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STUDY ON AIR QUILITY AND AIR POLLUTION TOLERANCE INDEX OF SOME ROAD SIDE TREE PLANTS AT SATNA CITY M.P.

Dissertation

Submitted For the Award of the Degree

Of

Master of Science
In
Environmental Science

Under the Guidance

Dr. Sadhan Chaurasia (H.O.D.)
Energy & Environment

Submitted By

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Certificate

This is to certify that the work entitled **"STUDY ON AIR QUILITY AND AIR POLLUTION TOLERANCE INDEX OF SOME ROAD SIDE TREE PLANTS AT SATNA CITY M.P. "** is a piece of dissertation work done by **Arvind Singh Yadav** under my guidance and supervision for the degree Master of Science in Environmental Science from the faculty of Science, Department of Energy & Environment, M.G.C.G.V., Chitrakoot, Satna (M.P.) The work incorporated in this thesis has not been submitted elsewhere earlier, in part or in full, for the award of any other degree or diploma of this or any other Institution or University.

Date :

1.Signature of Dean

Signature of Supervisor

(Dr. Sadhana Chaurasia)
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2. Signature of HOD

3. Signature of Examiner

Acknowledgment

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(Arvind Singh Yadav)

Declaration

I declare that my dissertation on **" STUDY ON AIR QUILITY AND AIR POLLUTION TOLERANCE INDEX OF SOME ROAD SIDE TREE PLANTS AT SATNA CITY M.P. "** is my own work conducted under the Supervision of **Dr. Sadhana Chaurasia**, HOD, Deptt. of Energy & Environment, MahatmaGandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot (Satna) M.P.

I further declare that to the best of my knowledge my dissertation does not contain any part of any work which has been submitted for the award of any degree either in this university or in any other university/Deemed university.

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M.Sc.

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Content

INTRODUCTION

1.1. Air Pollution

Air pollution occurs due to the presence of undesirable solid or gaseous particles in the air in quantities that are harmful to human health and environment. It can be defined as presence of foreign matter either gaseous or particulate or combination of both in the air which is detrimental to the health and welfare of human beings. Air pollution is one of the major problems faced by urban areas. It causes more ill effects on human health, environment as well as building structures. The growing level of motorization in urban areas with poor traffic management strategy and inadequate separation among working, living and moving space on major corridors have resulted in traffic congestion leading to longer travel time, extra fuel consumption, and associated air pollution problems. The problem is further compounded by the large share of ill maintained old vehicles, sizable share of ill maintained two stroke engines, and uncontrolled emissions from diesel engine buses plying on city corridors using poor quality fuel. The growing emissions from automobiles cause great discomfort to road users.

Air pollution is one of the severe problem world is facing today. It deteriorates ecological condition and can be defined as fluctuation in any atmospheric constituent from the value that would have existed without human activity. Over the years, there has been a continuous growth in human population, road transportation, vehicular traffic and industries which increases the concentration of gaseous and particulate pollutants **(Tripathi and Gautam, 2007)**.

1.2 Source of Pollution

Air is never found absolutely clean in nature. Ever since from the discovery of fire man started to pollute the air. Besides all human activities which are the major cause of air pollution, there are some natural activities too which increase the air pollution. Thus, source of air pollution can be grouped into two major categories.

Natural source

Man-made sources

Natural sources :- the natural source of air pollution are volcanic eruption, releasing poisonous gases (e.g. SO_2,H_2S,CO) forest fires, natural organic and inorganic decay , marsh gases, deflation of sand and dust , extra terrestrial bodies, cosmic rays , soil debris , pollen grains of flowers and fungal spores.

Man made source: - The major source of air pollution are man made , as natural air pollution is self controlled by natural auto cleansing and auto-repairing cycles. But man pollutes the air to such as extent that it cannot be repaired by natural itself. Ex. Population, Deforestation, Incomplete combustion of fuels, Emission from vehicles, Rapid industrialization, Agricultural activities.

1.3 Pollutant

Particulates are small pieces of solid material. Particulate matter can be Natural such as dust, seeds, spores, pollen grains, algae fungi, bacteria and viruses Anthropogenic such as mineral dust, cement, asbestos dust, fibers, metal dust, fly ash smoke particles form fires etc.

These are called primary pollutant and secondary pollutant.

1.4.Type of pollutant

Primary: - Pollutants that are emitted directly from identifiable sources are produced by natural events can be in the form of particulate matter or gaseous form. Thefive main primary pollutants. Suchas theoxides ofnitrogen, sulfur dioxide, carbonmonoxide, unburned hydrocarbons, and particulate matter.

Secondary:- The pollutants that are produced in the atmosphere, when certain chemical reactions take place among the primary pollutants and with others in the atmosphere are called secondary air pollutants. Such as Ozone, PAN, sulphuric acid, nitric acid, carbonic acid and acid rain.

1.5. Gasses Pollutant

NOx (Oxides of Nitrogen)

NOx (NO and NO_2). Nitric oxide (NO) and nitrogen dioxide (NO_2) are the two most important nitrogen oxide air pollutants. NO_2 is the most toxic and irritating compound. NO_2 is a reddish-brown gas with a sharp odor. The primary source of this gas is vehicle traffic, and it plays a role in the formation of tropospheric ozone. Large concentrations can reduce visibility and increase the risk of acute and chronic respiratory disease.

Sox (Oxides of Sulphur)

This compound is colorless, but has a suffocating, pungent odor. The primary source of SO_2 is the combustion of sulfur-containing fuels (e.g., oil and coal). Exposure to SO_2 can cause the irritation of lung tissues and can damage health and materials.

Sulfur dioxide (SO_2) is formed from the oxidation of sulfur contained in fuel as well as from certain industrial processes that utilize sulfur-containing compounds. Anthropogenic emissions of SO_2 result almost exclusively from stationary point sources. Estimated annual emissions of SO_2 in the United States in 1978 are given in A small fraction of sulfur oxides is emitted as primary sulfates, gaseous sulfur trioxide (SO_3), and sulfuric acid (H_2SO_4), It is estimated that, by volume, over 90% of the total U.S. sulfur oxide emissions are in the form of SO_2, with primary sulfates accounting for the other 10%.Sulfur dioxide (SO_2).

1.6. Particulate Matter

Particulate matter may contain both organic and inorganic pollutants. It is regarded as one of the most critical of all pollutants. The extent to which particulates are considered harmful depends on their chemical composition and size. For example particulates such as emissions from diesel vehicle exhausts mainly contain unburned fuel oil and hydrocarbons that are known to be carcinogenic. Very fine particulates pose the greatest health effects as they can penetrate deep into the lung and cause more damage, as opposed to larger particles that may be filtered out through the airways' natural mechanisms.

Particulate also called as aerosols are small particles of solid or liquid matter of such minute size that it can remain suspended in the atmosphere for a long time. The solid particulate exists in the form of spheres, filaments, and other irregular shapes, while liquid particles are generally spherical in shapes.

Particulate can either be natural or anthropogenic. Natural particulate include pollen, viruses, bacteria, fungi , protozoa, volcano dust, etc. anthropogenic particulate are smoke, fly ash, acid droplets, metallic oxides and salts, inorganic dust etc.

Exposure to particulate matter occurs as a result of inhaling air that contains the pollutant or ingesting (air cannot truly be "ingested"; the mechanism is through the ingestion of inhaled particulates that are expelled by the normal actions of the ciliated epithelium of the lung. The expelled particulates are deposited in the back of the throat, from where it is swallowed and ingested). Dermal contact may also occur although this is more significant to occupational exposure. People with chronic obstructive pulmonary and/or cardiovascular disease, asthmatics, the elderly and children, are more at risk to the inhalation of particulates than normal healthy people **(Pope, 2000; Zanobetti *et al*., 2000)**.

PM_{10}:- Particulate matter is a ubiquitous pollutant, reflecting the fact that it has both natural and anthropogenic sources. Natural sources of primary particulate matter include windblown soil and mineral particles, volcanic dust, sea salt spray, biological material such as pollen, spores and bacteria and debris from forest fires **(National Ambient Air Quality Objectives for Particulate matter, 1998)**. PM_{10} refers to particulate matter that is 10 μm or less in diameter.

The increases in particulate matter have been shown to cause small, reversible decrements in lung function in normal asymptomatic children, and in both adults and children who have some form of pre-existing respiratory condition, particularly asthma. These changes were often accompanied, especially in adults, by increases in symptoms such as chronic bronchitis or cough **(National Ambient Air Quality Objectives For Particulate matter, 1998)**.

$PM_{2.5}$:- PM2.5 refers to fine particles that are 2.5 micrometers (μm) or smaller in diameter. Ambient air is defined as any unconfined part of the Earth's atmosphere, that the surrounding outdoor air in which humans and other organisms live and breathe.

1.7. Air Pollution Tolerance Index (APTI)

APTI are very effective and important for selection of plants in order to check their susceptibility against any environmental stress like air pollution. This is a simple and easy method to adopt on different types of field conditions and reduced the use of costly environmental monitoring equipment's. To develop the usefulness of plants as bio-indicators requires an appropriate selection of plant species which entail an utmost importance for a particular situation. Air pollution tolerance index is used to select plant species tolerant to air pollution. Four physiological and biochemical parameters namely, leaf extract pH, ascorbic acid, total chlorophyll and relative water content were combined together in a formulation signifying the air pollution tolerance index of plants.

Air pollution tolerance index (APTI) is natural quality of plants to face problem of air pollution stress, now in present days it is most important especially in industrial and non-industrial areas. Therefore, APTI of the plants needs checked properly especially of economically important plant species that are present in the polluted and non-polluted areas. APTI is an inherent quality of plants to encounter air pollution stress which is presently of prime concern particularly of urban areas of the world. Since plants are stationary and continuously exposed chemical pollutants from the surrounding atmosphere, air pollution injury to plants is proportional to the intensity of the pollution. Air pollution has become a major problem arising mainly from industrialization and urbanization during the last few decades. Particulate matter is of great concern in relation to their adverse impact on human health and vegetation **(Rai, 2013)**. The particulates and gaseous pollutants, alone and in combination can cause serious setbacks to the overall physiology of plants **(Ashenden and Williams, 1980; Mejstrik, 1980; Anda, 1986.)**. Trees experience the greatest exposure and influenced greatly by pollutant concentration due to their perennial habit**.**

Air pollution tolerance index (APTI) is an inherent quality of plants to encounter air pollution stress which is presently of prime concern particularly in road site and control areas. Therefore, APTI of the plants needs to be monitored and checked for the predominant species that are present in the road site and control areas. In the present study, APTI of common growing roadside plants have been investigated.

The leaves are generally used as experimental material as they take up large amount of pollution. In the current study our prime objective was to go for phyto-optimization of the air quality of the plants as meager literature in relation to application of plants for APTI value was found. Secondly an attempt has been made to compare the APTI values of different plants and to screen out the relative sensitivity of four plant species towards air pollution taken from road site and control side of the study area.

APTI is a species dependent plant attribute which expresses the inherent ability of the plant to encounter stress emanating from pollution. According to Mashita and Pise, 2001 there is a scale of APTI value which indicates the APTI value between 30-100 the species is tolerant ; APTI value 17- 29 as intermittently tolerant and plants registering APTI value in the range of 1-16 are considered as sensitive ;APTI value lower than 1 is branded as highly sensitive.

