Study Of Quarry Dust Deposition On Leaves Of Some Plant Species In Ambaghanta- Danta, Banaskantha

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Abstract:
A survey of three dust polluted plants and non polluted plants of different families were carried out from different site in Quarry area at Ambaghanta. Matured leaves taken out in laboratory. Dust deposition, total chlorophyll content with respect to polluted and non polluted leaves is determined. The amount of dust deposition from the surveyed plants was measured from the randomly selected leaves. The maximum dust deposition on leaf surface was recorded in *Butea monosperma* and *Gmelina arborea*. Minimum dust deposition was found on *Azadirachta indica*. In comparison to the control, dust-polluted leaves had the highest pH of the leaf wash. The lowest level of total chlorophyll was seen in the leaves that had been exposed to dust.

Keywords: Dust, Leaves, Chlorophyll, pH.

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INTRODUCTION:

Environmental pollution is real and the effects are already felt worldwide with the start of the 21st century. Though water and land pollution is very dangerous, air pollution has become a global problem faced by both developed nations as well as developing ones. As air pollution has its peculiarity, due to the tendency of its transboundary dispersion of pollutants over the entire world. Pollution can be defined as the human introduction into the atmosphere of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans, or other living organisms or damage the environment.

The characteristics of air pollution have changed significantly over recent decades. Concentrations of traditionally important pollutants such as Sulphur dioxide (SO2) and black smoke have declined substantially (Brophy *et al*;2007).

According to the report of the Center for Science and Environment (2001) and the center Pollution Control Board (2002), it is estimated that vehicles account for 70% of CO, 50% of HC, 30% of SPM, and 10% of SO2 of the total pollution load in the major metros of India, of which two-thirds are contributed by two-wheelers alone.

Quarrying reduces vision, and particulate dust that settles on leaves may result in foliar damage, a decrease in yield, changes to photosynthesis and transpiration, among other things(Raina *et al*; 2008). Several studies conducted under field conditions have revealed that when these particulate matters are deposited on vegetation, plant growth is adversely affected(Chatter 1991; Gunamani and Arjunan, 1991; Rao, 1991; Sharma and Sharma, 1991; Aslam *et al*., 1992; Mishra *et al*., 1993; Pandey and Nand, 1995; Chowdhary and Rao, 1996; Somashakar *et. al*., 1999; Kumar *et al*.,2000).

Monitoring the effects of dust particles on vegetation is very important. Dust emission occurs from many operations in the marble industries viz., cutting, buffing, polishing, tile making, loading, and transportation therefore it was necessary to study the effect of dust on plants around the quarrying area.

STUDY AREA:

Danta is a census town in Banaskantha district in the state of Gujarat, India. Danta has more than 6577 SSI and cottage Industries. As per industrial statistics of 2006-07, there were 6577 units established in the district with an investment of 24134.58 lacs in plants and machinery and employing about 24014 workers.

The village of Ambaghanta is situated in Gujarat, India's Banas Kantha district, in the Danta Tehsil. It is situated 15km away from the sub-district headquarters in Danta and 50km away from the district headquarters in Palanpur. As per 2009 stats, Jasvantgadh is the gram panchayat A Ambaghanta village. As per 2019 stats, Ambaghanta villages come under the Danta assembly & Gadhada parliamentary constituency.
(https://villageinfo.in/gujarat/banas-kantha/danta/ambaghanta.html).

Ambaghanta is surrounded by the hills of Aravali which is very rich with different kinds of minerals and black stone, granites, and marbles, hence several Mineral Units of Gujarat Minerals Development Corporation and some private units of black stone Mines have established and flourished well here in the vicinity of Ambaghanta.

GEOGRAPHY AND CLIMATE:

Danta is located at 24˚20'N latitude and 72˚51'E longitudes in Gujarat state in India. In summer, it's hot and humid with an average temperature of 42˚ with hot sandy winds. The temperature sometimes reaches 46˚. However, just before the monsoon, it becomes swelteringly hot along with humidity. In winter, it's 5˚ to 15˚, which is quite cold as compared to other cities in Gujarat, and on Monsoon, the average rainfall is 20 to 30 inches per season.

MATERIAL AND METHODS:

Dust deposited fresh leaves of three plant species like *Butea monosperma, Gmelina arborea and Azadirachta indica* were collected in the time period 2020 to 2022. Each plant's polluted leaves from the top, middle, and base were chosen, gathered, and utilised in an experiment.

Measurements of dust fall on the leaves:
Each plant that was sampled had ten mature leaves, which were individually collected in a different polythene bag. At a height of three to four metres, leaves were gathered from every location. The Dry methodology described by Das and Pattanayak was used to measure the amount of dust that fell (1997). With a camel hair brush, dust particles from the leaf surfaces were gently gathered after the undamaged leaf was first weighted (in mg) and the weight of leaf was measured again. The amount of dust deposition in mg/ cm2 was calculated as per the following formula.

$$\text{Dust content (mg/cm2)} = \frac{\text{Weight of intact leaf - initial weight of leaf}}{\text{Total surface area of leaf (cm2)}}$$

