CHAPTER-II

REVIEW OF LITERATURE

Literature review enables to have a clear picture of what had been done in the particular field in the recent years and also facilitates clear view of what should be done in this field. This chapter analyses the views and main findings of different authors on the concept of Ambient Air Quality in atmosphere and induced changes of photosynthetic pigments in selected plants due to industrial and traffic air pollution which have attracted the attention of the experts in the field of air pollution.

2.1 Effect of Air Pollution in an urban areas

Literature study was carried out to find out the literature related to the effect of air pollution in an urban areas are discussed below.

Srinivas DSRK (1999) attempted to look at the spatial patterns of air pollution in Delhi, for sulphur dioxide (SO$_2$), oxides of nitrogen (NOx) and suspended particulate matter (SPM). The concentration of suspended particulate matter have exceeded from the National ambient air quality standards with the highest average values always above 380 g/m$^3$ at various seasons in Delhi were proved and some strategies have been suggested to reduce air pollution in the city of Delhi. An ambient air quality with special reference to the total oxidants was assessed in the four selected sites in Tiruchirapalli which was studied by Ravichandran, C. et al., (2001). The concentration of sulphur dioxide and oxides of nitrogen were sampled along with the total oxidants and it was found to be within the prescribed limits. Air pollution has pushed many plants and animals towards extinction and rapid changes in climate due to deposition of air pollutants to large distances from their source in the influence of meteorological factors was reported by Tripathy B.D and Dwivedi A.K. (2002).
Formation and destruction behavior of oxides of sulphur during combustion was studied by Verma S.S (2002)\(^4\) for a wide range of temperature and found that the conversion of sulphur dioxide into sulphur trioxide is only temperature sensitive, dependent and significant. Garg, A., et al., (2002)\(^5\) analyzed that the Indian Large Point Sources (LPS) contribute to carbon dioxide and sulphur dioxide emissions to a large extent and useful for policy-making to mitigate these pollutants and their associated impacts. Ravindra Khaiwal, et al., (2003)\(^6\) reported that the importance of rainfall in the scavenging of the criteria of air pollutants like SO\(_2\), NO\(_2\) and TSP which have significant decrease in concentrations at Shahdara in Delhi, after initial and subsequent rains of the monsoon.

An interesting relationship between population density and suspended particulate matter (SPM) and respirable suspended particulate matter (RSPM) concentration has been observed by Prasad Rajendra (2004)\(^7\) which hardly depends upon the local meteorology and climate of the place rather it depends upon the local polluting sources. Dust pollution caused by vehicles in Aligarh city was observed by Lone, P.M., et al., (2005)\(^8\) where the dust pollution was maximum on Kanpur road (46.44 gm/m\(^2\)/month) followed by Agra road (38.94 gm/m\(^2\)/month) and Delhi road (34.52 gm/ m\(^2\)/month) and minimum on Anoopshahar road (20.10 gm/ m\(^2\)/month) and the average dust fall rate per unit area about 35 gm/ m\(^2\)/month in Aligarh city was recorded. Atri, S.D (2005)\(^9\) gave the global attention is currently focused on the quantification of implications of climate change due to natural and anthropogenic sources. Rising levels of greenhouse gases are responsible for rapid changes in climate system.

The concentration of the air pollutants such as sulphur dioxide, oxides of nitrogen, suspended particulate matter(SPM) and respirable suspended particulate matter(RSPM) emissions are more affected in winter seasons, vehicular and industrial increasing areas of Chennai city which was proved by Jayanthi, V and Krishnamoorthy, R (2006)\(^10\) through
spatial distribution. The elemental concentrations of heavy metal pollutants that may be present in street dust samples in Mubi, Adamawa state, Nigeria, inferred by Shinggu, D.Y., et al., (2007)\textsuperscript{11} and suggested that these pollutants did not originate from common anthropogenic sources because some heavy metals are soil derived automobile emission, welding of metal and exhaust from generators may be the major sources of the elements.

A statistical approach of gaseous air pollutants based on traffic intersection and residential sites in Chennai city was investigated by Senthilnathan.T, (2008)\textsuperscript{12} and observed that the pollutant values always exceed the NAAQS value throughout the sampling period by a very large amount as a result the statistical calculations made on pollutant data showed significant changes and found that best curve fit for cubic equations. Sari Kovats, Rais Akhtar, (2008)\textsuperscript{13} reported the effects of temperature, rainfall and extreme events on human health, in particular the impacts of heat waves and floods. Aromar Revi (2008)\textsuperscript{14} gave the importance for urban areas of an effective rural adaptation agenda especially in maintaining the productivity and functioning of rural systems and highlighted the importance of infrastructure investments, taking into account climate changes, long lifespan of most infrastructure, urban management engaging with changing risk profiles are taken into account.