1.8. Air Pollution Effect on Plants

Today's growing population and increasing urbanization has resulted in deterioration of ambient air quality. Air pollution is causing vast changes in vegetation. Since plants are stationary and they are continuously exposed to chemical pollutants from the surrounding atmosphere, air pollution injury to plants is proportional to the intensity of the pollution. The pollutants enter into the plants and react in variety of ways before being removed or absorbed that may include accumulation, chemical transformation and incorporation into the metabolic system. In this process, some plants are injured while others show minimal effects **(Choudhury et al, 2009)**

Air pollution is one of the severe problem world is facing today. It deteriorates ecological condition and can be defined as fluctuation in any atmospheric constituent from the value that would have existed without human activity. Plant speices show a striking variation in their sensitivity to air pollution **(Teshow 1984).** Leaves are generally used for analysis because of its absorbance of largest amount of air pollutants. Air pollution decreases the photosysnthetic capacity of plants by affecting stomatal aperture and photosynthetic tissue **(Darley & Middleton 1966).** Damage to vegetation due to industrial air pollutant has been reported by **Rao, 1981**. Since plants are stationary and are continuously exposed to air pollutants, air pollution injuiy to plants are proportional to the intensity of pollution. Hence use of plants is often suggested for air quality monitoring **(Chaphekar 1982)**.

Air pollution has direct harmfull impact on plant leaves. Leaves are generally used. as they take up the largest amounts of pollutant **(Treshow 1984)**. A decrease in chlorophyll content has often been suggested as an indicator of air pollution injury **(Malhotra & Khan 1984)**. Chlorophyll is relatively sensitive but rathcr non specific to air pollution and can be used as bio indicator along with such metabolites as ascorbic acid and protein **(Varshney 1982)**.

Using plants as indicator of air pollution gives the possibility of synergistic action of pollutants **(Lakshmi *et al.*, 2008)**. The ambient environment of an urban area may be contaminated with several pollutants such as SO_2, CO, NOx and heavy metals and the plants growing there would be exposed not only to one but too many pollutants and their different conditions. Air pollution tolerance index is used by landscapers to select plant species tolerance to air pollution **(Agbaire, 2009)**.

1.9. Study Area

Satna is a city in the Satna District of Madhya Pradesh in India, which shares a border with neighboring Uttar Pradesh. It is is located at 24.34^0 N 80.55^0 E with an average elevation of 317 meters (1033 feet). As per provisional report of Census India, population of Satna in 2011 is 280, 22; of which male and female are 147,874 and 132,348 respectively. Although Satna city has population of 280,222; its Urban and Metropolitan population is 282,977 of which 149,415 are males and 133,562 are female. Satna is in the limestone belts of India. Satna has a literacy rate of 63.8% according to the 2011 Census. The location is renowned for dolomite mines and limestone. The city is a municipal corporation within the district, and the home of its administrative headquarters. As a result, it contributes around 8%–9% of India's total cement production. There is an abundance of dolomite and limestone in the area and the city has ten cement factories producing and exporting cement to other parts of the country. The electrical cable company Universal Cabalism Satna is among the pioneers in the country. The city of Satna is known as the commercial capital of Baghelkhand. The city is among the few most promising cities of Madhya Pradesh because of the several new industries planned by some of the reputed industrial houses in the country. Satna is known as the cement city of India.

1.10.Objectives of study

1. To know the Road side ambient air quality at Satna..
2. To determine air pollution tolerance index (APTI) of some road side plants.
3. To compare the air quality with standards.

REVIEW AND LITERATURE

Air pollution receives one of the prime concerns in India, primarily due to rapid economic growth, industrialization and urbanization with associated increase in energy demands. lacks of implementation of environmental regulations are contributing to the bad air quality of most of the Indian cities. **(Rai et al, 2011)**.

Tripathi et al., 2015 studied on ambient air quality of Chachai region and found higher particulate in summer due of enhanced dispersion of fugitive dust appends by coal and ash handling activity and in winter can be attributed to low temperature and low wind speed. The lowest concentration during monsoon season may be attributes to washout by rainfall and due to higher relative humidity, which reduces re–suspension of dust.

Dust pollution cause negative impact on plants as it reduced photosynthesis and cause leaf fall with tissue death **(Farooq et al., 2000; Shrivastava and Joshi, 2002)**. Dust affects the synthesis of chlorophylland resulted in leaf chlorosis **(Seyyednejad et al., 2011)**. Similary morphology and anatomy of leaves is also altered by dust **(Gostin, 2009; Sukumaran, 2012)**.At the same time many plants are able to survive in high dust load due to the synthesis of caroteneoids and ascorbic acid which give non enzymatic resistance to plants to numerous a biotic stresses **(Prajapati and Tripathi, 2008).** In addition to the direct effects of air pollution on plants, dust has indirectly effects on agricultural production **(Kia et al., 2005)**

SPM can produce a wide variety of effects on the physiology of vegetation that in many cases depend on the chemical composition of the particle. **Rao (1991)** noticed that plants growing around polluted sites showed visible leaf injury symptoms like marginal necrosis, interveinal necrosis and leaf tipburns. The chlorophyll content was reduced to 12.40 %. Germination and seedling growth was hampered in some crop plants when grown on soil polluted with cement dust. **Pandey et al. (1992)** studied the effect of coal dust pollution on biomass, chlorophyll, nutrients and grain characteristics of wheat in coal field area of Dhanbad, Bihar. The total chlorophyll of polluted wheat plants was reduced to 8.9 per cent at the age of 75 days. **Shanmughavel (1996)** studied the effect of particulate pollutants on tobacco plants growing in the vicinity of sugar factory and reported the injury symptoms like marginal necrosis, interveinal necrosis and leaf tip burnt. **Somashekar et al. (1999)** examined the biological characteristics of some plant species in and around quarrying and crushing areas of Bangalore District and observed that chlorophyll concentration differed significantly with control in most cases and a few samples possessed high proline content. A reduction in leaf area was also observed. These changes are mainly attributed to the accumulation of dust.

Saha and Padhy (2011) have studied the effects of stone crushing industry on Shorea robusta and Madhuca indica foliage. Investigations on ten annual plant species reveals that the foliar surface was an excellent receptor of atmospheric pollutants leading to a number of structural and functional changes(**Rai et al., 2010)**.

Pandey et al. (1999) reported that maize crop cultivated in the prevailing wind direction of stone crusher, Bihar exhibited the impact of dust on the biomass and chlorophyll content. The biomass was higher at each sampling date of the control maize plant than the polluted ones. **Wilson (2000)** observed that concentration of asbestos fibrils in the ambient air in Pulivendla, Cuddappah district, Andhra Pradesh and suspended particulate matters (SPM) were high above the permissible limit of 500 $\mu g/m^3$ which affected the biochemical parameters of Ricinus communis L. and Calotropis gigantean L.

The continuous cement industry pollution closes the stomata so interfering with gaseous exchange. The plants growing near the industry were having lesser quantity of chlorophyll and the distance increases the quantity of total chlorophyll, affect the photosynthetic activity adversely **(Chaurasia et al, 2014)**.

Larcher 1995, reported that increased concentrations of pollutants cause progressive reduction in the photosynthetic ability of leaves, closure of leaf stomata reduction in growth and productivity of plants.

Tiwari (2012), studied on air pollution induced changes in foliar morphology of two shrub species at Indore city, reported the total pollution stress of an area affects the growth of various plants in non-uniform manner. Therefore, various plant parameters can be used to measure the effect of pollution. The parameters examined were fresh and dry weight of leaves, L/B ratio, specific leaf area, size of stomata and stomatal index of the plants growing in polluted habitats. Dust particulates remain in air for varying length of time and get deposited on various plant parts of the plants; especially on leaf surface and affect vegetation.

Raajasubramanian et al. 2011, studied on cement dust pollution on growth and yield attributes of groundnut (*Arachis hypogaea* L.) and reported increased concentration of cement dust pollutants causes invisible injuries like progressive decline in the physiological process such as photosynthetic ability and respiration rate of leaves. Similarly, visible injuries such as closure leaf stomata, a marked reduction in growth and productivity. The effect of cement dust deposition on soil and over the vegetation and its consequences effect on groundnut crop, which was popularly grown in and around the vicinity of cement industry. All the morphological and biochemical and yield parameters were analyzed. Morphological parameters Root length, Shoot Length, Total leaf area, fresh and dry weight were inhibited in high dose of cement deposition when compare control plant.

Amal & Migahid (2011) studied on effect of cement-kiln dust pollution on the vegetation in the western Mediterranean desert of Egypt and reported that cover and phytomass of *Atriplex halimus* were increased greatly in response to cement dust pollution, and this was accompanied by a reduction in the mature seeds and leaf-area of the plant. Air pollution generally and especially dust from stone crusher plant sites are known to be responsible for vegetation injury and crop yield loss and thus become a threat to the survival of plants in industrial areas. Such dust reduces plant cover, height and number of leaves **(Iqbal and Shafig, 2001)**.

Shaha and Padhy, 2011 studied effect stone crushing industry on *Shorea robusta* and *Madhuca indica* foliage in Lalpahari forest. *Shorea robusta* and *Madhuca indica* which are two dominant broad–leaved tree species of the forest concerned. Heavy deposition of dust particles on leaf surfaces was noted. Various types of foliar anomalies, both microscopic and macroscopic, were detected externally. Decrease in amount of chlorophyll and total carbohydrate in foliar tissues indicated reduction of photosynthesis, Reduction of protein content in foliar tissues.

Madungwe & Mukonzvi (2011) studied on assessment of distribution and composition of quarry mine dust. Highest dust concentrations for both parameters (PM_{10} & $PM_{2.5}$) were recorded near the plant and decreased with increasing distance from the plant (ranging from 209.9 mg/m3 - 19.41 mg/m3 inhalable and 69.01 mg/m3 - 14.23 mg/m3 respirable). Dust pollution cause negative impact on plants as it reduced photosynthesis and cause leaf fall with tissue death **(Farooq *et al.*, 2000; Shrivastava and Joshi, 2002).** Dust affects the synthesis of chlorophyll and resulted in leaf chlorosis **(Seyyednejad *et al.*, 2011).** Similary morphology and anatomy of leaves is also altered by dust **(Gostin, 2009; Sukumaran, 2012).** Sufficient amount of dust pollution formed a layer on leaves than reduced light capturing ability of leaves which resulted in the declining of photosynthesis and ultimately plant growth **(Farmer, 1993)**.

The role of air pollutants causing injury to plants either by direct toxic effect or modifying the physiology rendering it more susceptible to infection. In severe case of pollution, the injury symptoms were expressed as foliar necrosis or completely disappearance of the plant **Raaja subramanian et al. (2011).** Higher values of biomass especially of leaves and roots at budding and flowering stages are observed. **(Stancheva, 2004).** Growth and development of crops depend largely on the development of root system. Phosphorus (P) is one of the three macronutrients that plants must obtain from the soil. It is a major component of compounds whose functions relate to growth, root development, flowering, and ripening **(Raboy, 2003)**.

Chaurasia, et al. (2013) reported that the dust escaping from cement industries is often transported by wind and deposited in areas closed and far away from the factory. These include agricultural lands, natural vegetation, towns, and villages. Such deposition of particulate matter and other pollutants interfere with normal metabolic activities of plants, causing direct injury impairment of growth and quality and ultimately lead to decrease in plant yield.