Measurement of total chlorophyll:
The chlorophyll pigment of dust polluted leaves was estimated following the method of Arnon (1949). The fully expanded and dust deposited leaves from different sites of the Quarry site were collected in the polythene bags and brought to the college laboratory. In distilled water, the leaves were carefully rinsed. Three replicates were used for each plant. The sampled material's leaf tissue, weighing 0.1 grammes, was ground, homo genised, and extracted three times in cooled 80% acetone (v/v). After five minutes of centrifugation at 5000 rpm, the supernatant was diluted to 100 ml with 80% acetone, and a spectrophotometer was used to determine the optical density at 645 and 663 nm. The following formula was used to determine the concentration of the chlorophyll pigments, and the findings are represented in mg/g of 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:

Table: 1.1-Dust fall content in mg/cm2 (*Azadirachta indica*)

	Winter	Summer	Monsoon	Average
Site-1	0.8	0.85	0.6	0.75
Site-2	0.62	0.8	0.2	0.54
Site-3	0.75	0.82	0.09	0.55
Site-4	0.82	0.92	0.14	0.63
Site-5	0.8	0.9	0.16	0.62
Control	0.14	0.25	0.05	0.15

Table: 1.2-Dust fall content in mg/cm2 (*Butea monosperma*)

	Winter	Summer	Monsoon	Average
Site-1	0.78	0.85	0.2	0.61
Site-5	0.8	0.98	0.23	0.67
Control	0.42	0.55	0.05	0.34

Table: 1.3-Dust fall content in mg/cm2 (*Gmelia arborea*)

	Winter	Summer	Monsoon	Average
Site-1	0.85	0.9	0.7	0.82
Site-4	0.85	0.95	0.8	0.87
Site-5	0.8	0.85	0.65	0.77
Control	0.65	0.7	0.2	0.52

Table: 2.1- Chlorophyll content-Chlorophyll-a (*Azadirachta indica*)

	Winter	Summer	Monsoon	Average
Site-1	1.11	0.8	1.8	1.24
Site-2	1.78	2.7	1.32	1.93
Site-3	1.3	2.7	0.98	1.66
Site-4	0.83	0.93	1.6	1.12
Site-5	0.4	0.23	1.2	0.61
Control	1.92	1.5	1.98	1.8

Table: 2.2- Chlorophyll content-Chlorophyll-a (*Butea monosperma*)

	Winter	Summer	Monsoon	Average
Site-1	3.4	3.2	3.6	3.4
Site-5	2.79	0.96	3	2.25
Control	3.6	3.7	3.8	3.7

Table: 2.3- Chlorophyll content-Chlorophyll-a (*Gmelia arborea*)

	Winter	Summer	Monsoon	Average
Site-1	6.5	6.2	6.9	6.54
Site-4	5.6	6	5.9	5.17
Site-5	5	4.3	5.3	4.87
Control	6.7	6.3	7	6.67

Table: 3.1- Chlorophyll content-Chlorophyll-b (*Azadirachta indica*)

	Winter	Summer	Monsoon	Average
Site-1	1.5	1	1.9	1.47
Site-2	1.6	1.15	2.2	1.65
Site-3	0.63	0.53	1.1	0.76
Site-4	1.8	1.16	1.29	1.42
Site-5	1.9	1	2	1.64
Control	1.7	1.16	1.26	1.37

Table: 3.2- Chlorophyll content-Chlorophyll-b (*Butea monosperma*)

	Winter	Summer	Monsoon	Average
Site-1	2.2	2	2.5	2.24
Site-5	2.3	1.2	3.2	2.23
Control	2.5	2.3	3.5	2.77

Table: 3.3- Chlorophyll content-Chlorophyll-b (*Gmelia arborea*)

	Winter	Summer	Monsoon	Average
Site-1	3.4	3	3.5	3.3
Site-4	4.4	3	4.9	4.1
Site-5	3.8	3.3	4	3.7
Control	4.9	3.5	5	4.73

Table: 4.1- Chlorophyll content-Total Chlorophyll (*Azadirachta indica*)

	Winter	Summer	Monsoon	Average
Site-1	2.17	1.86	2.1	2.04
Site-2	2.89	1.96	3.06	2.64
Site-3	2.5	1.98	2.75	2.41
Site-4	2.8	1.6	2.9	2.43
Site-5	1.2	1.65	1.61	1.49
Control	2.95	1.8	2.98	2.58

Table: 4.2- Chlorophyll content-Total Chlorophyll (*Butea monosperma*)

	Winter	Summer	Monsoon	Average
Site-1	3.6	3.4	3.7	3.57
Site-5	3.8	3.2	3.9	3.63
Control	4.2	3.81	4.8	4.27

Table: 4.3- Chlorophyll content-Total Chlorophyll (*Gmelia arborea*)

	Winter	Summer	Monsoon	Average
Site-1	4.2	3.9	4.4	4.17
Site-4	4.1	3.7	4.3	4.03
Site-5	3.8	3.5	4	3.77
Control	4.6	4	4.9	4.5

