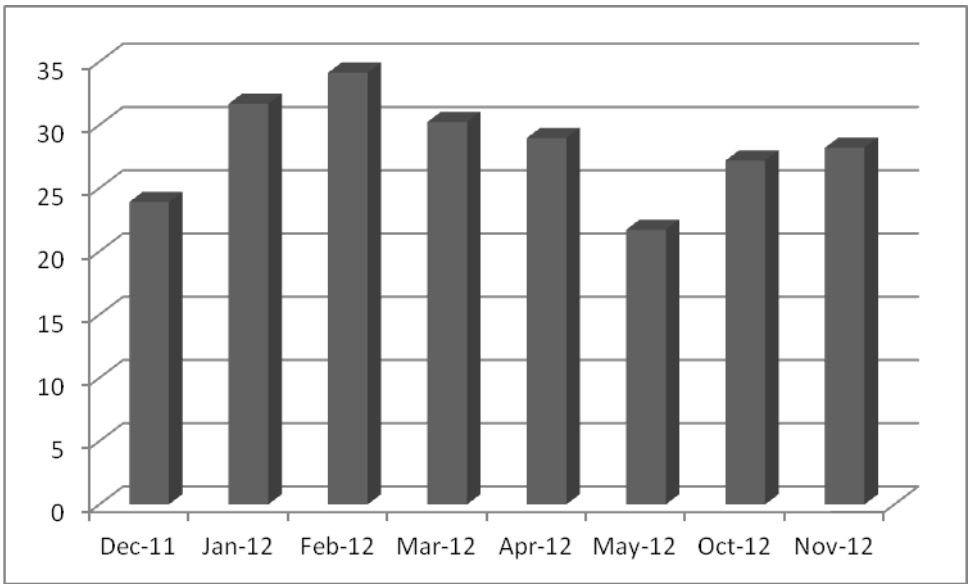


Fig 4: Dust fall on the leaves of *P. tithymaloides* Poit at Andheri in gm/m$^2$

**Western Express Highway, Borivali**: foliar dust recorded was found to be maximum in May-12 followed by lower values in March 12 and marginally less than that in April-12 (Fig 5).

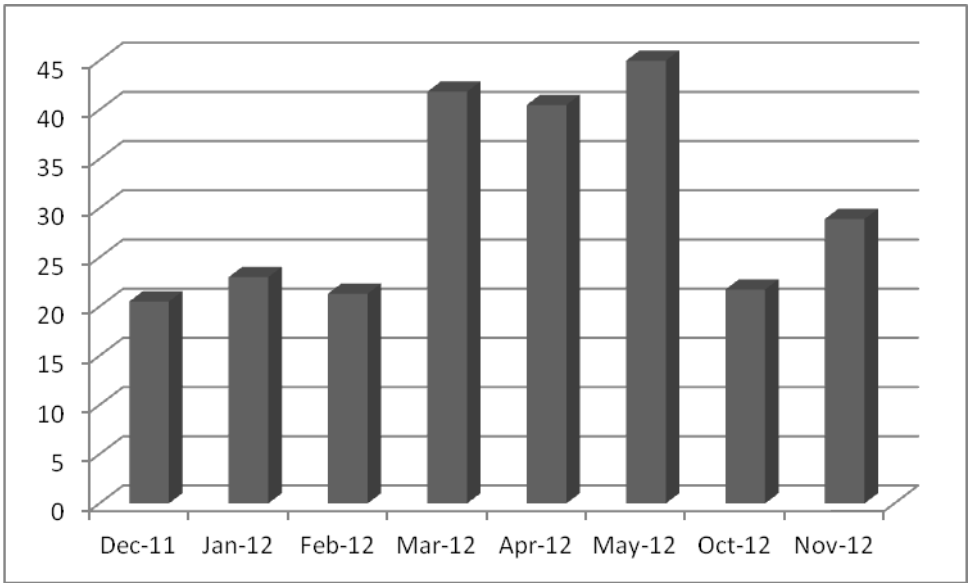


Fig 5: Dust fall on the leaves of *P. tithymaloides* Poit at Borivali in gm/m$^2$

**Lal Bahadur Shastri Road, Bhandup**: The maximum dust fall recorded was 45.81 gm/m$^2$ in May-12, followed by 41.38 gm/m$^2$ in Oct-12, and 39.11 gm/m$^2$ in the month of Nov-12. Dec-11 showed the least foliar dust value of 20.24 gm/m$^2$ (Fig 6).