The groundnut plant near the industry showed significant deterioration in morphological characteristics. The study indicated that parameters reductions in groundnut correlated directly with the particulate pollutant which led to lower yield at more polluted site. Increased concentration of cement dust pollutant cause in visible injuries like progressive decline in photosynthetic ability and closure of leaf stomata and this affect the growth and productivity of the plant **(Chaurasia et al. 2013)**.

Padhy (2013) studied the effect of stone crusher pollution on morphology and biochemistry, detected foliar anomalies and injury symptoms promoted by stone dust and found, tissue necrosis (both marginal and interveinal), brown patches, yellow patches, black spots, surface lesion, curling, insect eating, parasitic galls, growth retardation, cement-link surface with general hardness, dryness, lack of green pigment (paleness), lack of brightness and in extreme cases death of leaves.

Plant community is a part of total ecosystem in which flow of energy and nutrients are involved. The functioning of this system is ultimately related with the components of community **(Mishra, 2004)**. In nature plant communities become stabilized by the selective pressure of the environment, even a slight pressure or disturbance can upset the delicate balance of the ecosystem. The rapid growth of stone crushers in Mahoba district is a pose a major threat to the community structure and function.

Devarajan et al. (2015) studied on physico-chemical properties of soil and their impact on the mineral compositions of plants and reported that cement dust as an negative implication on soil and plants.

Rai et al, 2011 studied on gaseous air pollutant and effect on agriculture and reported that an adverse effect caused by air pollutants depends not only upon its concentration, but also on the duration and combination of air pollutants.

Air pollution has become a serious environmental stress to crop plants due to increasing industrialization and urbanization during last few decades **(Rajput and Agrawal, 2004)**. The particulates and gaseous pollutants, alone and in combination, can cause serious setbacks to the overall physiology of plants **(Ashenden and Williams, 1980; Mejstrik, 1980; Anda, 1986)**. Of all plant parts, the leaf is the most sensitive part to the air pollutants and several other such external factors **(Lalman and Singh, 1990)**. Plants provide an enormous leaf area for impingement, absorption and accumulation of air pollutants to reduce the pollutant level in the air environment **(Warren, 1973; Shannigrahi et al., 2004)**.

Pollutant gases originating from industries have a profound and increasing influence on natural vegetation and damage varies greatly in different plant species. **Middleton et al. (1950)** observed the effect of air pollution on forest trees and detrimental effect of photochemical oxidants on agricultural crops in USA. **Miller et al. (1969)** observed in conifers that visible damages may not be an indicator of the impact that the air pollutants have on plant species since large scale reduction in photosynthesis. **Critenden and Read (1978)** In India, the combination of pollutants so far used for studying plant responses were SO_2 and O_3, SO_2 and NO_2, SO_2 and HF, Coal smoke and SO_2, SPM and NO_2 **(Rao et al. 1985)**. The plants being consistently exposed to the environment, absorb, accumulate and integrate pollutants imposed on their foliar surface. Consequently, they undergo changes in their morphology, physiology, and biochemistry, which if properly quantified, can serve as a measure of the pollutant level affecting the plants **(Rao et al. 1985)**. Amongst the important plant parameters that have been used for relating and measuring pollutant concentration were gross morphology and leaf epidermal feature **(Yunus and Ahmad 1979, Garg and Varshney1980)**, change in chlorophyll **(Bell and Mudd 1976, Rao 1979)**, ascorbic acid content **(Kellerand Schwager 1977, Nandi et al.1984)**. Severe air pollution causes damage and in some cases kills vegetation. Visual indicators of pollution include a reddish-brown discolouration of foliage and premature leaf fall, both of which would contribute to decreased photosynthetic capacity for the tree **(Bell and Mudd 1976)**.

Emberson et al. (2000) observed that crop yield and forest productivity are being severely affected by local concentration of air pollution. Climate can have a twofold effect by influencing pollutant uptake through the stomata and also determining the seasonal pattern of air pollution, formation of secondary air pollutants like O_3. Vegetation response also varies with exposure to different air pollutant combination and the air pollutant composition of developed countries varies by region.

In India, northern and western part of the country experience higher level of air pollutants compared to the south and eastern part. The direct impact to vegetation caused by a number of air pollutant (SO_2, NOx, O_3, and SPM) in many rapidly industrializing in developing countries (**Emberson et al., 2001)**

Adverse impact of air pollution around industrial source and metropolitan cities have been reported from many parts of India and SO_2 as the most important air pollutant contributes to yield reduction of up to 50 per cent in agricultural species growing in the vicinity of thermal power plant where SO_2 concentration of 75 µg/m3 tol35 µg/m3 was recorded **(Agrawal 1991).** In India, high levels of SO_2 resulted in localized impacts on crops as demonstrated in the vicinity of industrial complexes.

Lalman and Singh (1990) concluded that the SO_2 fumigated plants undergo several reversible and irreversible physiological and biochemical changes as reflected by foliar injury reduced leaf area and biomass. Decreased photosynthetic activity and poor plant growth apparently reduced the dry matter and yield **(Khan and Khan, 1993)**. SO_2 decreases the chlorophyll and dry matter production **(Mandloi and Dubey, 1988: Rao and Dubey, 1988: Katiyar and Dubey, 2000)**. Low NO_2 dose is also believed to be toxic or inhibitory to some plants.

MATERIALS AND METHOD

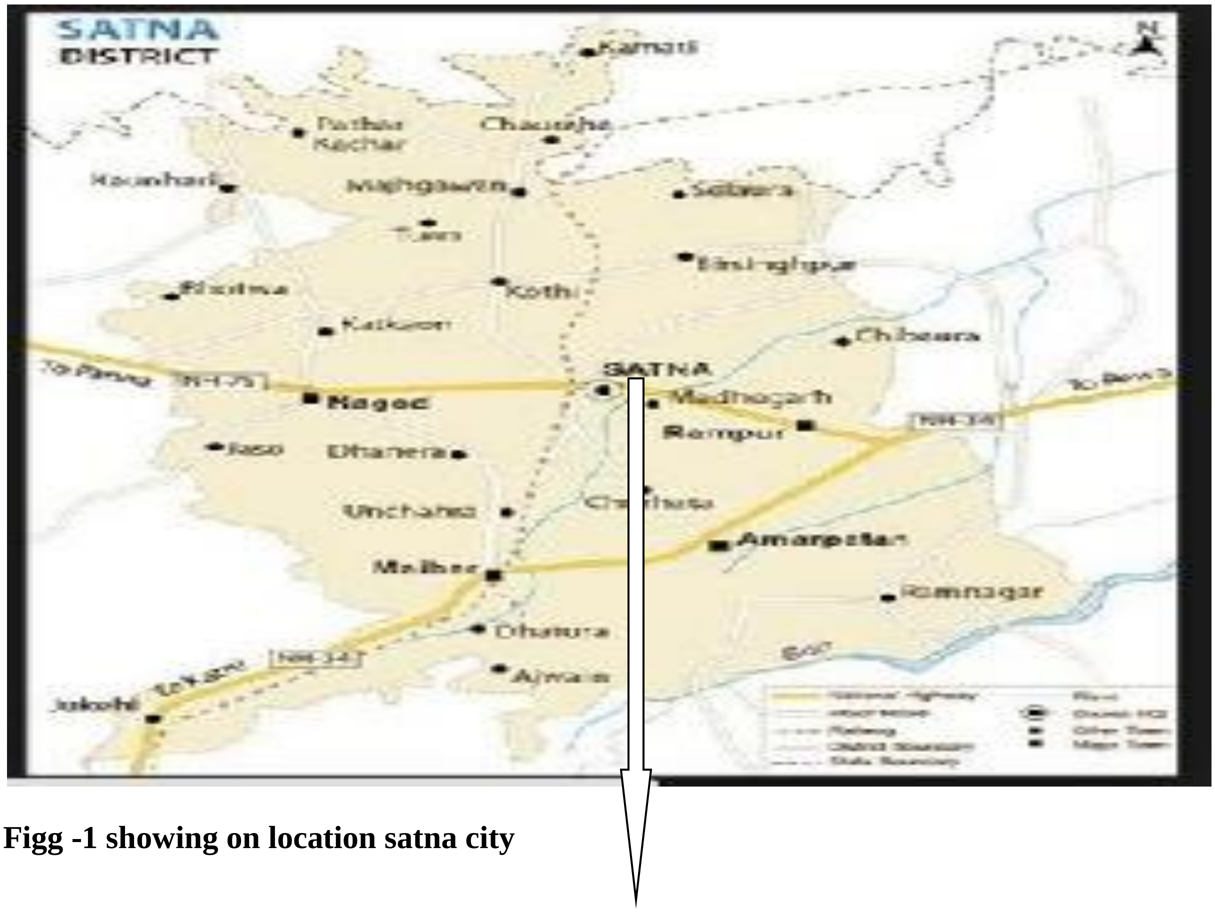
3.1.Ambient Quality study.
3.2.Plant study.
3.1. **Ambient Quality**

The purpose of this study was to investigate ambient air quality and its impact on the environment. The locations for AAQM study were selected approx 4 Km (Rewa road NH-39) road side. Ambient air quality was monitored on 5 (five) locations to generate representative ambient air quality data. The sampling locations are shown in table (1) and listed in figure (…).

Table-1 Showing sampling stations for ambient air quality monitoring

S.N.	Name of Station	Type of Station
1.	Semariya Chowk	Commercial
2.	Sindhi Campus	Industrial
3.	Gahra Nalla	Commercial
4.	Ramtekari	Commercial
5.	Utaily	Residential

The study was conducted in March to April, 2017 .Weekly air quality was monitored at all the five sampling station.To determine ambient air quality PM_{10}, PM2.5, SOx and, NOx parameters were monitored.Five tree sp. were selected to study air pollution tolrence index i.e *Psiduim guajava ,Mangifera indica ,Delbergia sisoo ,Madhuka indica , and Tectona grandis* .pl Ascorbic acid , P^H, relative water Content, and Total Chlolorophyll *was* monitored in all the selected plants..