Fig: 1-Dust fall content in mg/cm2

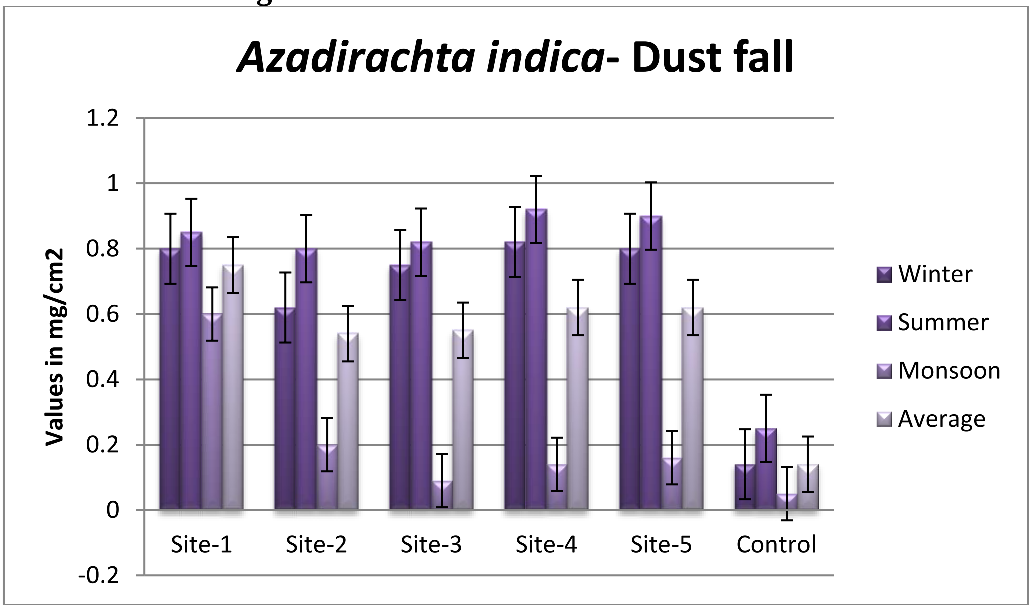

Fig: 1.1-Dust fall content in mg/cm2- (*Azadirachta indica*)

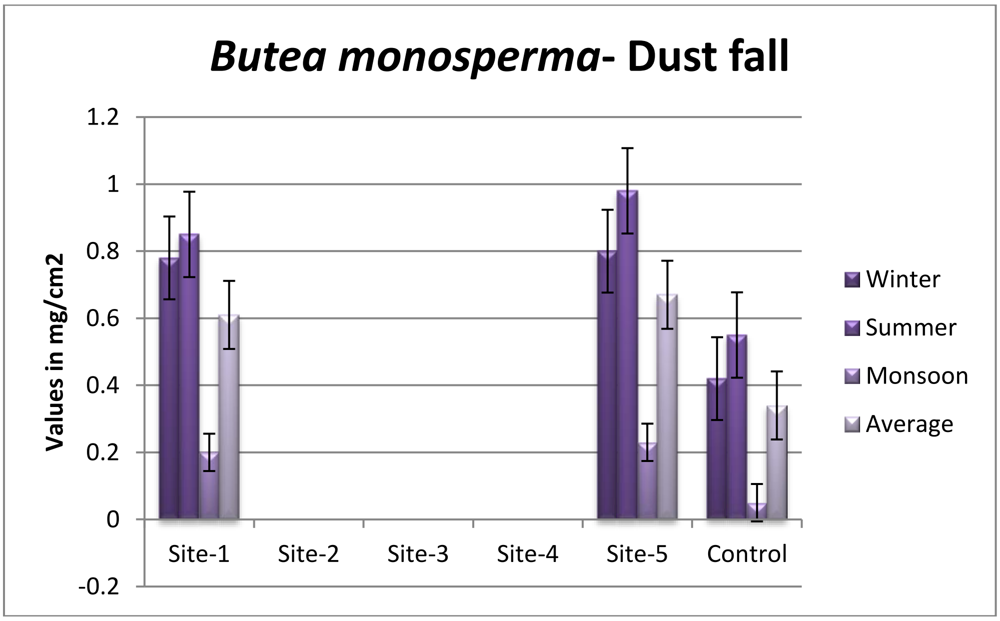

Fig: 1.2-Dust fall content in mg/cm2- (*Butea monosperma*)

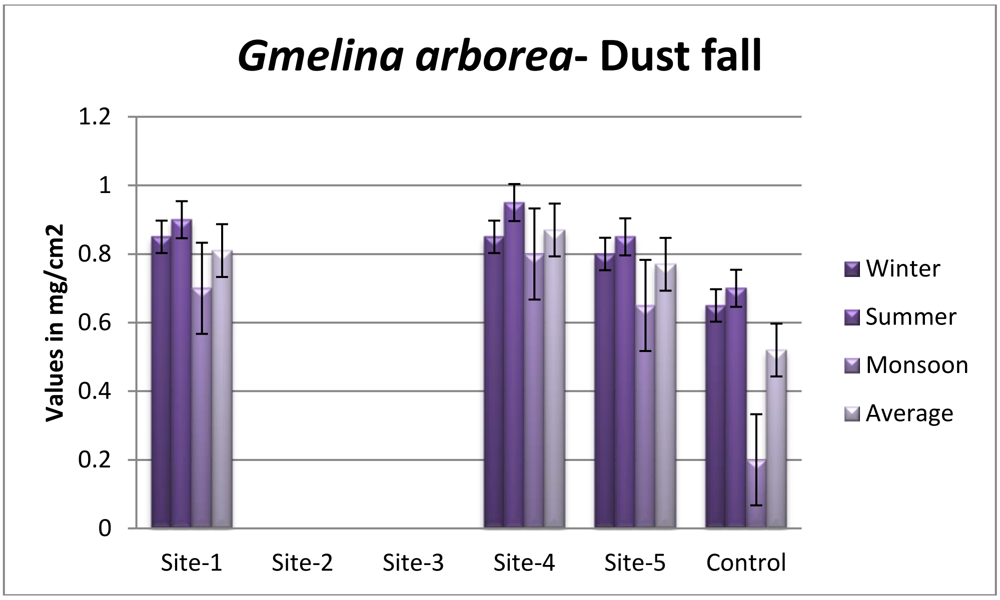

Fig: 1.3-Dust fall content in mg/cm2- (*Gmelia arborea*)