The spatial distribution of air pollution in response to recent air quality regulations in Delhi, India monitored by Naresh Kumar and Andrew D.Foster (2009)\textsuperscript{15} and reported that air pollution levels in Delhi and its surroundings were significantly higher than that of recommended World Health Organization and also the air quality regulations in the city and its surrounding areas are adversely affected due to major contribution of both fine and coarse particles from industries and trucks. Emmanouil Mentzakis, Doriana Delfino.(2010)\textsuperscript{16} quantified the impact of air pollution (CO, NO, NO\textsubscript{2}, SO\textsubscript{2}, O\textsubscript{3})
and meteorological parameters (air temperature, humidity and atmospheric pressure) on three indicators of human morbidity (circulatory, respiratory and skin diseases) and resulted that significantly increasing the concentration SO$_2$, NO, O$_3$ and CO causes circulatory, respiratory and skin diseases.

Concentration of air pollutants, meteorological parameters and traffic flow continuously measured in Gottinger Strasse (Hannover, Germany) and a dispersive velocity scale was evaluated using statistical methods for windward and leeward conditions in which leeward conditions a 'critical wind speed’ is defined as the roof-level wind speed at which traffic and wind induced turbulences inside the street canyon are equal and it varied with traffic density between 2 m s$^{-1}$ and 4.5 m s$^{-1}$ was reported by Nicolas A. Mazzeo, Laura E. Venegas, (2010). An adverse effect caused by air pollutants depends not only upon its concentration but also on the duration and combination of air pollutants observed by Richa Rai., et al., (2011) on present and future trends of major gaseous pollutants emissions and their impact on crop performance.

Balanzino A., et al., (2011) found an overestimation of NO$_2$ in the urban areas, probably due to an underestimation of the vertical diffusivity, the analysis of O$_X$ confirms that the discrepancies in ozone and nitrogen dioxide are mainly due to local scale effects and showed a general underestimation of the observed PM$_{10}$ concentrations due to the uncertainties in the emission inventories, spatial resolution, and the adopted aerosol modeling approach. The ratios of TSP, PM$_{10}$, PM$_{2.5}$, and PM$_1$ are below unity for the three shopping malls when the air-conditioning systems are operating and they are near unity when the air-conditioning systems are not operating was investigated by Yuangao Wen., et al., (2011) in an indoor air quality of Wuhan.
2.2 Ambient Air Quality (AAQ) in urban areas

The literature survey related to the ambient air quality in urban areas are listed below,

The air quality status of different sites was monitored in Lucknow city by Pandey V., et al., (1999) and it has witnessed a tremendous increase in two wheeler and three wheeler populations are the main source of visible pollution because they emit a lot of black soot from the exhaust creates eye irritation, breathing trouble and is deposited on clothes. Sreenivasa Rao, A., Rama Mohan Rao, P. (2000) gave the following observations that Pesticides, suspended particulate matter, nitric oxide and sulphur dioxide were measured to assess the ambient air quality to Kolleru Lake. The maximum average concentrations of a- BHC, g-BHC and endosulfan were 3.2, 4.6 and 2.7 mg/m$^3$ respectively. The maximum levels of suspended particulate matter, nitric oxide and sulfur dioxide were 291.4, 62.7 and 6.7 mg/m$^3$.

Mehta UK (2002) was found to be the impact zone for ambient air quality around SIEL chemical complex by selecting five ambient air-monitoring stations in this area and identified sulphur dioxide is the significant pollutant within the study region.

Kulshrestha Monika, J., et al., (2003) reported the dust fall deposition fluxes of major water-soluble components were estimated at five different sites of Delhi. The high values of pH of dust fall deposition suggest the dominance of crustal components that add higher alkalinity due to presence of components like Calcium and Magnesium. The ambient air quality survey in the commercial and mixed zones of the city of Jodhpur, Rajasthan, using Respirable Dust High Volume Air Sampler (APM-451, APM-411) presented by Shrivastava KL, Ojha Shrikant (2003) and gave the results of the concentration of suspended particulate matter, NO$_2$ and SO$_2$ contents were exceeding the permissible limits at some spots.

