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Efficiency of *Bougainvillea spectabilis* Willd in Monitoring Dust

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Abstract

Bougainvillea spectabilis Willd. is used as a phytomonitor and foliar dustfall was quantified in g/cm^2 . The study was conducted in the period of 8 months including two dry seasons viz; winter and summer. Leaves of *Bougainvillea spectabilis* Willd., growing on road dividers at all the 10 sites, were collected in the middle of each month in zipper pouches and brought to the laboratory for further experimental work.Sites was studied to calculate its vehicular density. Vehicular density was calculated using videography method. The leaves of *Bougainvillea spectabilis* Willd. showed significant variations in their dustfall values. At most of the sites, these dust values co-related well with vehicular count . Maximum vehicles were counted at Borivali Western Express Highway, so also consistently high values of foliar dust whereas the lowest vehicular count was recorded Marine Drive and low dustfall . Highways were noticed with the higher dust values. The dust values were observed to be more in summer than that of in winter. In summer, May-13 was the dustiest month and in winter Jan-14 was the cleanest month. *Bougainvillea spectabilis* Willd. are very easy to grow and could be grown by simple cutting method also. Easy availability, less maintenance and good dust capturing capacity made this plant suitable for phytomonitoring.

Keywords: Mumbai, dust, *Bougainvillea spectabilis* Willd. and Phytomonitoring.

INTRODUCTION

Air pollution is a big threat to the good health of human beings, animals and urban plants. Dust pollution is an common problem in urban air produced due to increasing demand of construction activity and many vehicles (Bhattacharya *et. al.*, 2011; Prajapati, 2012). Fast moving traffic and agricultural activities also generate high dust

concentrations (Leys, *et al.*, 1998; Manins, *et al.,* 2001). Dust means solid particles having diameters > 500 μm but particles of 2.5-10 μm in atmosphere are of great concern for health of local public (Borja-Aburto, *et al.,* 1998; Beckett, *et al.,* 1998). Dust also contains small amounts of pollen grains, human and animal hairs, stuff and paper fibers and many other materials (Kathleen Hess-Kosa, 2002).

600 million persons suffered from a variety of ailments due to dust pollution (Cacciola, *et al.,* 2002). The dust pollution leads to ill effects on the health of plants (Fluckiger *et al.,* 1977, 1978, 1979 and 1982; Thompson *et al.,* 1984). Dust on the leaf surfaces interrupts the light and cause the chemical injury to it (Prajapati, 2012). Dust fall was found to be responsible for physical and physiological damage of the leaves of *Shorea robusta* and *Madhuca indica* (Saha et al., 2011). Several studies have revealed that the dust contains heavy metals like Cu, Ni, Pb, Zn, etc. (Bhattacharya et al., 2011).

The air quality in urban areas can be improved by planting trees along road sides (Beckett, *et al.,* 2000; Freer-Smith, *et al.,* 2005; Raupach, *et al.,* 2001). Leaves act as constant absorbers for particulate matters (Samal and Santra, 2002). The dustfall differs with variation in season (Prajapati and Tripathi, 2008). Accumulation and deposition of gaseous pollutants and particulate matter depends upon the vegetation type (Bunzl, *et al.,* 1989; Fowler, *et al.,* 1989). Several studies have reported the impact of urban air pollutants responsible for leaf injuries like leaf defoliation, chlorosis, necrosis, bronzing, defective margin or tip, etc. Rao (1971), Chaphekar (1972), Yunus and Ahmed (1978), Varshney (1979), Das (1981), Dubey et al. (1982), Raza (1991) and many others have reported the impact of phytotoxic air pollutants on plant health.

STUDY AREA

In order to study the Active Phytomonitoring of dust at 10 critical locations (Fig 1) in Mumbai city on the basis of their traffic density (Table 1) thee dust fall was quantified on the leaf surfaces of *Bougainvillea spectabilis* Willd.