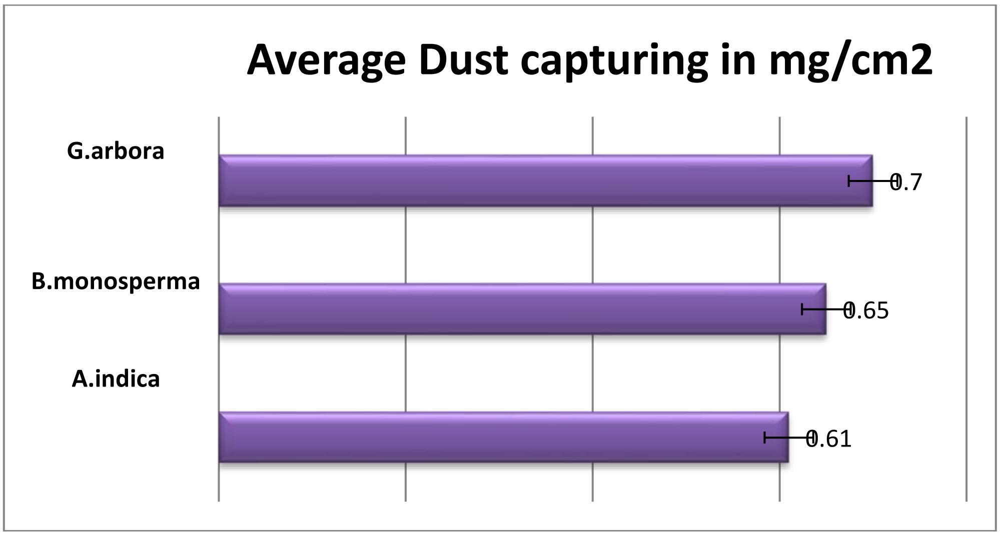

Fig: 1.5-Average Dust capturing capacity in mg/cm2

Fig: 2- Chlorophyll content

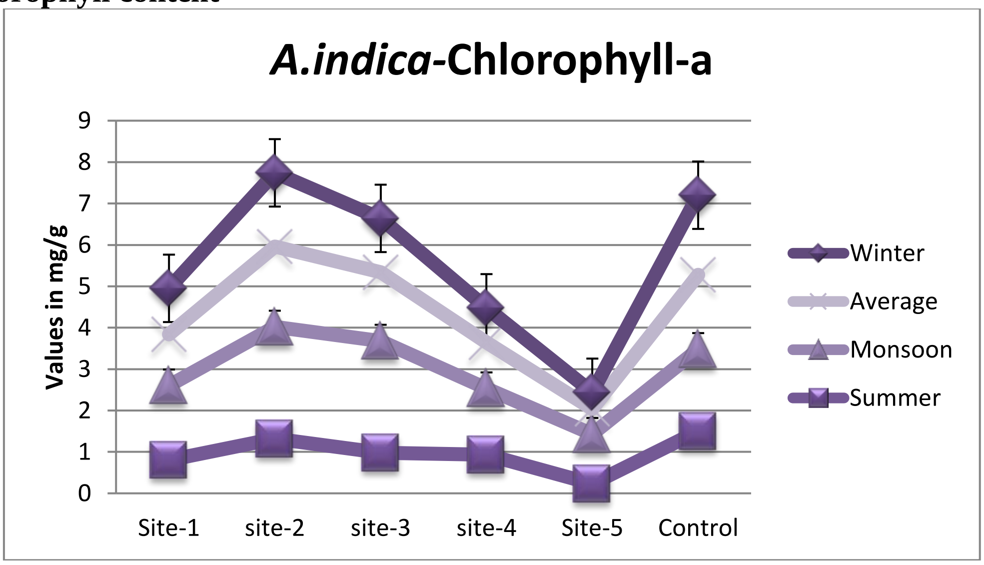

Fig: 2.1- Chlorophyll content-Chlorophyll-a

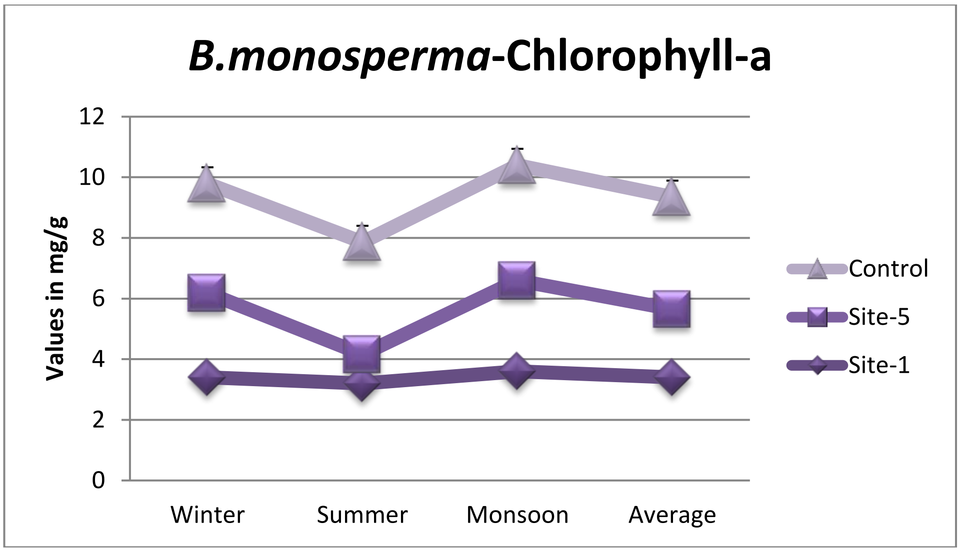

Fig: 2.2- Chlorophyll content-Chlorophyll-a

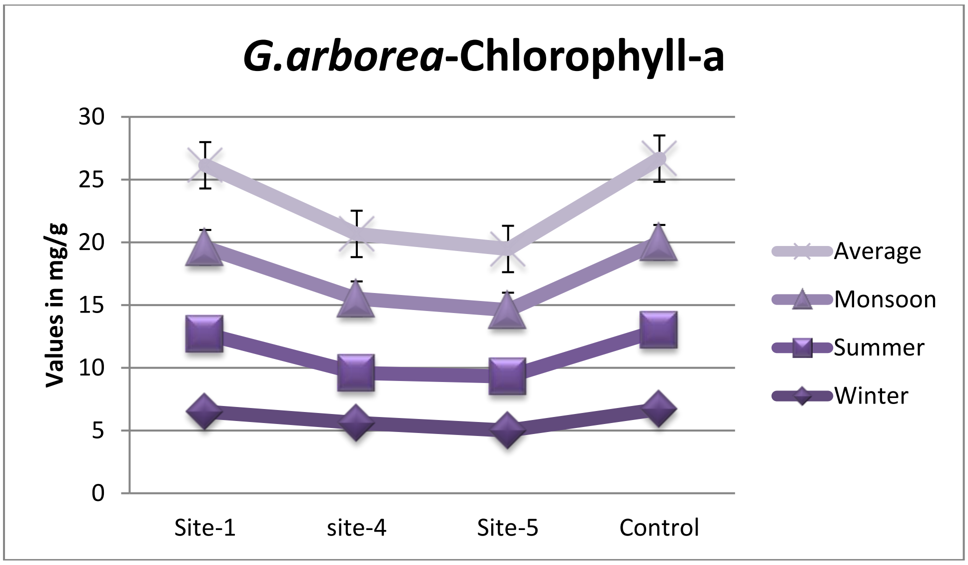

Fig: 2.3- Chlorophyll content-Chlorophyll-a

Fig: 3- Chlorophyll content-Chlorophyll-b

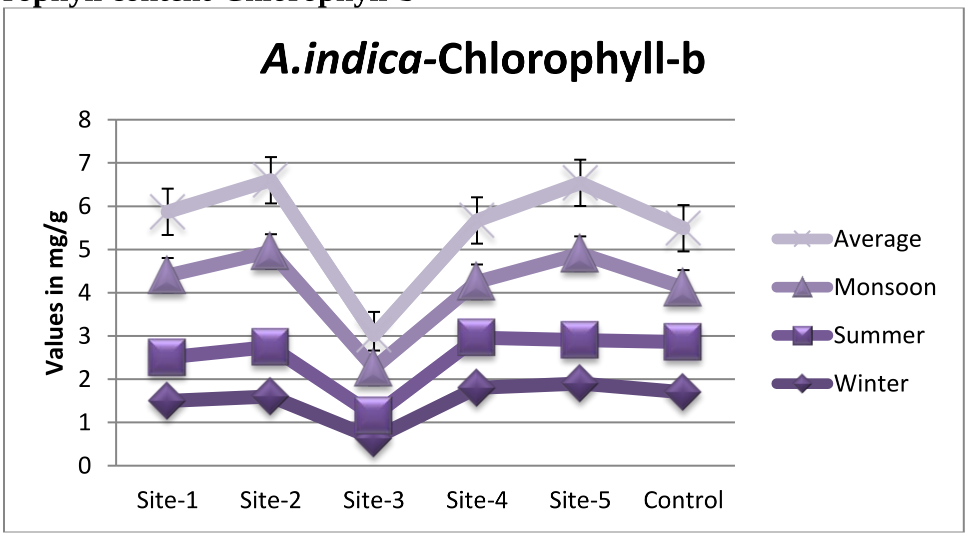

Fig: 3.1- Chlorophyll content-Chlorophyll-b

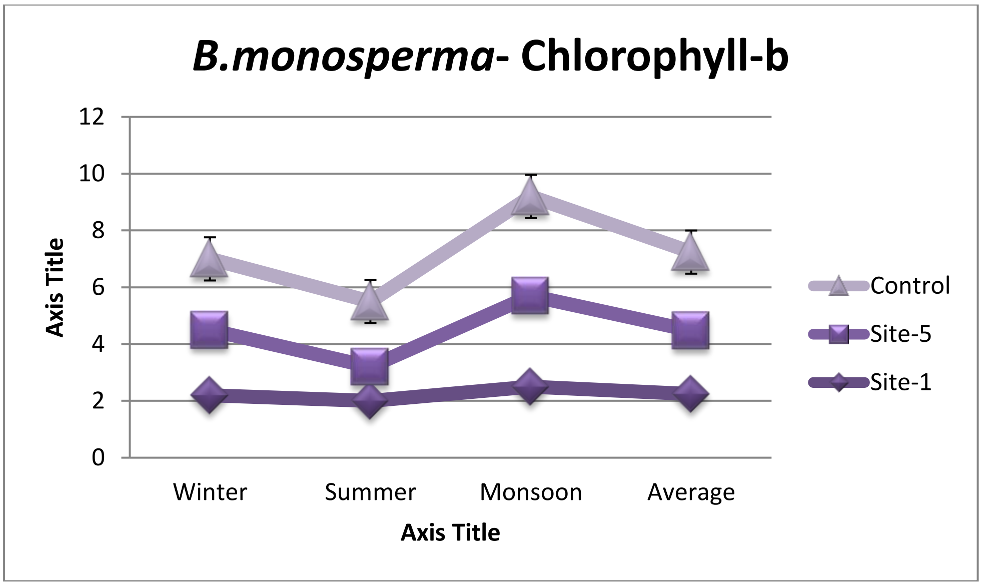

Fig: 3.2- Chlorophyll content-Chlorophyll-b

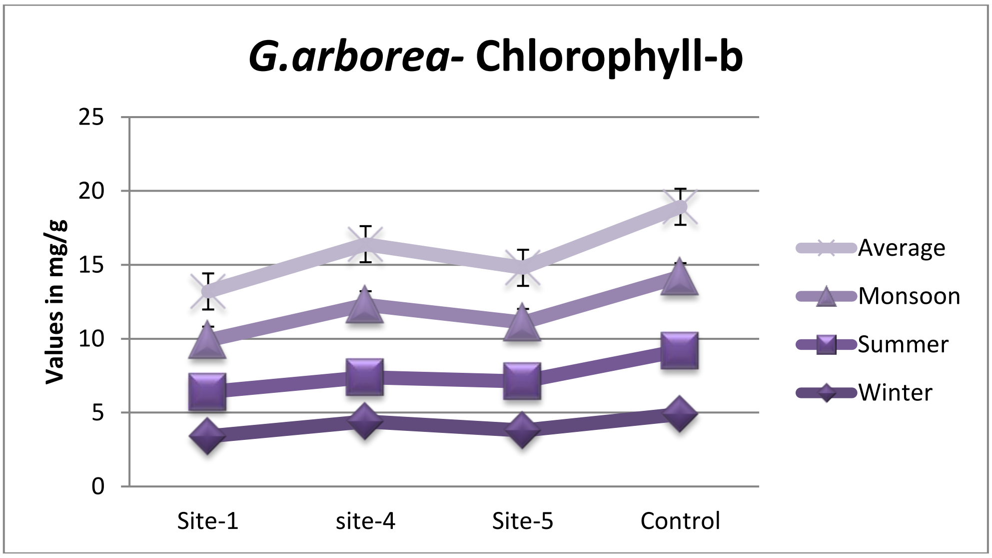

Fig: 3.3- Chlorophyll content-Chlorophyll-

Fig: 4- Chlorophyll content-Total Chlorophyll

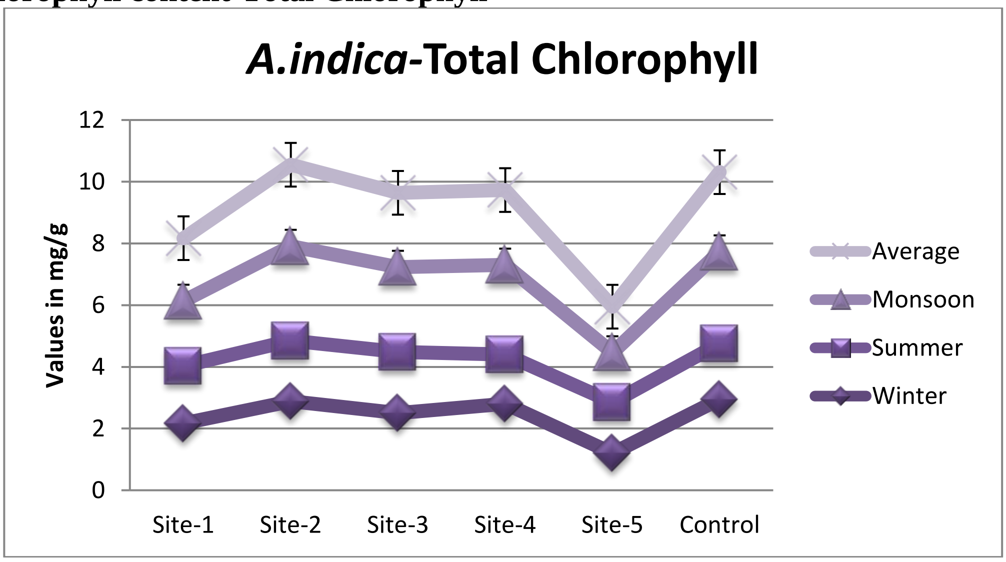

Fig: 4.1- Chlorophyll content-Total Chlorophyll