Mahendra SP, Krishnamurthy (2004) gave the report of carbon monoxide concentrations in the ambient air at selected arterial roads of Sheshadri road and Kempe Gowda road near junctions in Bangalore city concurrently with traffic flow and stream speed of vehicles during morning peak traffic hours and revealed that the traffic generated
CO concentrations were closely related to the traffic flow parameters and stream speed. Air quality status of Visakhapatnam on indices basis using a non-linear equation for suspended particulate matter (SPM), sulfur dioxide (SO$_2$) and oxides of nitrogen (NO$_X$) is analyzed by Reddy, M.K., et al., (2004)$^{27}$ indicated the SPM values in winter at most of the sites and in summer at few sites are exceeding the prescribed standards. Sastry M.S., et al., (2004)$^{28}$ observed that the air quality status and predicts at most of the localities in Hyderabad are experiencing the air pollution stress and the trend is likely to worsen in near future if proper control measures are not implemented.

Singh Gurdeep, Puri SK (2004)$^{29}$ observed the overall ambient status in the coalfield was found not satisfactory and in the indoor microenvironment, RSP concentrations were found higher than expected. Geological rocks in the coalfield, coal burning, wear and tear of tyres and metallic parts of HEMM and other machines operating in the coalfield were found to contribute to air pollution and suggested the strategy for Air Quality Management. An air quality sampling program has been designed and implemented to collect the concentration of gaseous pollutants (SO$_2$, NO$_2$ and NH$_3$) at weekdays and weekends from a network of three monitoring stations along a populated urban region of Kolkata inferred and reported by Karar Kakoli., et al., (2005)$^{30}$

An experimental inference that the concentration of soluble organic fraction (SOF) and benzo-a-pyrene (BaP) were determined in PM$_{10}$ samples collected from kerbside sites and ambient air quality (AAQ) sites in Mumbai and reported by Manual, J.A., et al., (2005)$^{31}$ where SOF showed better correlation (r=0.82) with kerbside PM10 whereas BaP (r=0.6) with ambient air PM 10. The status of ambient air quality of Bhadravathi town was observed by Naveen. D., et al., (2008)$^{32}$ as a result, SPM concentration was found very closer to the threshold limit among three main air pollutants namely SPM, NO$_X$ and SO$_2$. Similarly an assessment of ambient air quality in Varanasi City and its environmental management discussed by Singh, S.N., et al., (2008)$^{33}$ and resulted that the air quality of the area falls under the unhygienic category.
Air quality assessment (AQA) is another important approach to decision makers for implementation of various air pollution control strategies illustrated through computation technique of an AQA with respect to exceedance factor (EF) studied by Gupta H.K., et al., (2008) and revealed that SPM in the areas of Indore has reached the critical levels since last 7 years and in between 1991-1993, 2000 and 2005 which reflects more improvement of air quality is required. Surinder Deswal, Pankaj Chandna. (2010) also determined the relationships between concentrations of Suspended Particulate Matter (SPM), Respirable Suspended Particulate Matter (RSPM), sulphur dioxide ($\text{SO}_2$) and nitrogen dioxide ($\text{NO}_2$) with meteorological parameters on monthly basis from 2000 to 2006. The multi-linear regression approach used in the study has facilitated analysis of the air quality-meteorology relationship and predicted the concentrations of SPM and RSPM within a scatter of $\pm 18\%$ and of $\text{SO}_2$ and $\text{NO}_2$ within a scatter of $\pm 14\%$.

Vedamadavan and Sarithabanuraman, (2012) presented the air quality status of Coimbatore city and compared the measured values with the recommended threshold limit to determine the air quality index. The ambient concentrations of trace metal composition of airborne particulate matter ($\text{PM}_{10}$) in the coal mining and non-mining areas of Dhanbad region at Jharkand, India, using EPM 2000 filter paper followed by acid digestion, extraction and analysis through atomic absorption spectrophotometer (AAS) reported by Bhawna Dubey., et al., (2012) and the mean concentrations of trace metals were found in the order of Fe>Cu>Zn>Mn>Cr>Cd>Pd>Ni.