Figg -1 showing on location satna city

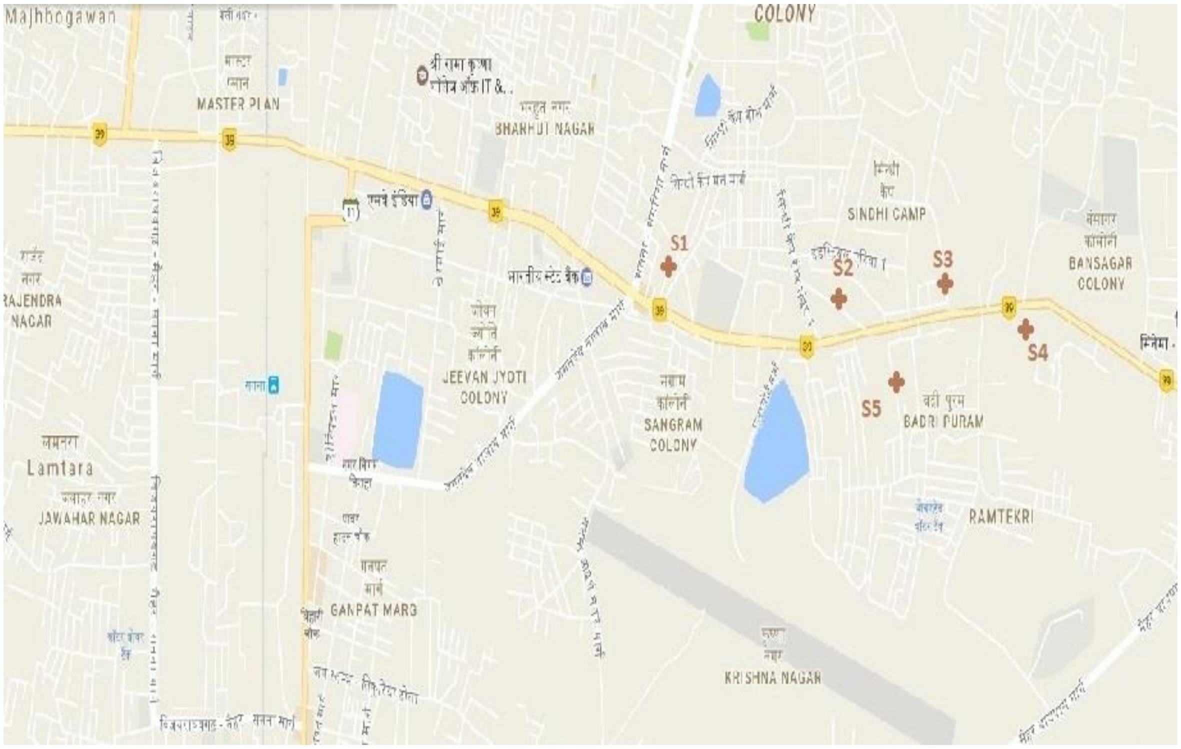


Fig.2 showing various sampling station of Satna City

Ambient air quality was monitored according to the CPCB (Central pollution control board) the methods prescribed for the pollutant gases and the particulate pollutants. The methods prescribed for the gases SO_2, NOx and the particulate pollutants, PM_{10}, $PM_{2.5}$ are respectively are given below

(i)Modified West and Geake method for SO_x

(ii) Modified Jacob Hochheiser method NO_x

(iii) Gravimetric Method forPM_{10} and $PM_{2.5}$.

DITAIL ANALITICAL METHODE FOR sox (MODIFIED WEST AND GAEKE METHOD)

PRINCIPLE

Sulphur dioxide from air is absorbed in a solution of potassium tetra chloromercurate (TCM). A dichloro sulphitomercurate complex, which resists oxidation by the oxygen in the air, is formed. Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may bestored for some time prior to analysis. The complex is made to react with para-rosaniline and formaldehyde to form the intensely coloured pararosaniline methylsulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer

Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of sulphur dioxide in ambient air:

- Analytical balance:
- Respirable Dust Sampler (RDS)
- Calibrated flow-measuring device to control the airflow 1 LPM.
- Absorber: all glass midget impinger
- Spectrophotometer: Capable of measuring absorbance at 560 nm equipped with 1 cm path length cells.

Reagents / Chemicals

- ❖ **Absorbing Reagent, 0.04 M Potassium Tetrachloro mercurate (TCM)** – Dissolve 10.86 g, mercuric chloride, 0.066 g EDTA, and 6.0 g potassium chloride or 4.68 g sodium chloride in water and bring to the mark in a 1 litre volumetric flask.*Caution : highly poisonous if spilled on skin, flush off with water immediately.* The absorbing reagent is normally stable for six months.
- ❖ **Sulphamic Acid (0.6%) -** Dissolve 0.6 g sulphamic acid in 100 ml distilled water. Prepare fresh daily.
- ❖ **Formaldehyde (0.2%) -** Dilute 5 ml formaldehyde solution (36-38%) to 1 litre with distilled water. Prepare fresh daily.

- **Purified Pararosaniline Stock Solution (0.2% Nominal)-** Dissolve 0.500 gm of specially purified pararosaniline (PRA) in 100 ml of distilled water and keep for
- 2 days (48 hours).
- **Pararosaniline Working Solution -** 10 ml of stock PRA is taken in a 250 ml volumetric flask. Add 15 ml conc. HCL and make up to volume with distilled water.

Sampling

Place 30 ml of absorbing solution in an impinger and sample for four hours at the flow rate of 1 L/min. After sampling measure the volume of sample and transfer to a sample storage bottle.

Analysis

Replaced water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber. Mixed thoroughly, pipette out 10/20 ml of the collected sample into a 25 ml volumetric flask. We added 1 ml 0.6% sulphamic acid and allow reacting for 10 minutes to destroy the nitrite resulting from oxides of nitrogen. Added 2 ml of 0.2% formaldehyde solution and 2 ml pararosaniline solution and make up to 25 ml with distilled water. Prepare a blank in the same manner using 10 ml of unexposed absorbing reagent. After a 30 min colour development interval and before 60 minutes, measure and record the absorbance of samples and reagent blank at 560 nm. Use distilled water; not the reagent blank, as the optical reference

Calculation

$$C\ (SO_2\ \mu g/m^3) = (As-Ab) \times CF \times Vs\ /Va \times Vt$$

Where,

$C\ SO_2$ = Concentration of Sulphur dioxide, $\mu g/m^3$

As = Absorbance of sample

Ab = Absorbance of reagent blank

C = Calibration factor

Va = Volume of air sampled, m^3

Vs = Volume of sample, ml

Vt = Volume of aliquot taken for analysis, ml

(II). Sampling and analysis of NO_2 (MODIFIED JACOB AND HOCHHEISER METHOD)

Principle of the method: - Ambient nitrogen dioxide (NO_2) is collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion (NO_2) produced during sampling is determined colorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N-(1-naphthyl)-ethylenediamine dihydrochloride (NEDA) and measuring the absorbance of the highly coloured azo-dye at 540 n m.

Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of Nitrogen dioxide in ambient air:

- Analytical balance:
- Respirable Dust Sampler(RDS)
- Calibrated flow-measuring device to control the airflow from 0.2 to 1 l/min.
- Absorber: all glass midget impinger
- Spectrophotometer: Capable of measuring absorbance at 540 nm equipped with 1 cm path length cells.

Reagents / Chemicals

- ❖ Absorbing solution (Dissolve 4.0 g of sodium hydroxide in distilled water, add 1.0 g of sodium Arsenite, and dilute to 1,000 ml with distilled water) Sulphanilamide - Melting point 165 to 167 C
- ❖ N-(1-Naphthyl)-ethylenediamine Di-hydrochloride (NEDA) - A 1% aqueous solution should have only one absorption peak at 320 nm over the range of 260-
- ❖ 400 nm. NEDA showing more than one absorption peak over this range is impure and should not be used
- ❖ Hydrogen Peroxide - 30%
- ❖ Phosphoric Acid - 85%
- ❖ Sulphanilamide Solution - Dissolve 20 g of sulphanilamide in 700 ml of distilled water. Add, with mixing, 50 ml of 85% phosphoric acid and dilute to distilled water.
- ❖ 1,000 ml. This solution is stable for one month, if refrigerated
- ❖ NEDA Solution - Dissolve 0.5 g of NEDA in 500 ml of distilled water. This solution is stable for one month, if refrigerated and protected from light.

- Hydrogen Peroxide Solution - Dilute 0.2 ml of 30% hydrogen peroxide to 250 ml with distilled water. This solution may be used for one month, if, refrigerated and protected from light.
- Sodium nitrite - Assay of 97% $NaNO_2$ or greater.
- Sodium Nitrite stock solution (1000 µg NO_2 /ml)
- Sodium Nitrite solution (10 µg NO_2 /ml.)
- Sodium Nitrite working solution (1 µg NO_2 /ml) (Dilute 2 with absorbing reagent, prepare fresh daily)

Sampling

Place 30 ml of absorbing solution in an impinger and sample for four hour at the flow rate of 0.2 to 1 L/min. After sampling measure the volume of sample and transfer to a sample storage bottle.

Analysis

Replace water lost by evaporation during sampling by adding distilled water up to the calibration mark with the absorber, mix thoroughly and out 10 ml of the collected sample into a 50 ml volumetric flask. Pipette in 1 ml of hydrogen peroxide solution, 10 ml of sulphanilamide solution, and 1.4 ml of NEDA solution, with thorough mixing after the addition of each reagent and make up to 50 ml with distilled water. Prepare a blank in the same manner using 10 ml of unexposed absorbing reagent. After a 10 min colour development interval, measure and record the absorbance of samples and reagent blank at 540 nm.

Calculation

$$C\ (NO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s / V_a \times V_t \times 0.82$$

Where,

$C\ NO_2$ = Concentration of Nitrogen dioxide, $\mu g/m^3$

A_s = Absorbance of sample

A_b = Absorbance of reagent blank

CF = Calibration factor

V_a = Volume of air sampled, m^3

V_s = Volume of sample, ml

V_t = Volume of aliquot taken for analysis, ml

0.82 = Sampling efficiency

(III). Sampling and analysis of Particulate Matter (PM_{10}) in ambient air (GRAVIMETRIC METHOD)

Principle of the method

Air is drawn through a size-selective inlet and through a 20.3 X 25.4 cm (8" X 10" inch) filter at a flow rate, which is typically 1132 L/min. Particles with aerodynamic diameter less than the cut-point of the inlet are collected, by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of PM_{10} in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of Particulate Matter PM_{10} in ambient air

- Analytical balance
- Respirable Dust Sampler(RDS)
- Calibrated flow-measuring device to control the airflow at 1132 l/min.

Reagents / Chemicals

- Filter Media - A Glass fiber filter of 20.3 X 25.4 cm (8" X 10" inch) size

Sampling

Tilt back the inlet and secure it according to manufacturer's instructions. Loosen the faceplate wing nuts and remove the faceplate. Remove the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replace the faceplate and tighten the wing nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. For automatically flow controlled units, record the designated flow rate on the data sheet. Record the reading of the elapsed time meter.

After the required time of sampling, record the flow meter reading, take out the filter media from the sampler, and put in a container or envelope.

Analysis

Filter inspection: Inspect the filter for pin holes using a light table. Loose particles should be removed with a soft brush. Apply the filter identification number or a code to the filter if it is not a numbered. Condition the filter in conditioning room maintained within 20-30°C and 40-50%

relative humidity or in an airtight desiccators for 24 hours. Take initial weight of the filter paper (W_i) before sampling. Condition the filter after sampling in conditioning room maintained within 20-30°C and 40-50% relative humidity or in an airtight desiccators for 24 hours. Take final weight of the filter paper (W_f)

Calculation

$$C\ PM_{10}\ \mu g/m^3 = (Wf - Wi) \times 10^6 / V$$

Where,

$C\ PM_{10}$ = Concentration of PM_{10}, $\mu g/m^3$

W_f = Initial weight of filter in g

W_i = Initial weight of filter in g

10^6 = Conversion of g to µg

V = Volume of air sampled, m^3

(iv) Sampling and analysis of Particulate Matter ($PM_{2.5}$) in ambient air (Gravimetric Method)

Principle

An electrically powered air sampler draws ambient air at a constant volumetric flow rate (16.7 lpm) maintained by a mass flow / volumetric flow controller coupled to a microprocessor into specially designed inertial particle-size separator (i.e. cyclones or impactors) where the suspended particulate matter in the $PM_{2.5}$ size ranges is separated for collection on a 47 mm polytetrafluoroethylene (PTFE) filter over a specified sampling period. Each filter is weighed before and after sample collection to determine the net gain due to the particulate matter. The mass concentration in the ambient air is computed as the total mass of collected particles in the $PM_{2.5}$ size ranges divided by the actual volume of air sampled, and is expressed in µg/m. The microprocessor reads averages and stores five-minute averages of ambient temperature, ambient pressure, filter temperature and volumetric flow rate. In addition, the microprocessor calculates the average temperatures and pressure, total volumetric flow for the entire sample run time and the coefficient of variation of the flow rate.