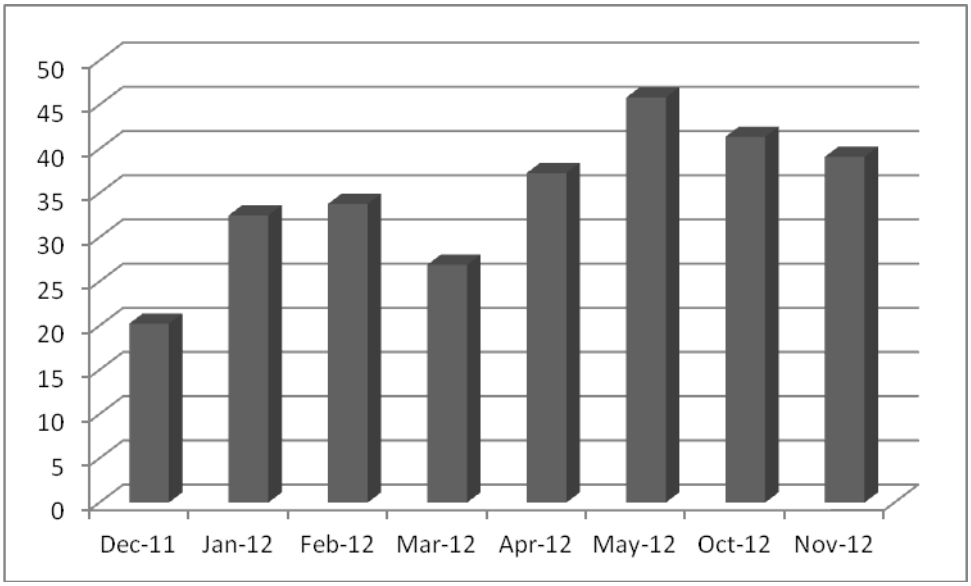


Fig 6: Dust fall on the leaves of *P. tithymaloides* Poit at Bhandup in gm/m$^2$

## CONCLUSION:

Dec-11 had the least dust deposition compared to all other months at all the sites of the study. High dust deposition was recorded in the month of May (Table 3 and Fig 8). Similarly, Mar-12 and Nov-12 were marked to be the second and third dustiest months respectively in terms of foliar dust deposition. The plants growing on the road dividers of sites Andheri and Bhandup showed

consistently high values of dust deposition. This is largely due to the location of the sites being in an area with high vehicular density (Fig 7).

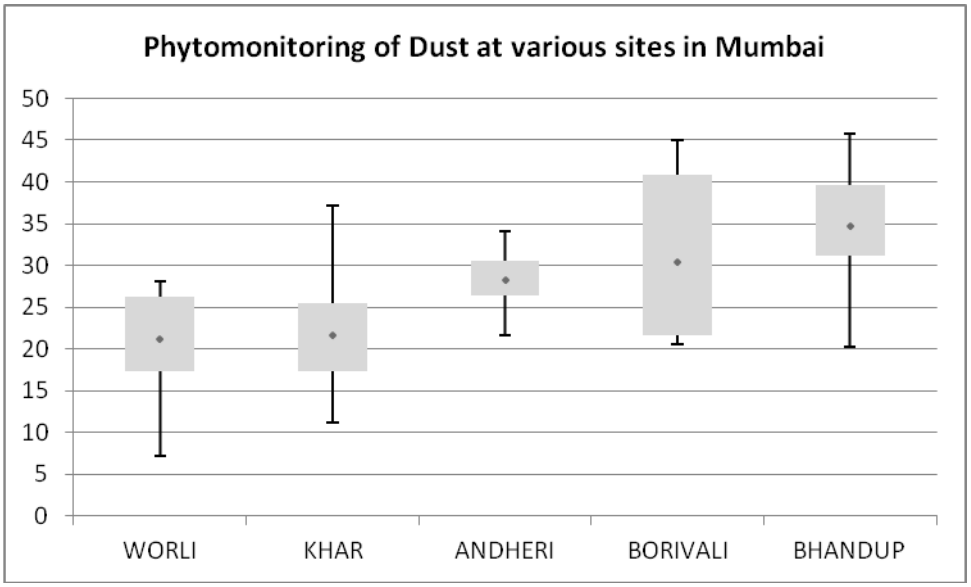


Fig 7: Box and Whisker Plot of Dust in g/m$^2$ on leaves of *P. tithymaloides* Poit