2.3 Air Quality Index (AQI) in an urban areas

An air quality index (AQI) is a number used by government agencies to communicate to the public how polluted the air is currently or how polluted it is forecast to become. The literature survey related to air quality index in urban areas is given as below.
Air quality index and standard deviation at different sampling points were calculated by Mohanty, S.K (1999)\textsuperscript{38} in and around Koraput district at monthly intervals and the results showed that a comparative study of the air quality in different areas and identified the potential sources for effective pollution control measures to improve the air quality in future. Patnaik, K.N., et al., (1998)\textsuperscript{39} described the general features of the air quality index and then a case study of Paradip area is considered to illustrate the computation of an air quality index for that locality and concluded that the annual average of the indices for Paradip area indicates a clear increasing trend in the values which reflects the deterioration of the air quality in the area over the years.

Air pollution indexing is a scheme that transforms the (weighted) values of individual air pollution related parameters for various pollutants into a single number or set of numbers called the Air Quality Index (AQI) reported by Senthilnathan, T., et al., (2000)\textsuperscript{40} and elucidated the concentration of SO$_2$, NO$_X$, PM$_{10}$ and SPM pollutants present in air by using air pollution indexing technique and offers a software solution for computation of AQI.

Tripathy AK, Panigrahi GP (2001)\textsuperscript{41} evaluated the air quality index level of atmospheric pollution where the parameter has been computed for judging the ambient air quality around OSCOM (IRE Ltd) and resulted that the atmosphere towards the eastern side of OSCOM shows only moderate air pollution due to suspended particulate matter. Air Quality Indices (AQI) are important to decision makers for implementation of various air pollution control strategies studied by Gupta, H K., et al., (2002)\textsuperscript{42} and it is illustrated through computation techniques of an AQI which is showed that the annual average of the indices has a decreasing trend, which reflects improvement of air quality in the study area over the years. The index values obtained for various areas are feedback for effective pollution control measures adopted for reduction of emissions from various sources.
Srivastava, R.K, and Rajasree Sarkar (2006) reported that air quality index values should be uniform, simple and consistent with health message to get proper idea of air quality index for a region. An assessment of air quality indices of South Eastern Coal Mining Area, Korba studied by Rajesh kumar., et al., (2008), where the pollutants evaluated to derive air quality index at all the monitoring locations and it is concluded that the industrial activities of coal mining and miscellaneous road transport are indictable for deterioration of air quality in korba.

An attempt has been made to calculate the air quality index based on Factor analysis (NAQI) which incorporates the deficiencies of USEPA method for an urban environment by Biswanth Bishoi., et al., (2009) and observed that a significant difference exists between NAQI and EPAQI. There was a continuous decrease of particulate pollutants concentrations within Ahmadabad a mega city in Gujarat State in western India during this study period observed by Vijay Bhaskar B, Vikram M. Mehta (2010). However, the concentrations were just above the permissible limits set by the Central Pollution Control Board (CPCB). These particulate pollutants concentrations were compared with meteorological variables such as rainfall, humidity, temperature, and wind speed.

2.4 Effect of Particular Matter in an urban areas

Particulate Matter (PM) is the term used to describe solid or liquid particles that are airborne and dispersed. It originates from a variety of anthropogenic sources, including diesel trucks, power plants, wood stoves and industrial processes. These particles are especially detrimental to human health because they can penetrate deep into the lungs. Scientific studies show a link between PM$_2.5$ alone or combined with other pollutants and series of significant health effects even death. The literature study in related with the effect of particulate matter in an urban areas are discussed below.
**Sivacoumar, R., et al., (2000)** presented a detailed air pollution survey conducted at Pammal, 26 km to the southwest of Chennai and indicated that high percentage of finer particles and silica content possess health problems to the people exposed for longer duration. The total suspended particulate matter and respirable dust concentration in the ambient air from the roadsides of Indore city observed by **Joshi Gunwant, Jain Chandresh (2000)** where high particulate matter concentration, both respirable and non respirable are found to exceed the permissible limits at most of the locations due to bad road conditions and high density of vehicular movement are the main causal factors for high concentrations of particulates which gradually builds up due to high rise buildings on either sides of the road in the city area in contrast to open areas located in the outskirts of the city.

**Sivacoumar, R., et al., (2001)** explained the various unit operations involved in stone crushing have the potential to emit process and fugitive dust where the fine inhalable particulate matter (PM$_{2.5}$) has more associated human health problems was found high in the workplace of stone crushers. This study indicates that most of the people are having respiratory problems. The concentration of suspended particulate matter (SPM) in the ambient air of Madurai using an existing street canyon model popularly known as Johnson air quality model predicted by **KulandiSamy, I., et al., (2001)**.