Calculation:-

The equation to calculate the mass of fine particulate matter collected on a Teflon filter is as below:

$$C\ PM_{2.5}\ \mu g/m^3 = (Wf - Wi) \times 10^6 / V$$

Where,

$C\ PM_{2.5}$ = Concentration of $PM_{2.5}$, $\mu g/m^3$

W_f = Final weight of filter in g

W_i = Initial weight of filter in g

10^6 = Conversion of g to µg

V = Volume of air sampled, m^3

3.2. **Plant Study**

Selection of plants species- On the basis of dominance, frequency of damage and economic importance five plants were selected from both Pollution site and control site.

Following plants were selected to study the impact of ambient air pollution.

Biochemical analysis of plants

pH, ascorbic acid, total chlorophyll, relative water content, air pollution tolerance index was performed by using standard methods.

Leaf sample collection

For the present study,Fresh leaves were collected during pre-monsoon season (March to April) from road side of NH-39 (Semariya chowk to Rewa Maihar Bypass) and control side (Away from 500 m from road side in Satna area) by following necessary precautionary measures were brought to the laboratory for analysis. Leaves brought to the laboratory were weighed with dust and then after washing, width and length of the leaves were also measured. Common plants identified were selected from both areas.

Selected plants were on the edge of the road almost with similar topography or condition and leaf samples were immediately brought to the laboratory in polythene bag, kept in ice box for further analysis of various biochemical parameters such as leaf extract pH (Singh and Rao, 1983), relative water content (Singh, 1997), total chlorophyll (Arnon, 1949), ascorbic acid (Bajaj & Kaur, 1981).

Extract preparation

Fresh leaves were used according to the standard prescribed methods adopted. Aqueous extract was used for the whole study.

Biochemical parameters

PH

100 mg of fresh leaves was homogenized in 10ml deionized water. This was filtered and pH of the leaf extract was determined after calibrating pH meter with buffer solution pH 4 and pH 9.

Relative water content

Fresh weight was obtained by weighing the leaves. The leaf samples were then immersed in water over night blotted dry and then weighed to get the turgid weight. The leaves were then dried overnight in a hot air oven at 70 0C and reweighed to obtain the dry weight. RWC was determined and calculated by the method as described by Singh 1977.

RWC=[(FW-DW) / (TWDW)] x 100.

Where: FW-Fresh weight, DW-Dry and TW-Turgid weight.

Ascorbic acid content

Ascorbic acid content was measured by Titrimetric method of Sadasivam 1987, using 2,6, Dichlorophenol indo phenol dye. 500mg of leaf sample was extracted with 4% oxalic acid and then titrated against the dye until pink colour develops. Similarly a blank is also developed.

Total chlorophyll and carotenoid content

This was carried out according to the method described by Arnon 1949 . 500mg of fresh leaves were blended and then extracted with 10 ml of 80% acetone and left for 15min. The liquid protein was decanted into another test tube and centrifuged at 2,500 rpm for 3 min. The supernatant was then collected and the absorbance was taken at 645 nm and 663 nm for chlorophyll a, b and 480, 510 nm for carotenoid using a micro controller based visible spectrophotometer (340- 990 nm).

Calculation were done by using the formula given below:

Total chlorophyll: Chlorophyll a + Chlorophyll b;

Calculation of Air Pollution Tolerance Index (APTI)

Air pollution tolerance index was assessed by Singh and Rao 1983. The air pollution tolerance index was calculated using the following formula:

APTI = A (T+ P) + R/10

Where:

A =Ascorbic Acid (mg/g)

T =Total Chlorophyll (mg/g)

P = pH of the leaf extract,

R = Relative water content of leaf (%)

Table -2 APTI values are rated as follows;

APTI values	**Response**
30-100	Tolerant
29-17	Intermediate
16-1	Sensitive
<1	Very Sensitive

RESULT AND DISCUSSION

4.1. AMBIENT AIR QUALITY

Particulate matter (PM_{10}) :- The PM_{10} was measures at five ambient air quality station within the help of RDS .PM_{10} the concentration from 75.72 – 213.00 µg/m^3. The minimum concentration was found **75.72** µg/m^3 at Utaily residential area within in the limit and maximum value was found 213.00 µg/m^3 at Sindhi Campus industrial beyond the limit prescribed by NAAQM (100 µg/m^3)

Particulate matter ($PM_{2.5}$):-$PM_{2.5}$ was measures at five ambient air quality station within the help of ambient fin dust sampler control module.

$PM_{2.5}$ the concentration ranged from 44.32–80.76 µg/m^3. The minimum concentration was found 44.32 µg/m^3 at Utauly residential area within the limit and maximum value was found 80.76 µg/m^3 at Ramtekari commercial area beyond the limit prescribed by NAAQM (60 µg/m^3)

Gases pollutant :-Gases pollutant was measures at five ambient air quality station with the help of RDS . Sulpher dioxide **(**SO_2) the concentration ranged from 4.77–17.15 µg/m^3. The minimum concentration was found 4.77 µg/m^3 at Utauly area and maximum value was found 17.15 µg/m^3 at Sindhi campus industrial area within the limit prescribed by NAAQM (80 µg/m^3)

Nitrogen dioxide (NO_2). The NO_2 concentration ranged from 9.19–26.80 µg/m^3. The minimum concentration was found 9.19 µg/m^3 at Utauly residential area and maximum value was found 26.80 µg/m^3 at Sindhi Campus industrial within limit prescribed by NAAQM (80 µg/m^3).

Table:-3. Ambient air quality of Semaria Chowk.

S.N.	Dated	PM10 (µg/m3)	PM2.5 (µg/m3)	SO2 (µg/m3)	NOx (µg/m3)
1	03/03/2017	134.12	64	14.6	20.3
2	10/03/2017	154.54	65	15.7	21.87
3	17/03/2017	166.55	78	16.48	19.6
4	24/03/2017	177.80	84	16.98	18.34
Min		134.12	64	14.6	18.34
Max		177.8	84	16.98	21.87
Mean (±)		158.25±18.68	72.75±9.84	15.94±1.03	20.02±1.47
Standard Error		9.34	4.92	0.51	0.73

Table:-4. Ambient air quality of Sindhi Campus

S.N.	Dated	PM10 (µg/m3)	PM2.5 (µg/m3)	SO2 (µg/m3)	NOx (µg/m3)
1	01/03/2017	180	87	16.56	26.7
2	08/03/2017	212.8	81	16.38	25
3	15/03/2017	220	76	17.12	28.2
4	22/03/2017	243	75	18.54	27.32
Min		180	75	16.38	25
Max		243	87	18.54	28.2
Mean (±)		213.95±26.04	79.75±5.5	17.15±0.97	26.80±1.35
Standard Error		13.02	2.75	0.48	0.67

Table:-5. Ambient air quality of Gahra Nalla.

S.N.	Dated	PM10 (µg/m3)	PM2.5 (µg/m3)	SO2 (µg/m3)	NOx (µg/m3)
1	05/03/2017	112.33	77.5	11.80	13.72
2	12/03/2017	120.80	78.11	13.21	14.66
3	19/03/2017	131.45	81.50	12.32	13.98
4	26/03/2017	147.22	84.76	14.24	16.32
Min		112.33	77.5	11.8	13.72
Max		147.22	84.76	14.24	16.32
Mean (±)		127.95±15.04	80.46±3.35	12.89±1.07	14.67±1.16
Standard Error		7.52	1.67	0.53	0.58

Table:-6. Ambient air quality of Ramtekari.

S.N.	Dated	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_x (µg/m³)
1	05/03/2017	111.32	73.58	10.82	12.73
2	12/03/2017	122.43	78.11	11.22	13.45
3	19/03/2017	129.99	85.53	14.33	13.98
4	26/03/2017	143.78	88.78	14.94	15.38
Min		111.32	73.58	10.82	12.73
Max		143.78	88.78	14.94	15.38
Mean (±)		126.88±13.62	81.5±6.91	12.82±2.10	13.88±1.12
Standard Error		6.81	3.45	1.05	0.56

Table:-7. Ambient air quality of Utaily

S.N.	Dated	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_x (µg/m³)
1	03/04/2017	69.21	38.97	3.92	8.17
2	10/04/2017	74.48	41.88	4.24	8.13
3	17/04/2017	75.67	46.74	4.85	9.69
4	24/04/2017	83.55	49.70	6.10	10.8
Min		69.21	38.97	3.92	8.13
Max		83.55	49.7	6.1	10.8
Mean (±)		75.72±5.92	44.32±4.80	4.77±0.96	9.19±1.29
Standard Error		2.96	2.40	0.48	0.64

Table:-8. Average ambient air quality at various sampling stations.

S.N.	Name of Station	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_x (µg/m³)
1.	Semariya Chowk	158.25	72.75	15.94	20.02
2.	Sindhi Campus	213.00	79.75	17.15	26.80
3.	Gahra Nalla	127.95	80.46	12.89	14.67
4.	Ramtekari	126.88	81.5	12.82	13.88
5.	Utaily	75.72	44.32	4.77	9.19