Table 1: Vehicular Count recorded at 10 selected sites

Sites	2-Wheeler per min	3-Wheeler per min	4-Wheeler per min	Bus / Truck per min	Total/min
Site 1 - Marine Drive	9	0	14	4	27
Site 2 - Dr B. Ambedkar Road	24	0	12	9	45
Site 3 - Ghatkopar, E. Express Highway	16	7	24	15	62
Site 4 - Mulund, LBS Marg	15	10	20	19	64

Site 5 - Borivali, W. Express Highway	27	19	22	8	76
Site 6 - Goregaon, SV Road	13	15	20	5	53
Site 7 - Malad, Linking Road	14	11	14	10	49
Site 8 - Bandra, Linking Road	12	21	13	5	51
Site 9 - Bandra Kurla Complex	14	10	13	11	48
Site 10 - Krishna Chandra Marg	10	16	15	3	44

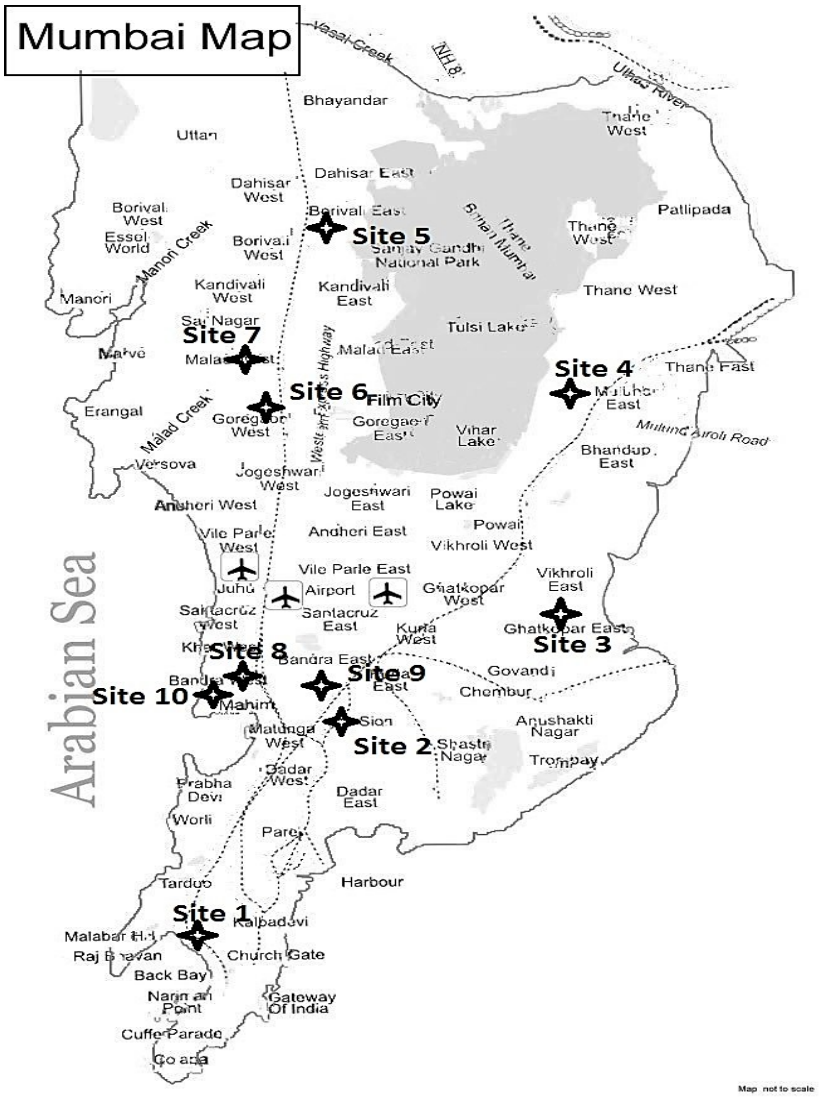

Figure 1: Map of Mumbai city showing selected sites

MATERIALS AND METHODS

The leaves of *Bougainvillea spectabilis* Willd. growing along road dividers at the selected sites were washed carefully to completely remove dust particles from the leaf surfaces. The plants growing near traffic signals were selected and the leaves growing above 2 feet from the ground were selected. After washing, the plant species were marked with a ribbon tied to it. On the seventh day, the dustiest leaves from the same plant species were collected in the zipper pouches. From all the ten sites three leaves were collected during the study period. The study period was from Feb-13 to Jan-14 excluding Monsoon (Jun-13 to Sep-13).

Leaves were brought to Laboratory and washed with water using spray bottles and were carefully collected on pre-weighed Whatman's filter paper No 1. The filter paper was then oven dried at 60^0C and later weighed to calculate the dust fall. Washed leaves were blotted dry and then traced on graph paper which gave the total leaf area in cm² and dust fall was calculated in g/m² (Joshi N. C., 1990, Chaphekar *et al*. 1980).

Traffic volume was monitored using a digital camera (Sony, Model No. DSC – W150). Hourly traffic count was calculated by analyzing the video footage taken during field observation (Table 1). Hourly traffic count has been expressed in number of vehicles per minute (Kadiyali, 1996).

RESULTS AND DISCUSSIONS