**Goyal P, Sidhartha (2002)** studied the concentrations of sulphur dioxide (SO$_2$) and suspended particulate matter (SPM) has been performed in Delhi. The monthly and seasonal variations of concentrations and winds are analyzed. The monthly mean concentrations of sulphur dioxide were in the range of 16.15-34.44 mg m$^{-3}$ and showed regular seasonal variations with the highest concentrations in winter and lowest in monsoon season. Air particulate samples collected by **Negi, B.S., et al., (2002)** at a background site situated on the east coast of Thar Desert in Rajasthan State of India were analyzed for atmospheric dust loads (SPM) and elemental composition. The values of SPM were 3 to 5 times higher than the average during summer months.
Ruj Biswajit, Reddy, G.S. (2002)\textsuperscript{53} determined the variations in diurnal, average monthly and seasonal levels of suspended particulate matter at four sites in Raniganj-Asansol area and indicated that the concentration of suspended particulate matter remains higher during winters as compared to other periods where the SPM remain highest during the time between 14:00 and 22:00 hours. Senthilnathan T, Rajan, R.D (2003)\textsuperscript{54} identified the particulate matter having size less than 10 microns (PM\textsubscript{10}) as critical pollutants causing potential health hazard for human beings and the study was carried out to assess the concentration of PM\textsubscript{10} present in the ambient air in Chennai city during the summer season of the year 2000. The monthly mean concentration of PM\textsubscript{10} concentration was found to lie above the National Ambient Air Quality Standards values.

Reddy GS, Ruj Biswajit (2003)\textsuperscript{55} presented the assessment of ambient air quality with respect to suspended particulate matter (SPM), sulphur dioxide (SO\textsubscript{2}) and oxide of nitrogen (NO\textsubscript{X}) at four sites in the Raniganj-Asansol area in West Bengal, India and observed that the concentrations of the pollutants are high in winter in comparison to the summer or the monsoon seasons due to industrial activities, indiscriminate open air burning of coal by the local inhabitants for cooking as well as coking purposes and vehicular traffic are responsible for the high concentration of pollutants in this area.

Study was carried out to predict the size Separated Suspended Particulate Matter below 10 \textmu m size (SSPM\textsubscript{10}) from vehicular exhaust at traffic intersections using modified general finite line source model by Gokhale SB, Patil(2004)\textsuperscript{56} and it was also applied to predict the total particulate matter for downwind distances from the road intersection and resulted that the model’s performance was good for the finer range of particles (below 4.7 \textmu m) with r-square values of 0.49 and 0.57 found at both the intersections respectively. An experimental inference of the concentrations of total suspended particulate matter (TSP) and particulate matter less than 10 microns (PM\textsubscript{10}) were measured at various locations in
Jawaharlal Nehru port and surrounding harbour region founded by Gupta, A.K., et al., (2004)\(^{57}\) and it is concluded that the statistical analysis of air quality data of TSP is strongly correlated with wind speed but weakly correlated with temperature.

Gupta I, Joseph A.E. (2004)\(^{58}\) observed the particulate matter concentration in Greater Mumbai is higher than the prescribed standards and World Health Organization guidelines. Results of ambient air quality monitoring was carried out in India by Kannan, G.K, Kapoor J.C. (2004)\(^{59}\) showed that particulates encountered in urban areas are appreciably higher especially during winter and summer months while the gaseous pollutants are much below the permissible limits and it gives a pseudo impression of clean air quality.

The correlation study of secondary aerosol (nitrate and sulfate) with RPM in ambient air at different traffic junctions of Vadodary city is reported by Sinha, S.N., et al., (2005)\(^{60}\) using ion chromatography technique and measured the level of nitrate and sulfate in ambient air and it was found to be significant. It indicates that the secondary aerosols such as nitrate and sulfate in excess may cause irritation and increasing lung disease. Ambient particulate matter concentration was studied in mixed urban rural environment in the state of Uttar Pradesh, India by Singh, S.N., Rajnikant Sharma (2008)\(^{61}\) and resulted the air quality of the study area falls under the unhygienic category in the selected areas.