Table:-9 National ambient air quality (NAAQM) standards

S.No.	Parameters	Standards
1	PM_{10}	100
2	$PM_{2.5}$	60
3	SO_x	80
4	NO_x	80

Fig. 3:- Ambient air quality at Semaria Chowk

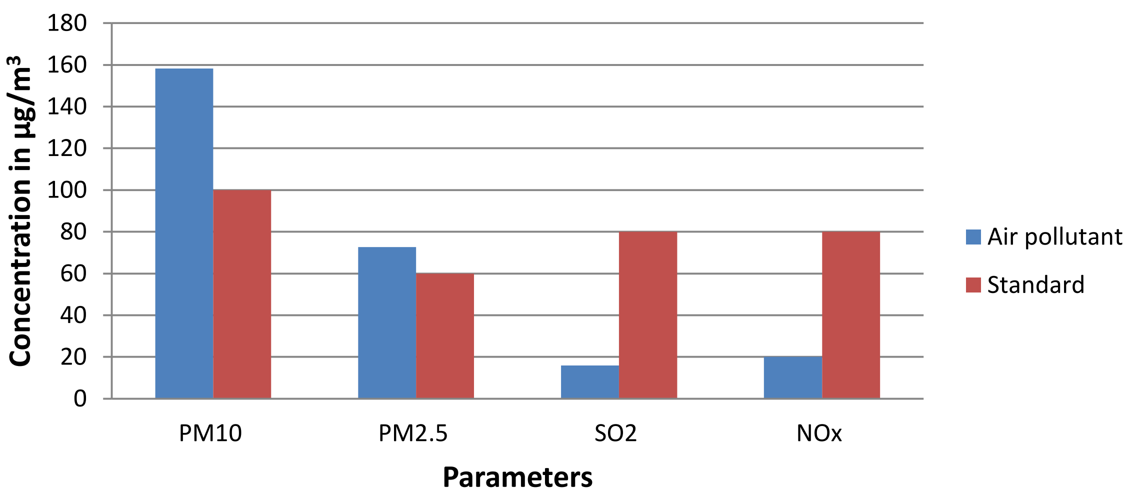


Fig. 4:- Ambient air quality at Sindhi Campus

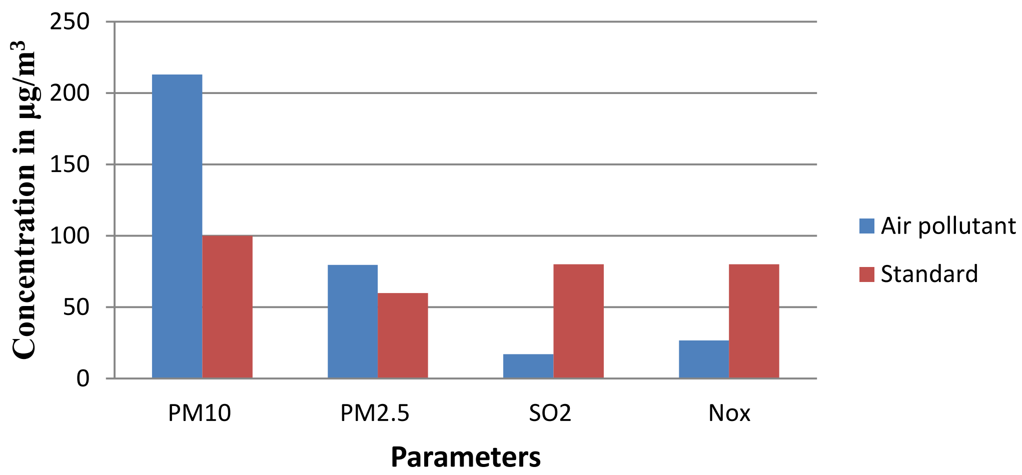
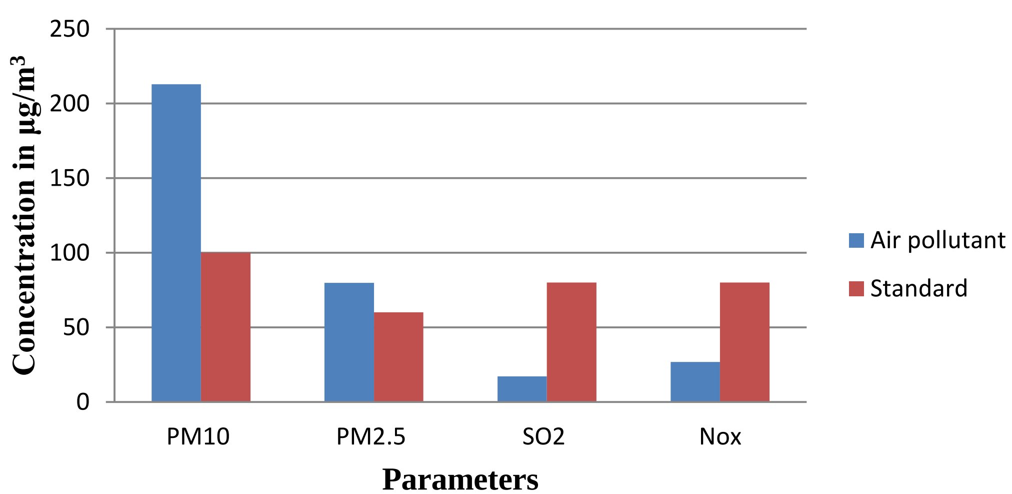


Fig. 5:- Ambient air quality at Gahra Nalla



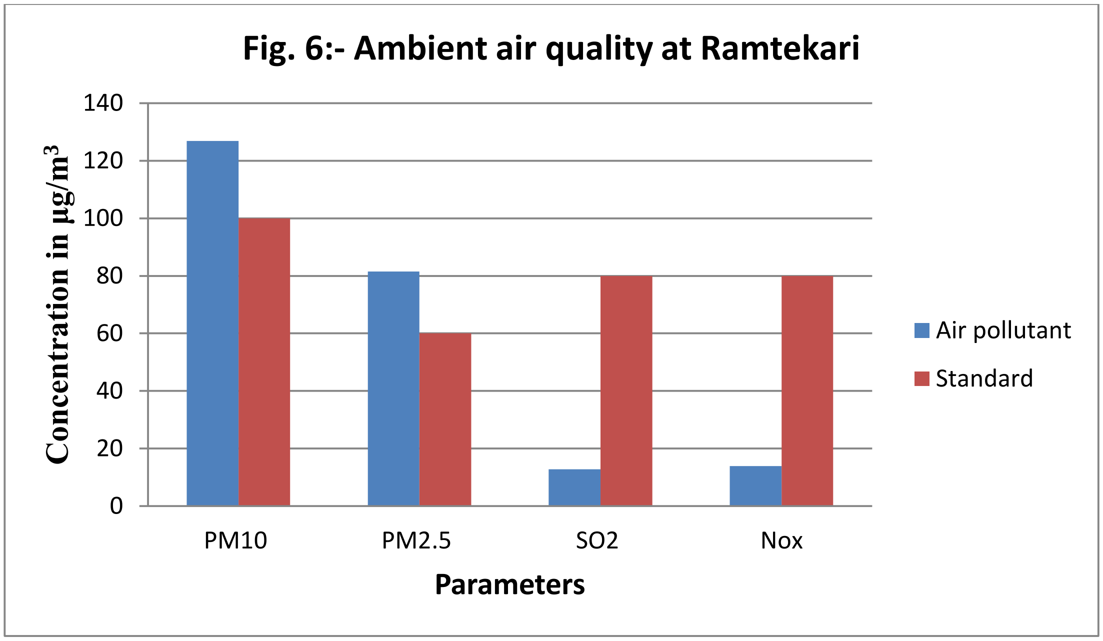


Fig. 6:- Ambient air quality at Ramtekari
Concentration in µg/m3
140
120
100
80
60
40
20
0
PM10
PM2.5
SO2
Nox
Parameters
Air pollutant
Standard

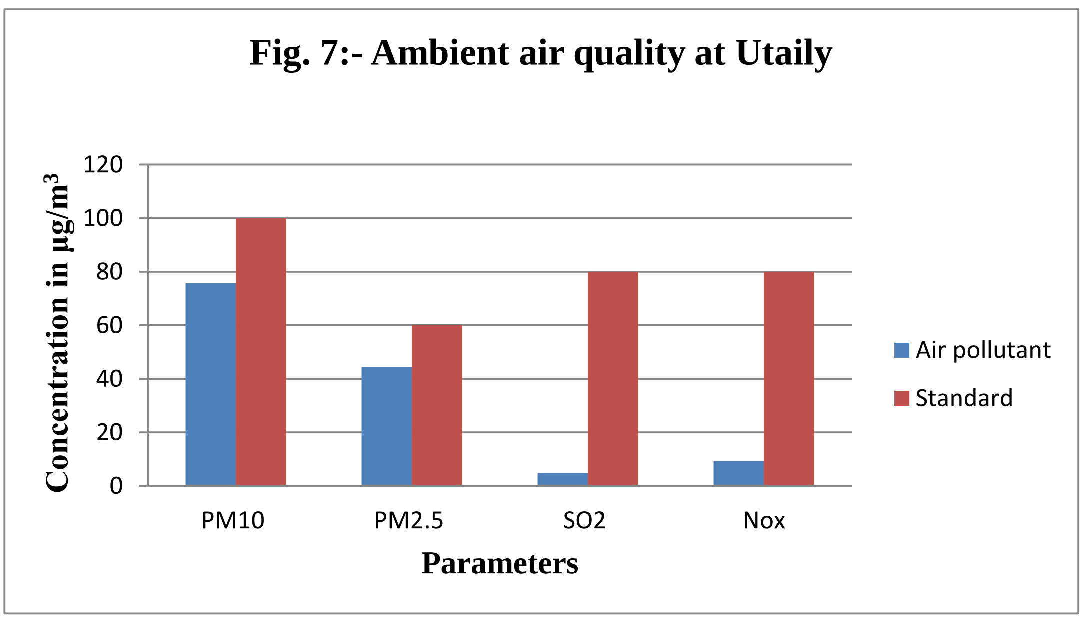


Fig. 7:- Ambient air quality at Utaily
Concentration in µg/m3
120
100
80
60
40
20
0
PM10
PM2.5
SO2
Nox
Parameters
Air pollutant
Standard

Fig-8: PM_{10} (µg/m^3) at different selected stations

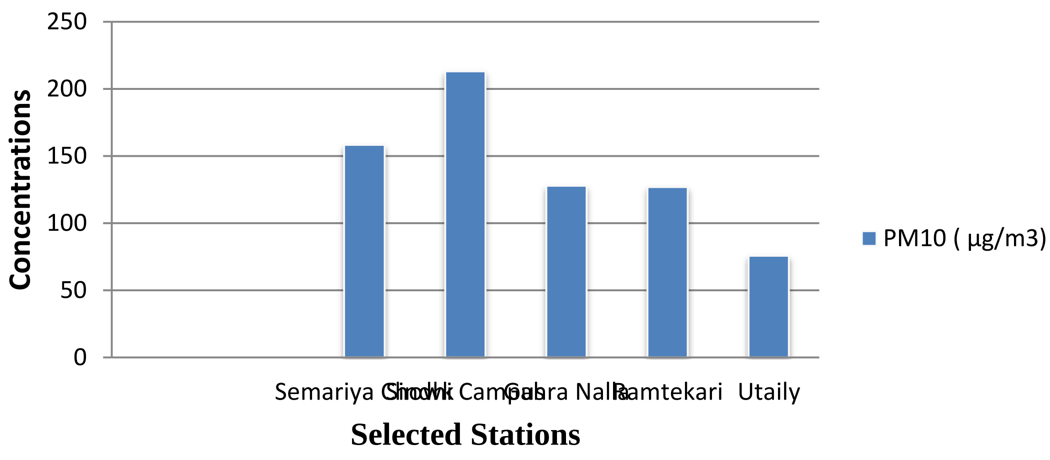
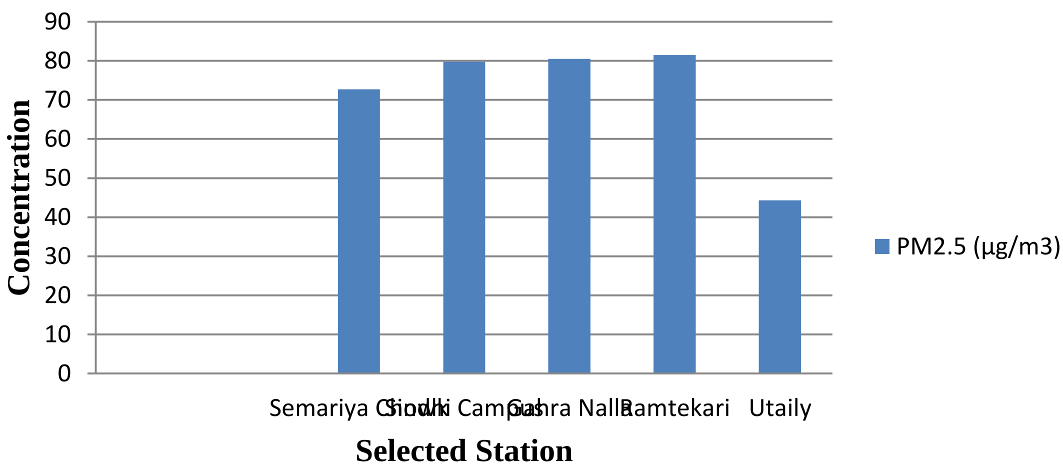