The selected 10 sites were visited to count the number of vehicles (Kadiyali, 1996). The vehicles were counted and classified as per their type's viz. 2-Wheelers, 3-Wheelers, 4-Wheelers and heavy vehicles (Table 1).

The maximum number of vehicles was noticed at Site 5 – Borivali, Western express highway and the minimum were observed at Site 1 – Marine Drive. The maximum number of heavy vehicles was found at Site 4 - Mulund, LBS Marg, Whereas, maximum number of 4 - wheelers was seen at Site 3 - Ghatkopar, E. Express Highway. Similarly, the maximum numbers of 3 - wheelers and 2 - wheelers were recorded at Site 8 - Bandra, Linking Road and Site 5 - Borivali, W. Express Highway. The entry of 3 - wheelers was prohibited at Site 1 - Marine Drive and Site 2 - Dr B. Ambedkar Road (Table 1). The vehicular count from more number to lesser can be expressed as:

Site 5 > Site 4 > Site 3 > Site 6 > Site 8 > Site 7 > Site 9 > Site 2 > Site 10 > Site 1

Dustfall on *Bougainvillea spectabilis* Willd.

The amounts of dustfall recorded on the foliar surfaces of *Bougainvillea spectabilis* Willd. during the study period of 8 months at 10 sites (Table 2).

Site1 - Marine Drive

Bougainvillea spectabilis Willd. overall showed lower values of dust deposition on their leaves in comparison to other plant species studied at this site . No value was more than 10 g/m^2. The highest value recorded was 8.15 10 g/m^2 in May-13 and the lowest was 2.83 10 g/m^2 in Dec-13. The dust values showed a specific trend of an increase in dust values from Feb-13 to May -13 (summer) and a decrease from Oct-13 to Dec-13 (winter). (Table 2 and Fig 2)

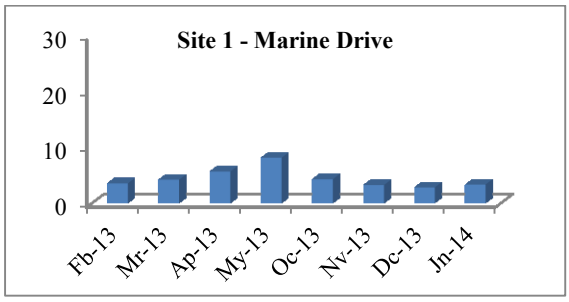

Figure 2: Seasonal Variation in Dustfall using *Bougainvillea spectabilis Willd.* in g/m^2 *at Site* 1

Site 2 - Dr Babasaheb Ambedkar Road

At this site, the foliar dust on *Bougainvillea spectabilis* Willd. was ranging from 4.62 g/m^2 in Feb-13 to 14.33 g/m^2 in May-13. The recorded dust values showed an increase from Feb-13 to May-13 but decrease after monsoon (Table 2 and Fig 3).