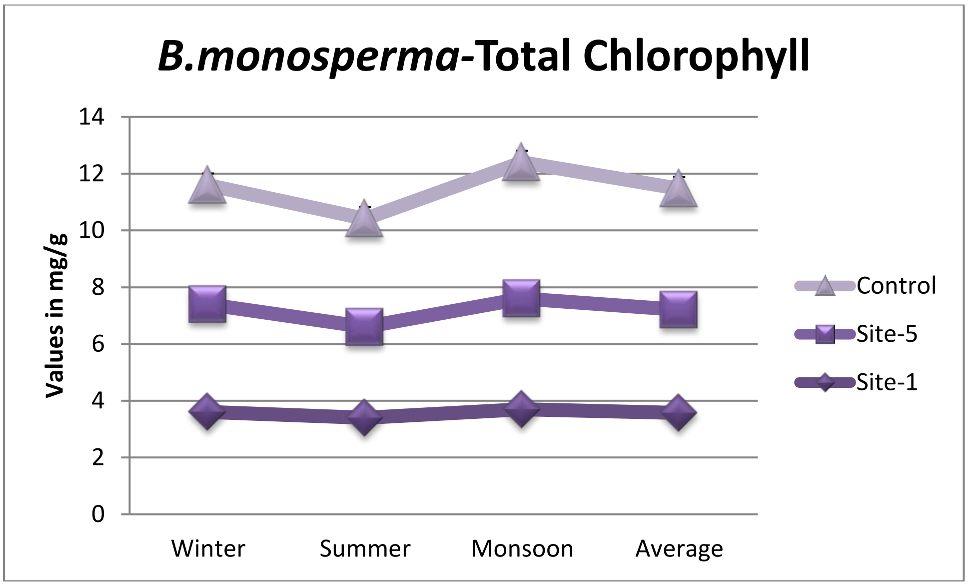

Fig: 4.2- Chlorophyll content-Total Chlorophyll

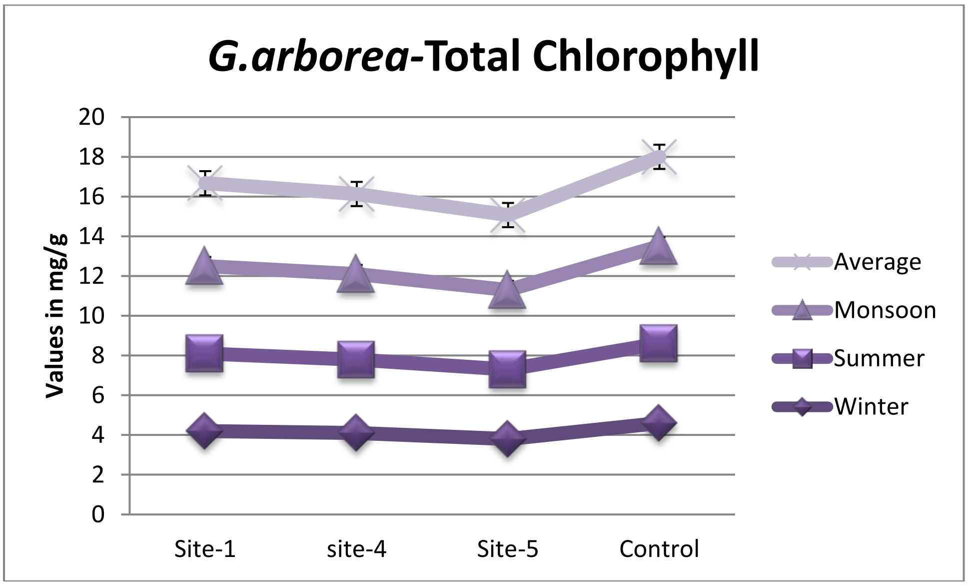

Fig: 4.3- Chlorophyll content-Total Chlorophyll

Dust fall:

According to Bernatzky (1974), there is typically a large amount of dust in metropolitan air. Researchers have attributed numerous explanations for plants' ability to store dust.

Leaf orientation, age, roughness, and wetness of the leaf surface all affect dust absorption and retention. (Neinhuis and Barthlott in 1998; Beckett and colleagues in 2000). According to Raupach et al., it also depends on the wind's strength and cosistency, the vegetation's porosity with regard to air flow, and the quantity and intensity of rain (2001). The deposition of In comparison to shorter vegetation, forests are better at