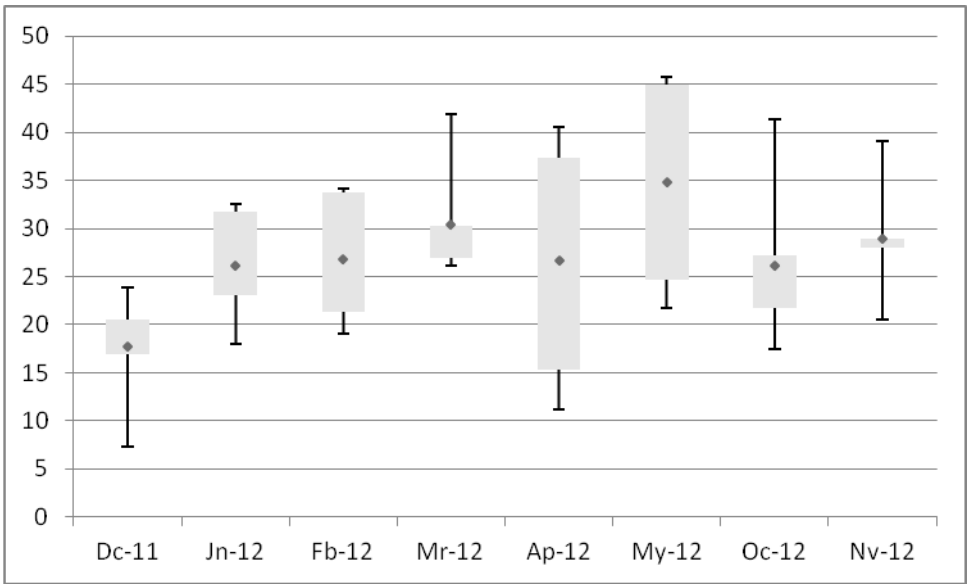


Fig 8: Seasonal Variation in Foliar Dust deposition of *P. tithymaloides*

It was found that Andheri had maximum SPM in the air in Jan-12 (422 µg/m$^3$) and Feb-12 (500 µg/m$^3$); also the SPM levels were higher in Dec-12 (389 µg/m$^3$), whereas in Mar-12 and Apr-12 there were no readings available. Similarly at Bhandup four months (Dec-11 to Mar-12) of study period were found to have very high levels of SPM i.e. above 400 µg/m$^3$, whereas remaining four months (Apr-12 to Nov-12) of study period were showing lesser SPM values i.e. below 350 µg/m$^3$. At Khar, SPM values were between 300-400 µg/m$^3$ in the months of Dec-11, Mar-12 and Nov-12 whereas all remaining months had SPM levels lesser than 300 µg/m3. Similarly at Worli, SPM levels

were found above 300 µg/m$^3$ in Dec-11 and Mar-12 and in remaining months values were below 300 µg/m$^3$. In May-12, SPM value noted at Worli was lowest of all. Borivali recorded lower SPM values in all six months though readings were not available for the months of May-12 and Oct-12 this is largely due to the air monitoring station being located around residential complex (Table 1 and Fig 9)