Table 2: Seasonal Dust Capturing Capacities of *Bougainvillea spectabilis Willd.* in g/m^2

Sites	Fb-13	Mr-13	Ap-13	My-13	Oc-13	Nv-13	Dc-13	Jn-14
Site 1 - Marine Drive	3.55	4.22	5.67	8.15	4.29	3.26	2.83	3.35
Site 2 - Dr B. Ambedkar Road	4.62	10.67	12.31	14.33	7.61	8.14	7.85	5.39
Site 3 - Ghatkopar, E. ExpressHighway	7	13.33	14.92	16.61	8.94	5.49	7.33	7.62
Site 4 - Mulund, LBS Marg	5.07	10.15	10.33	12.89	7.83	8.91	9.04	8.64
Site 5 - Borivali, W. ExpressHighway	5.5	13.47	17.48	19.24	9.03	10.21	10.34	9.82
Site 6 - Goregaon, SV Road	7.23	12.22	3.15	10.27	6.32	5.87	5.24	2.39
Site 7 - Malad, Linking Road	9.69	7.43	8.84	11.31	8.25	7.35	5.87	5.74
Site 8 - Bandra, Linking Road	4	7.59	9.15	9.35	7.48	6.73	5.02	4.67
Site 9 - Bandra Kurla Complex	4.07	6.53	12.32	10.6	7.09	6.72	7.62	5.32
Site 10 - Krishna Chandra Marg	8.92	15.71	9.75	11.23	6.47	7.15	5.42	4.54

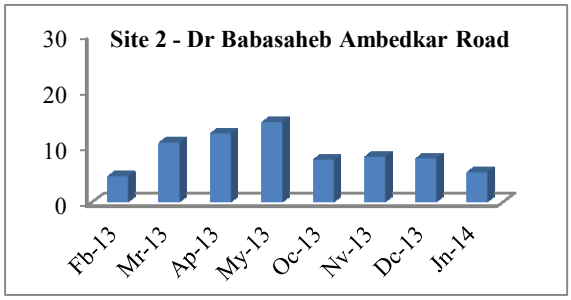

Figure 3: Seasonal Variation in Dustfall using *Bougainvillea spectabilis Willd.* in g/m^2 *at Site* 2

Site 3 - Ghatkopar, Eastern Express Highway

The leaves of *Bougainvillea spectabilis* Willd., at this site, showed the dust deposition as much as 16.61 g/m^2 in the month of May-13 and as low as 5.49 g/m^2 in Nov-13. This site also showed an increase from Feb-13 to May-13 and then after the values decreased in Oct-13. Also, the values of deposited dust recorded in summer season were higher than that of winter season (Table 2 and Fig 4).

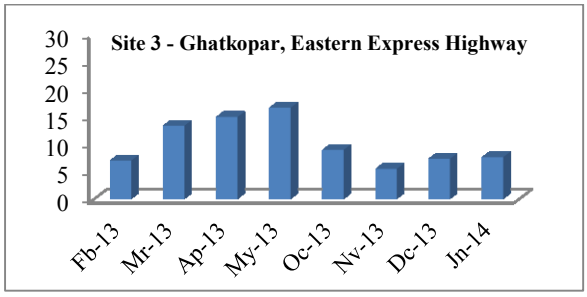

Figure 4: Seasonal Variation in Dustfall using *Bougainvillea spectabilis Willd.* in g/m^2 *at Site* 3

Site 4 - Mulund, LBS Marg

This site was showing maximum dust in the month May-13 but the values were not so high i.e. 12.89 g/m^2. Similarly the lowest value was 5.07 g/m^2 in Feb-13. At this site also, the dust values were comparatively more in summer than in winter (Table 2 and Fig 5).