intercepting gaseous pollutants and particle particulates (Fowler et al., 1989; Bunzl et al., 1989). It is known that in a polluted environment, leaves and other exposed plant parts typically function as persistent absorbers. (Samal and Santra, 2002). Three methods are used by plants to remove pollutants from the air: absorption by the leaves, deposition of particulates and aerosols across leaf surfaces, and fallout of particulates on the vegetation's leeward side as a result of slowed air movement (Tewari, 1994; Rawat and Banerjee, 1996). Leaf petioles are more efficient particulate impactors than either twigs (stems) or leaf lamina (Ingold, 1971). Together with all of these morphological traits, the position and placement of the tree are crucial. If the tree is nearer road chance of getting more dust increases *G. arborea* showed maximum dust trapping efficiency among all the plants which may be due to its habitat and morphological characters. It is an evergreen plant with big and horizontally arranged leaves. It has smooth leaf surface, vein is thick, large and many on the lower surface all these characters help dust to adhere more on leaves. According to Ahmed and Yunus (1981), the key characteristics of a leaf that aid in dust collecting include larger and more veined leaves. Once the dust particles settled down there are less chance to rid of as it has small petiole, which reduces the movement of leaf. Anatomical features of leaves also play an important role of high dust capturing capacity. *B. monosperma* also showed maximum dust trapping efficiency because it has a rough leaf surface and large leaves.