Fig-9: $PM_{2.5}$ (µg/m^3) at different selected Stations



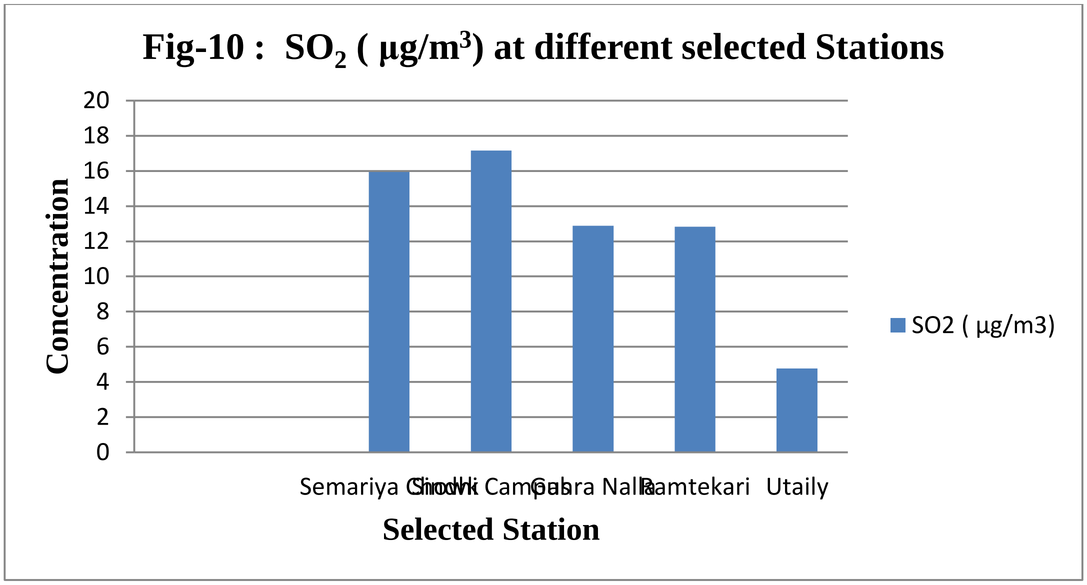


Fig-10 : SO_2 (µg/m^3) at different selected Stations

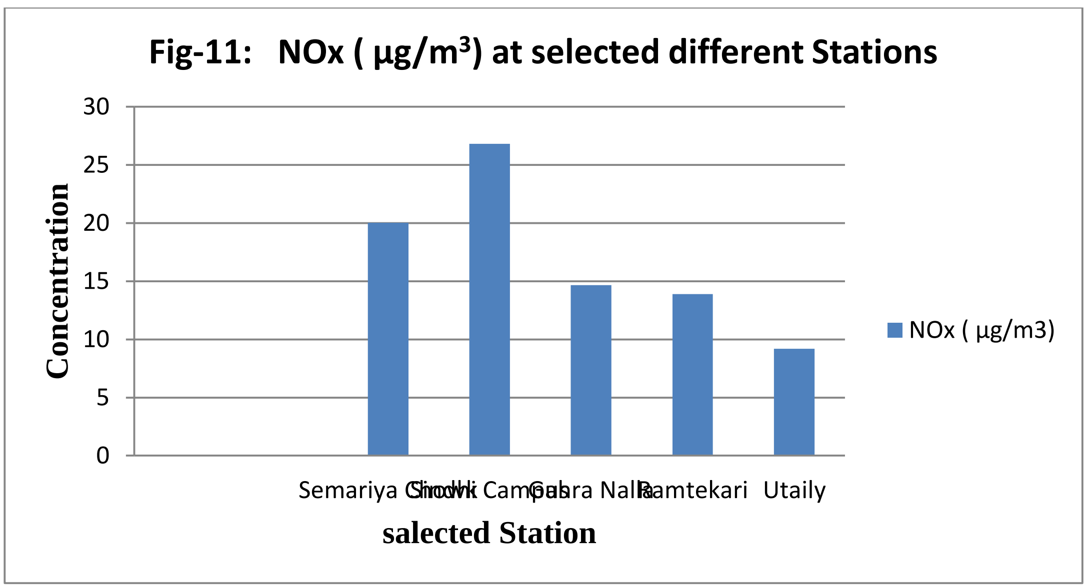


Fig-11: NOx (µg/m^3) at selected different Stations

AIR POLLUTION TOLERANCE INDEX (APTI)

The biochemical characteristics and the APTI for plants from road site and control site are given in table 7.

P^{H}

pH of road site range was found 06.08-08.85. The minimum pH was observed 06.08 in Mangifora *indica* while maximum pH was 08.85 in Tectona *grandis* whereas pH of control site range was 05.28-07.26. The minimum pH of control site was observed 05.28 in Mangifora *indica* while maximum was 07.26 in Delbergia *sisoo*. Hence the leaf extract pH on the higher side gives tolerance to plants species against pollution (Agrawal, 1988).

Relative Water Content

RWC of all plants species of control site were higher compared to road site plant species. At road site minimum RWC was found 64.76 % in Psiduim *guajava* while maximum RWC was 78.23 % in Mangifora *indica*. Whereas at control site minimum RWC was found 72.33 % in Delbergia *sisoo* while maximum was 87.45 % in Mangifora *indica*. The RWC indicates change in leaf matrix hydration condition and will generate higher acidity condition when RWC is low. More water will dilute acidity.

Ascorbic acid

Ascorbic acid of road site range was found 04.40-06.56 mg/g. The lower ascorbic acid was observed 04.40 mg/g in Delbergia *sisoo* while higher was 06.56mg/g in Mangifora *indica*. Whereas ascorbic acid of control site range was 05.17-08.72 mg/g. The lower ascorbic acid of control site was observed 05.17 mg/g in Delbergia *sisoo* while higher was 08.72 mg/g in Mangifora *indica*. Plants maintaining high ascorbic acid under pollutant conditions are considered to be tolerant to air pollution. Pollution load dependent increase in ascorbic acid content of all the plant species may be due to the increased rate of production of reactive oxygen species (ROS) during photo-oxidation of SO_2 to SO_3 where sulfites are generated from SO_2 absorbed (Chaudhary and Rao, 1977). Higher ascorbic acid content of the plant is a sign of its tolerance against sulphur dioxide pollution (Varshney and Varshney, 1984).

Total chlorophyll (TC)

Total chlorophyll of road site range was found 08.30-11.11 mg/g. The lower chlorophyll was observed 08.30 in Delbergia *sisoo* while higher was 11.11 in Mangifora *indica*. Whereas chlorophyll of control site range was 10-11-14.10. The lower chlorophyll of control site was observed 10-11 mg/g in Delbergia *sisoo* while higher was 14.10 in Mangifora *indica*.. Chlorophyll take part in Chlorophyll content of plants signifies its photosynthetic activity as well as the growth and development of biomass.

Air Pollution Tolerance Index (APTI)

Air pollution tolerance index is not an independent component but it involves four components such as pH, ascorbic acid, chlorophyll, relative water content. Any observed changes in these components lead to alteration in the level of air pollution tolerance index.

High dust collecting capacity may be one of the reasons for the sensitive plant species studied to become highly susceptible to the auto-exhaust pollutants, making reduction or increase of different biochemical and physiological parameters (Singh, 2005).

APTI value of road site is lower as compared to the control site. The APTI of plant species from road site ranged from 13.59-18.96. The lower APTI was observed 13.59 in Delbergia *sisoo* while higher was 18.96 in Mangifora *indica*. The APTI value of control site ranged from 16.12-25.64. The lower APTI was observed 16.12 in Delbergia *sisoo* while higher was 25.64 in Mangifora *indica*. Dust pollution and chronic concentration of gaseous pollutants may affect the biochemical make up and tolerance capacity of plants to the air pollution (Rai et al., 2013).

Based on the previous studies (Lakshmi *et al*., 2008; Agbarie and Esiefarienrhe, 2009), APTI values can be utilized as bio-indicators of the air quality, while those species in the tolerant group can be used for development of streetscape greening.

Table: 10. Air pollution tolerance index in different selected plant pollution and control side.

S.No.	Plant Name	pH		Relative Water Content (%)		T. Chlorophyll (mg/g)		Ascorbic Acid (mg/g)		APTI	
		PS	CS	PS	CS	PS	CS	PS	CS	PS	CS
1.	*Psiduim guajava*	7.39	6.2	68.76	79.28	09.67	12.65	4.76	6.43	15.7	21.93
2.	*Mangifora indica*	6.08	5.28	76.89	87.45	11.11	14.10	6.56	8.72	18.96	25.64
3.	*Delbergia sisoo*	8.23	7.26	64.00	72.33	08.13	10.71	4.40	5.17	13.59	16.52
4.	*Madhuka indica*	6.91	6.08	78.23	86.28	10.62	13.54	5.34	6.12	17.18	20.63
5	*Tectona grandis*	8.85	7.21	75.23	87.23	09.23	12.85	5.89	7.00	18.17	22.76

Table 11. The plant of road side with APTI value

S.N.	Name of Plant	APTI Value	Response
1.	*Psiduim guajava*	15.70	Sensitive
2.	*Mangifora indica*	18.96	Intermediate
3.	*Delbergia sisoo*	13.59	Sensitive
4.	*Madhuka indica*	17.18	Intermediate
5	*Tectona grandis*	18.17	Intermediate

CONCLUSION & SUGGESTION

5.1. Ambient air quality

From the result of average value of one month (March to April, 2017, four times in weekly) it is concluded that the ambient air quality, the higher value of PM_{10} was found(213.00) at Sindhi Campus (Industrial area) and $PM_{2.5}$ (80.46) at Ramtekari (Commercial area). PM_{10} and $PM_{2.5}$ at all sampling station was found beyond the limit prescribed by NAAQM (100 $\mu g/m^3$ and 60 $\mu g/m^3$) except Utauly station. Gasses pollutant was found within the limit at all sampling station.

5.2. Air pollution tolerance index (APTI)

The air pollution tolerance index was Sensitive for Mangifora *indica and* Psiduim *guajava in* road side plant and APTI is Intermediate was found in Mangifora *indica and* Tectona *grandis* Plants that are continuously exposed to pollutants leads to accumulation of pollution, integration of pollutants in to their own system, thereby altering the nature of leaf and make them more sensitive. This sensitivity is measured through various biochemical changes and finally to air pollution tolerance index. In our study, all the plants were found to be sensitive species.