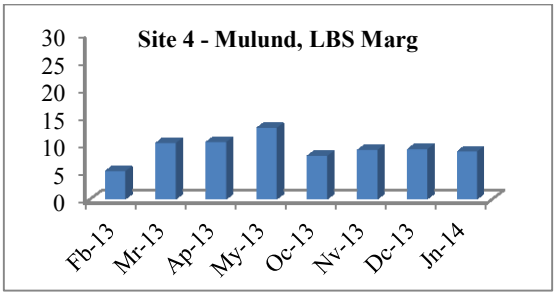

Figure 5: Seasonal Variation in Dustfall using *Bougainvillea spectabilis Willd.* in g/m^2 *at Site* 4

Site 5 - Borivali, Western Express Highway

Foliar dust values recorded at Site 5 - Borivali, Western Express Highway were noted to be quiet high. All the value of dustfall were higher (above 10 g/m^2) in summer than in winter (Table 2 and Fig 6).

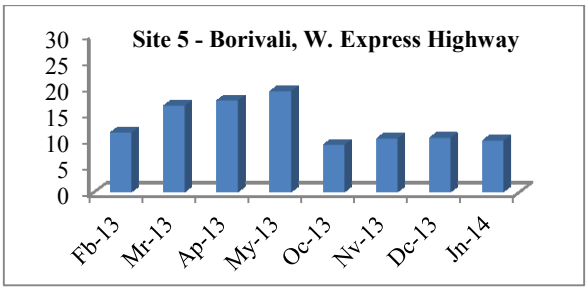

Figure 6: Seasonal Variation in Dustfall using *Bougainvillea spectabilis Willd.* in g/m^2 *at Site* 5

Site 6 - Goregaon, SV Road

At Goregaon, SV road the dust values recorded were comparatively lesser than Borivali, western express highway. The highest value of dust recorded was 14.27 g/m^2 in May-13. Similarly the lowest value was 2.39 g/m^2 in Jan-14. The dust values were increased from Feb-13 to May-13. On the other hand a gradual decrease in dust values was noticed from May-13 to Jan-14 (Table 2 and Fig 7).

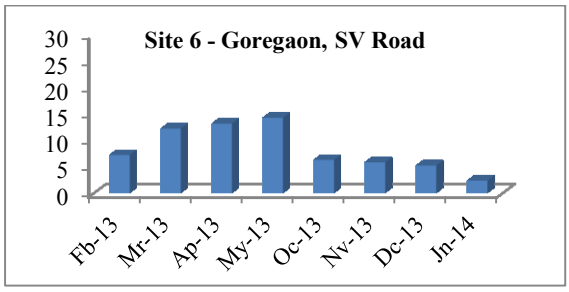

Figure 7: Seasonal Variation in Dustfall using *Bougainvillea spectabilis Willd.* in g/m^2 *at Site* 6

Site 7- Malad, Linking Road

The highest value of foliar dust on *Bougainvillea spectabilis* Willd. was 11.31 g/m^2 in May-13 followed by second highest value 9.69 g/m^2 in Feb-13. The dust values were more in summer and lesser in winter. (Table 2 and Fig 8).