Chlorophyll content:

The pigments used in photosynthesis are particularly susceptible to harm from auto-pollution. Since chlorophyll is thought to be a productivity indicator, any change in chlorophyll concentration may have an impact on the morphology, physiology, and bio chemistry of the plant. Chlorophyll pigment data showed that over the whole study period, there was a significant decrease at all polluted sites compared to the control site. Maximum concentration of chlorophyll pigments was found at site-6 (control) in both plants except in *A. indica* in which chlorophyll a was found maximum at site-1 in *G. arborea* and *B. monosperma*. The highest reduction was observer at site - 4 &5 which may be due to it's a quarry dust because duct contain lime stone. No significant difference was found site-6(control) as it is a low polluted site.

According to Bhatnagar et al. (1985), the harmful effects of industrial dust and other gaseous pollutants on leaves were the reason why plants growing in polluted areas had less chlorophyll-containing leaves. The reduction in chlorophyll concentration in the polluted leaves could be due to damage to the chloroplasts (Pandey et al., 1991), a reduction in the manufacture of chlorophyll (Esmat 1993), or an increase in the breakdown of chlorophyll. Photosynthetic pigments are the ones most likely to be harmed by air pollution, according to Prusty et al. (2005). Chlorophyll a is assumed to be degraded to phaeophytin, whereas chlorophyll b molecule loses its phytol group (Rao and Le Blanc 1966).

Less chlorophyll contents in the leaves of all the plants growing at the cross-roads of polluted region may be due to long term exposure of these plants to pollutants like SO2, NO2, and SPM. The synergistic effects of these pollutants caused foliar injury i.e. chlorosis and necrosis, which degrade the chlorophyll pigments. The same view has been reported by Rao and LeBlack (1966), Puckett et al., (1973) and Mahlotra(1976). This decrease in chlorophyll concentration in polluted areas may be caused by the shading effects caused by the deposition of suspended particulate matter on the leaf surface. It may obstruct the stomata, hindering gas exchange, raising the temperature of the leaf, and perhaps delaying the synthesis of chlorophyll. Reduced photosynthesis is caused by a leaf surface that has dust or encrustation, which also lowers the amount of chlorophyll (Joshi and Swami, 2009).

Some researchers have also noted that photosynthetic pigments are degrading due to air pollution (Bansal 1988; Singh et al., 1990; Sandelius et al., 1995). Chlorophyll pigments exist in highly organized state, and under air pollution stress they may undergo several photochemical reactions such as oxidation, reduction, pheophytinisation and reversible bleaching (Puckett et al., 1973). Pollutants like SO2 are particularly harmful to photosynthetic pigment. Comparatively, polluted area has high SO2 concentration which may affect the chlorophyll pigments. SO2 enters in the mesophyll tissues and reacts with water to produce the sulphite ion which has strong phytotoxic properties, Taylor (1973). As nitrogen dioxide is soluble in water, oxides of nitrogen come in contact with water, both nitrous and nitric acids are formed, Jolly (1964). These toxic reactions may also be responsible to alter the concentration of photosynthetic pigments.

Prasad (1980) reported a decrease of chlorophyll contents due to the effects of SO2, and NO2. Reduction in the total chlorophyll content may be attributed to the heavy vehicular traffic (especially due to diesel driven four wheelers) that are responsible for the release of huge quantities SOx in particular and other pollutants as diesel contains four times more sulphur than petrol. This reduction may be due to the SO2 induced activity resulting in the removal of Mg++ ions, which converts it into Phaeophytin. It modifies the light spectrum characteristics as reported by Malhotra (1977). While as another study by Zeigler (1977) suggested that the reduction in the chlorophyll content is caused by toxic ions formed by the dissolution of SO2 in water inside the leaf tissue, which preferentially incorporates into the thylakoid membrane. Reduction in the chlorophyll content of plants exposed to air pollution enriched by SO2 has also been reported b many workers (Pawar and Dubey, 1982; 97 Boralkar and Shinde, 1983;Darrall and Jager, 1984; Ayer and Bedi, 1986; Kumawat and Dubey, 1988; Panigrahi et al., 1992: Pandey and Rao, 1977; Varshney and Varshney, 1979; Singh and Rao, 1980a; Agrawal, 1982 and Agrawal et al., 1982, 1983a). Photosynthetic pigments are fairly sensitive to air pollutants and their sensitivity may determine the responses of plants to pollutants. According to Katiyar & Dubey (2001), the amount of chlorophyll in plants varies depending on the species, age of the leaf, level of pollution, and other biotic and abiotic variables. In the present study also different amount of chlorophyll content was observe in different plant species present at the same site. It has been found that maximum total chlorophyll was obtained in *G. arborea* (4.17mg/g) and minimum in *A. indica* (2.64 mg/g) .Chlorophyll a was maximum in *G. arborea* (6.54 mg/g) and minimum in *A. indica* (1.24 mg/g), while chlorophyll b in *G. arborea* (4.1mg/g) and minimum in *A. indica* (1.47mg/g).

The age of the leaf, the stage of senescence, the sensitivity of the plant species, the biotic and abiotic conditions, and the location of the plant at the intersection could all have a role. According to Mir et al. (2008), taller plants close to roadsides have less chlorophyll due to high levels of traffic pollution.

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