Rapid urbanization, industrialization and population growth are associated with increase in air pollution. However trees play crucial roles in mitigation and indicating air pollution. The selection of trees that are tolerant of air pollution will benefit urban planning, design and environmental management. APTI of plants provides a simple and convenient method of achieving this. In the present study none of the tree species screened can be considered tolerant of air pollution in the study area. However, the intermediate species may be useful in mitigating air pollution.

Bibliography

1. Agarwal, A., Narain, S., Srabani, S., 1999. State of India's Environment: The Citizens FifthReport. Part I. National Overview Centre for Science and Environment, New Delhi.
2. Agbaire, P.O. and Esiefarienrhe, E. (2009). Air pollution Tolerance Indices (APTI) of some plants around Otorogun gas plants in Delta State, Nigeria, *Journal of Applied Sciences Environmental Management*, 13:11-14.
3. Amal and Migahid (2011)**.** Studied on effect of cement-kiln dust pollution on the vegetation in the western Mediterranean desert of Egypt. International Journal of Environmental, Ecological, Geological and Marine Engineering, 5(9) 1-7.
4. Anda A.(1986) Effect of cement liln dust on the radiation balance and yields of plants. Environmental Pollution 40: 249-256.
5. Ashenden TW, Williams IAD (1980). Growth reduction in *Lolium multiflorum* Lam. and Phleum pratense L. as a result of sulphur dioxide and nitrogen dioxide pollution. *Environmental Pollution*, 21: 131-139.
6. Bell J.N.B & Mudd C.H. (1976) Sulphur dioxide resistance in plants: A case study of Lo I ilium perenne in effect of air pollutants on plants, Society for Experimental Bology Seminor Series, Cambridge University Press Cambridge. 87-103.
7. Chaphekar, S.B. 1982. *Zndinrr R~YI$ e Srl'twrc.* 2: ***4*** 1-56,
8. Chaurasia S., Karwaria A. and Gupta A.D.(2013). Cement dust pollution and morphological attributes of Groundnut (Arachis hypogaea), Kodinagar, Gujrat, India. *IOSR-JESFTFT* 4(1): 2319-2402.
9. Chaurasia S., Karwaria A., and Gupta A.D. (2014). Impact of Cement Industry Pollution on Morphological Attributes of Wheat (*Triticum Species*) Kodinar Gujarat, India, *IOSR-JESTFT* 8(6): 84-89.
10. Crittenden P.D. and Read D.J.(1978). The effects of air pollution on plant growth with special reference to sulphur dioxide. II Growth studies with Lolium perenne L. New phytologist 80:49-62.
11. Darley. E.F. and J. Middleton 1966. Problems ofair pollution in plant pathology. *Annu. RCY. Plctnt PotIrI.* 1: 103-118.

12. Devarajan R., Hanumappa H., Narendra Kuppa N. (2015). The study of change in physico-chemical properties of soil due to cement dust pollution-A hazardous terrorization to ecosystem, Canadian Journal of Pure and Applied Sciences 9 (1): 3193-3200.

13. Dietz, K.J., Baier, M and Kramer, U (1999). Free radicals and reactive oxygen species as mediators of heavy metal toxicity in plants: From molecules to Ecosystems. Berlin, Springer – Verlag.

14. Emberson L.D. Asmore M.R. Cambridge H.M. Simpson D,Tuovinen J.P. (2000). Modeling stomatal ozone flux across Europe. Environmental Pollution 109: 403-414.

15. Emberson L.D. Asmore M.R., Simpson D., Tuovinen J.P., Cambridge H.M. (2001). Modelling and mapping ozone deposition in Europe. Water and Soil Pollution 130:577-582.

16. Enete, I.C., Ogbonna, C. E and officha, M.C. (2012). Using Trees as Urban Heat Island Reduction tool in Enugu city, Nigeria based in their air pollution tolerance index. *Ethiopian Journal of Environmental Studies and Management*, 5(4) supplementary 484-488.

17. Farooq, M.; Arya, K.R.; Kumar, S.; Gopal, K.; Joshi, P.C.; Hans, R.K., (2000). Industrial pollutants mediated damage to mango (*Mangifera Indica)* crop: A case study, J. Environ. Biol., (21):165-167.

18. Garg K.K., and Varhney (1980). Effect of air pollution on the leaf epidermis at the submicroscopic level. Experientia, 36: 1364-1366.

19. Gostin , I.N., (20 09). Air pollution effect on leaf structure of some fabaceae species, Not. Bot. Hort. Agrobot. Cluj., (27): 57-63.

20. Keller, T (1986). The Electrical conductivity of Norway spruce needle Diffusate as affected by air pollutants. *European Journal of Forestry Pathology*, 7:338-350.

21. Khan M R, Khan MW *(*1993). The interaction of SO2 and root-knot nematode on tomato. *Environmental Pollution*; 81: 91-102.

22. Kia S.F., Chinipardaz F., Kia M.F., and Gholami A. (2005). Investigation of causes and the dust phenomenon, counter measure strategies and its consequences in agriculture sector. Indian Journal of Fundamental and Applied Life Sciences 5 (S1):1503-1508

23. Kuddus, M., Kumari, R and Ramteke, P.W. (2011). Studies on air pollution tolerance of selected plants in Allahabad city India. *Journal of Environmental Research and Management*, 2(3): 42 – 46.
24. Lakshmi, P. S., Sravanti, K. L. and Srinivas, N. (2008). Air pollution tolerance index of various plant species growing in industrial areas. *The Ecoscan*, 2(2), 203-206.
25. Lalman and Singh B. (1990) Phytotoxic influence of SO_2 pollution on leaf growth of Vigina mungo L. Journal of Environmental Biology 11(2): 111-120.
26. Malhotra, S.S. and A.A. Khan 1984. Biochemical and Physiological impacts of major pollutants. In: *AirPollution and Plairt Life.* (Ed. Treshow, M.) John U'ileyand Sons Ltd. pp. 1 13-1 57.
27. Middelton J.T. Kenric J.B. Jr. and Schwalin H.W. (1950) Injury to Herbaeceous plant by smog or air pollution, "Plant disease reporter 34,245-252.
28. Mishra, M (2004): Project achievement reports; update, Nov. 2004 on demonstration of dust suppression Technology to reduce occupational and Environmental health hazards in stone crusher industries, a project study in Khurda Orissa, India by JrP, CISS (India) and PKI (USA).
29. Nandi P.K. Agrawal M and Rao D.N. (1984). SO_2- Induced enzymatic changes and ascorbic acid oxidation in Oryza Sativa: Water Air Soil Pollution, 21: 25-32.
30. Noctor, G and Foyer, G.H (1998). Ascorbate and glutathione: keeping active oxygen under control. *Annual Review in Plant Physiology and Molecular Biology*, 49: 249 – 279.
31. Pandey D.D., Nirala A.K., Gaulam R.R. (1999). Impact of stone crusher dust pollution on maize crop. Indian Journal of Environmental and Eco-planning 2:43-46.
32. Pandey, J., Agrawal, M., (1992). Ozone: concentration variabilities in a seasonally dry tropical climate. Environmental International 18: 515–520.
33. Prajapati, S.K.; Tripathi, B.D., (2008). Seasonal variation of leaf dust accumulation and pigment ontent in plant species exposed to urban particulate pollution, J . Environ. Qual., (37): 865-870
34. Raajasubramanian D., Sundaramoorthy P., Baskaran L., Sankar Ganesh K., Chidambaram A and Jeganathan M.(2011). Effect of cement dust pollution on

germination and growth of groundnut (*Arachis hypogaea* L.), *International Multidisciplinary Research Journal* 1(1):25-30.

35. Raboy V (2003). Molecules of interest: myo-inositol-1, 2, 3, 4, 5, 6-hexakisphosphate. Phytochem 64:1033–1043.
36. Rai R, Rajput M, Agrawal M and Agrawal S.B. (2011). Gaseous air pollutants: A review on current and future trends of emissions and impact on agriculture, J*ournal of Scientific Research*, 55, 77-102.
37. Rai, A, Kulshreshtha, K, Srivastava, P. K and Mohanty, C. S (2010): Leaf surface structure alterations due to particulate pollution in some common plants. Environmentalist, 30, 18-23.
38. Rajput M. and Agrawal M. (2004) Physiological and yield responses of pea plants to ambient air pollution. Indian Journal of Plant Physiology, 9(1): 9-14.
39. Rao D.N. (1979). Plant leaf as pollution device fertilizer News May: 25-28.
40. Rao D.N.(1985) Bio-monitoring of air quality. Symp, Bio-monitoring Status Environmental:262-263.
41. Rao M.V. & Dubey P.S. (1988). Plant response against SO_2 in field conditions. Asian Environment 10:1-9.
42. Rao, D. N (1985): Plants and Particulate pollutants. Air pollution and plants: A state of Art Report, Ministry of Environment and Forest; Department of Environment, Govt. of India, new Delhi, India.
43. Rao. D.N. 1981. Phytomonitoring of air pollution In: Pro. WHO worhhop on Biol. Indicators and Indices of Envirorr. PoNut. (Ed. A.A. Zafar, K.A. Khan and G. Seenayya). Osrnania University, Hyderabad.
44. Saha D.and Padhy P.K.(2011)): Effects of stone crushing industry on Shorea robusta and Madhuca indica foliage in Lalpahari forest , Atmospheric pollution Research, 2, 463-476.
45. Seyyednejad, S.M.; Niknejad, M.; Koochak, H., (2011). A review of some different effect of air pollution on plants, Res. J. Environ. Sci., (5): 302-309
46. Shafiq M, Iqbal MZ (1987). Plant sociology around the stone quarries and processing plants of Karachi and Thatta districts. Inter J Ecol Environm Sci 13: 33-35.

47. Shannigrahi A.S., Fukushima T. and Sharma R.C. (2004) Anticipated air pollution tolerance of some plant species considered for green belt development in and around an industrial/urban area in India: An overview. International Journal of Environmental Studies, 61(2): 125-137.
48. Shrivastava, N.; Joshi, S., (2002). Effect of automobile air pollution on the growth of some plants at Kota, Geobios., (29): 281-282.
49. Singh, S.V and Verma, A (2007). Phytoremediation of air pollutants: A Review. In, *Environmental Bioremediation Technology,* Singh, S.N and Tripath, R.D. (Eds) Berlin. Springer. Pp 293 – 314.
50. Sukumaran, D., (2012). Effect of Particulate Pollution on various Tissue Systems of Tropical Plants. Central Pollution Control Board (CPCB), Zonal Office, Kolkata, India.
51. Tiwari Shweta (2010). Air pollution induced changes in foliar morphology of two shrub species at Indore city, India. *Research Journal of Recent Sciences,* 2(ISC-2012): 195-199.
52. Treshow, M. 1984 .Diagnosis of Air Pollution Effects and ~imickiin~,&~rn~t*Aoir*m *pso.l lution and Plarlt Life.* Ed. M. Treshow, John Wiley and Sons Ltd.
53. Tripathi A.K. and Gautam M. (2007). Biochemical parameters of plants as indicators of air pollution. Journal of Environmental Biology; 28: 127-132.
54. Varshney, S.R.K. 1982. Effhct of Sulplzur dioxide or1 plant processes. Ph.D. thesis, Jawaharlal Nehm University, New Delhi.
55. Warren J.L. (1973) Green space for air pollution control. School of Forest Resources, *Technical Report No. 50,* North Carolina State University, Raleigh, North Carolina.