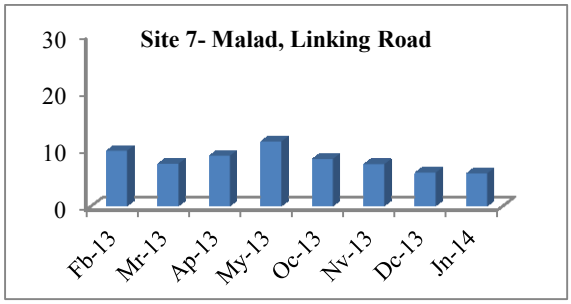

Figure 8: Seasonal Variation in Dustfall using *Bougainvillea spectabilis Willd.* in g/m^2 *at Site* 7

Site 8 - Bandra, Linking Road

At this site in Bandra, the foliar dust recorded was found to be lesser compared to previous sites as no value was more than 10 g/m^2. The maximum foliar dust 9.35 g/m^2 was noted in Feb-13. The dust values were increasing from Feb-13 to May-13. Except for the lowest value i.e. 4 g/m^2 in Mar-13, the summer months showed higher values than that of winter months (Table 2 and Fig 9).

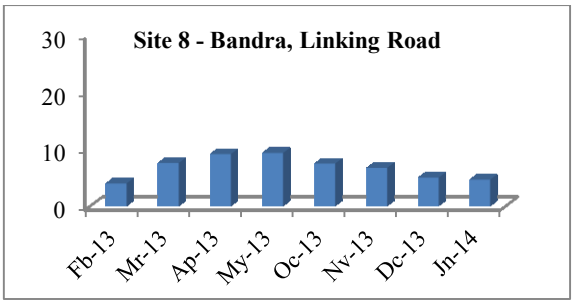

Figure 9: Seasonal Variation in Dustfall using *Bougainvillea spectabilis Willd.* in g/m^2 *at Site* 8

Site 9 - Bandra Kurla Complex

At Bandra Kurla Complex, the foliar dust deposition noted was lesser than 10 g/m^2 except for the months of Apr-13 and May-13 where the dust values were 12.32 g/m^2 and 10.6 g/m^2 respectively. Also, the dust values of Feb-13 and Mar-13 were very lower in comparison to winter months and were recorded to be lesser than winter months. The lowest value of 8 months was recorded 4.07 g/m^2 in Feb-13 (Table 2 and Fig 10).

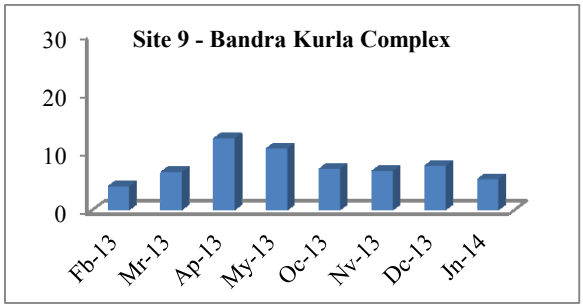

Figure 10: Seasonal Variation in Dustfall using *Bougainvillea spectabilis Willd.* in g/m^2 *at Site* 9

Site 10 - Krishna Chandra Marg

At Krishna Chandra marg, Mar-13 and May-13 were showing higher values i.e. >10g/m^2 whereas remaining 6 months showed values less than 10 g/m^2. The two maximum values of dust were recorded as 16.23 g/m^2 and 15.71 g/m^2 in the months May-13 and Mar-13 respectively. Also, the foliar dust values of summer months were higher than that of winter months. The values showed an increase from Feb-13 to Mar-13, a decrease from Mar-13 to Apr-13, an increase from Apr-13 to May-13 and hence there was no sequence or trend in the changing values (Table 2 and Fig 11).

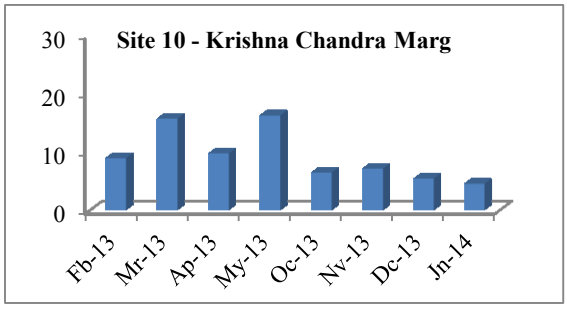

Figure 11: Seasonal Variation in Dustfall using *Bougainvillea spectabilis Willd.* in g/m^2 *at Site* 10