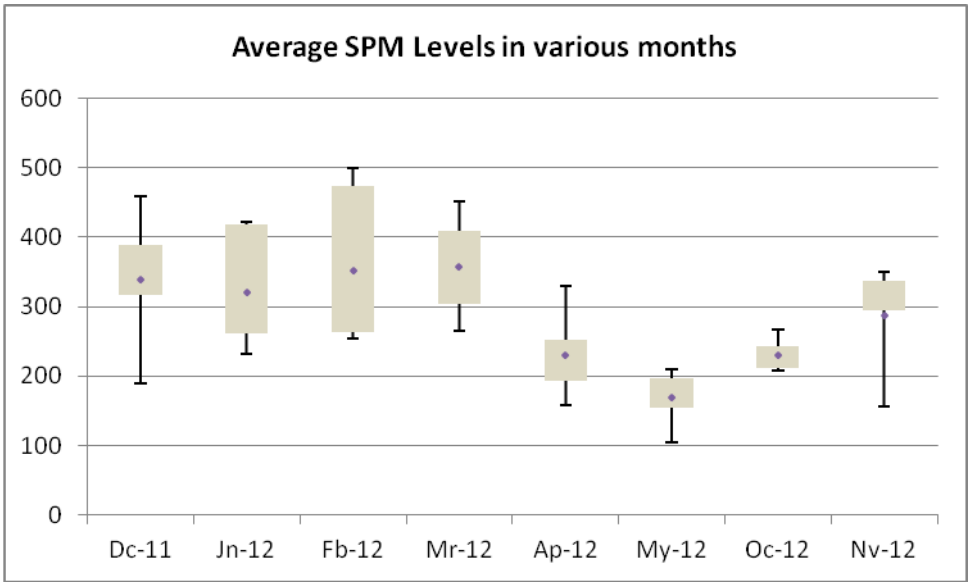


Fig 9: Average SPM values around study sites

It would be pertinent to mention here that the values of SPM and the dust fall may not coincide always. This is largely due to the monitoring stations being placed at different height levels and area.

Bhandup and Andheri were found to have consistently high values of both SPM and dust fall values. Whereas Borivali showed higher values of foliar dust fall but lesser values of SPM levels. Based on foliar dust values, the dustiest site is Borivali and least is Worli. Dust fall depends on local and regional climate as well as the prevailing microclimatic conditions. Hence, different sites show different values of foliar dust deposition on *P. tithymaloides* Poit. There is a general increase in Dust fall on the leaves form the month of December to the month of May, with the exception of a slight dip in foliar dust in the month of April (Fig 9). High dust values on the plants in the month of May were also recorded by Chaphekar et. al, 1980.

Variations in wind speed, wind Direction, humidity of air, etc. play a vital role in dust deposition. Hence *P. tithymaloides* Poit. can be used for Phytomonitoring dust. Air pollution due to anthropogenic sources such as traffic, industries is the major source contributing to the personal exposure to respirable particulates. Therefore, efforts should be made to reduce air pollution due to these sources. In India, there are many old vehicles (more than 15 years old) still in use. These should be gradually phased out. Transportation system should be improved to reduce idling time of vehicles at the traffic signals. There are many small scale industries of an unauthorized nature. They should be

identified and brought under the purview of the regulatory authorities. Plants can either be placed or locally grown to monitor dust fall and its accumulation. Using plants as monitors of dust has an advantage over more sophisticated and costly energy instruments. Thus use of plants can be a cost-effective substitute and can be placed at specific sites. *Pedilanthus tithymaloides* Poit. can be used as a Phytomonitor of dust in the city .The plant is easy to grow, and needs relatively less care and water which further makes suitable phytomonitor of dust in the city. A foliar dust map was prepared based on the study during the dry season representing all the sites (Fig 10).

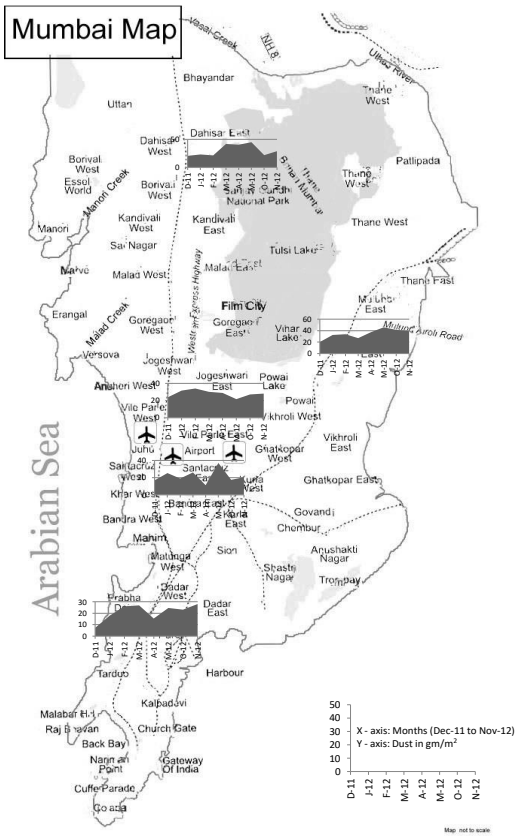


Fig 10: Foliar Dust Map of Study Area

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