CONCLUSION

During the entire study period of 8 months, the foliar dust deposition on *Bougainvillea spectabilis Willd.* was not more than 20 g/m^2. The amounts of dust deposited on the leaves were higher in summer months than in winter months. In summer season there was an increasing trend in the Mean dust values from Feb-13 to May-13 whereas in winter months the trend was decreasing from Oct-13 to Jan-14. The consistent highest dust depositions on *Bougainvillea spectabilis Willd.* leaves were recorded at Site 5 – Borivali , W. Express Highway in all the 8 months. The amounts of dust recorded at Site 5 showed following trend of dust values in decreasing order. The maximum dust was noted in the month of May-13 (19.24 g/m^2) followed by Apr-13 (17.48 g/m^2) followed by Mar-13 (16.47 g/m^2) followed by Feb-

13 (11.37 g/m^2) followed by Dec-13 (10.34 g/m^2) followed by Nov-13 (10.21 g/m^2) followed by Jan-14 (9.82 g/m^2) and finally Oct-13 (9.03 g/m^2). (Table 2 and Fig 6). Similarly, the consistent lowest dust deposition was recorded at Site 1 - Marine Drive in all 8 months. The minimum amounts of dust in their increasing order at Site 1 were recorded in the months of Jan-14 (2.39 g/m^2) followed by Dec-13 (2.83 g/m^2) followed by Nov-13 (3.26 g/m^2) followed by Feb-13 (3.55 g/m^2) followed by Mar-13 (4.22 g/m^2) followed by Oct-13 (4.29 g/m^2) followed by Apr-13 (5.67 g/m^2) followed by May-13 (8.15 g/m^2) (Table 2 and Fig 12).

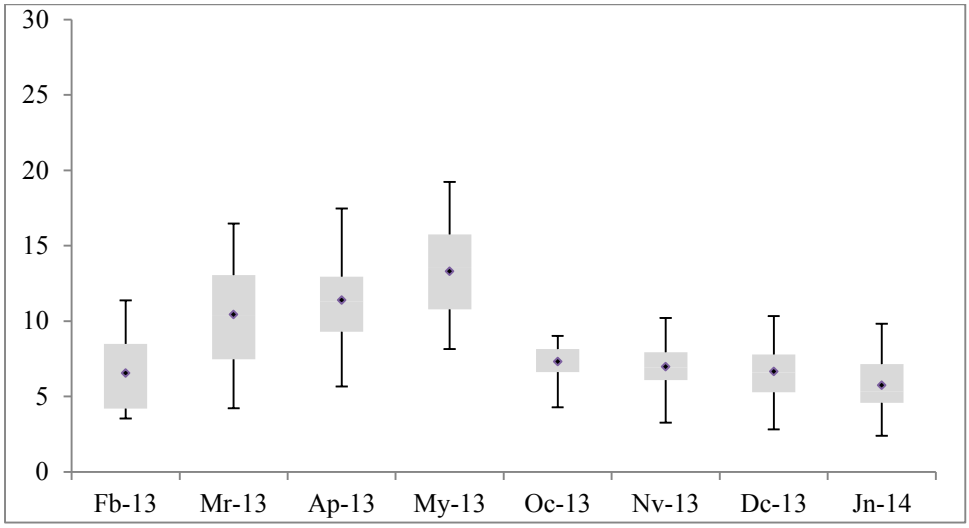

Figure 12: Seasonal dust capturing capacities using *Bougainvillea spectabilis Willd.* in g/m^2

On the basis of Mean Dust values at seasonal dust fall using *Bougainvillea spectabilis Willd.* can be expressed as (Fig 12):

May-13 > Apr-13 > Mar-13 > Oct-13 > Nov-13 > Dec-13 > Feb-13 > Jan-14

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