In order to address the issue of elevated pollutant levels in Hyderabad, India, a series of intensive monitoring campaigns were undertaken over a one year period in 2005-2006 at three locations namely, residential, mobile source dominated and upwind or background developed by Alan Gertler., et al., (2009)\(^{62}\) and it was found to be that residents of Hyderabad are exposed to unhealthy levels of Particulate matter with motor vehicles being the major source of the problem. Enrique Puliafito, S., et al.,(2011)\(^{63}\) calculated a detailed inventory of PM\(_{10}\) emissions in the urban area of Mendoza,
Argentina, and evaluates the impact of such emissions by using the CALPUFF dispersion program and included direct and indirect emissions from mobile sources, emissions from industrial sources and fugitive emissions from unpaved road and dust production from bare land showed the results of the relevance of indirect vehicular particulate emissions owing to resuspension, which contributes 37% of the emissions compared with 21% from exhaust emissions.

Borrego, C., et al., (2012)\(^{64}\) investigated that PM\(_{10}\) limit values have been surpassed in the northern region of Portugal and according to European legislation, Plans and Programmes must be designed and implemented to reduce those PM10 levels.

2.5 Effect of Automobile pollution

The literature survey associated the effect of ambient air due to automobile pollution in the city are described as bellow.

Chandrasekaran, G.E., et al., (1997)\(^{65}\) investigated the quality of air in Bangalore city at selected sites and noticed that except for lead levels at Bapuji Nagar, no other pollutants exceeded those ambient air quality standards due to the presence of large number of trees and other vegetation and existing pucca roads in Bangalore. A rapid assessment of air quality in Jaipur city was carried out to identify critical zones by Das, D.B., et al., (1997)\(^{66}\) for evolving a proper environmental management strategy and the concentration of gaseous pollutants that is SO\(_2\), NO\(_2\) and CO have been presented and analyzed which gave the maximum concentration observed in a day.

Dambal Aditi., et al., (1999)\(^{67}\) found that lead in gasoline is emitted into the environment through the exhaust gases of automobiles and deals with the determination of SPM, PM\(_{10}\), TSPM and lead levels at selected sites in Pune city. Sikdar P.K, Mandal S, (1999)\(^{68}\) reported Calcutta is one of the large cities in India known to have severe air pollution problems with respect to suspended particulate matter, oxides of nitrogen, sulphur dioxide, carbon monoxide, and lead.
Sivacoumar R, Thanasekaran K (2000) inferred the detailed survey of vehicular pollution in the city of Chennai has been undertaken to assess pollution contribution from transport sector. The traffic density of typical Indian categories of vehicle along with respective emission factors has been used for generating emission scenarios. Dayal, H.V, Nandini SN (2000) found that vehicular pollution is one of the main sources of air pollution in Bangalore city and parameters measured the parameters include suspended particulate matter, oxides of nitrogen and sulphur dioxide are shown the results are SPM values are above the limit while both nitrogen oxides and sulphur dioxides are within the prescribed limit in all the areas.

Jayshree, J. (2000) attempted to identify the various types of pollutants emitted by automobiles in Thiruvananthapuram city and resulted various operating modes of vehicles influence the amount of pollutants released by them. Mondal R., et al., (2000) presented a year long programme of measuring ground-level concentration of oxides of nitrogen at 19 important traffic intersection points within the city of Calcutta and concluded that the results of oxides of nitrogen concentration was maximum at winter and minimum at peak monsoon. Lal Shishir, Patil R.S. (2001) reported the physical and chemical fate of NO\textsubscript{X} released in the atmosphere from vehicles, which are the main sources of atmospheric NO\textsubscript{X} and resulted that at larger distance from the road the level of NO decreases but the concentration of NO\textsubscript{2} which is very harmful remains the same and statistical analysis was conducted to establish the relationship between likely change in NO\textsubscript{2} concentration as a result of NOx emission changes.

The reduction of vehicle emission to improve air quality that advances in vehicle design and fuel quality mean transports vehicles can be made cleaner and more efficient was observed by Prashanti Sam R, Rajeswari CV (2001) where lower emission of carbon monoxide, nitrogen oxides, sulphur dioxide, particles and hydrocarbons will lead
to better urban air quality and less summer time smog and lower emission of carbon dioxide (CO₂) from better fuel efficiency will lower the risk of dangerous climate change are resulted. The concentration of carbon monoxide monitor method used to predict the CO level in Chidambaram town reported by Ramamurthy N, Thirumarran M (2002) and it is evident that the pollution level is closely related to the density of motor vehicles plying on the roads with increase in number of motor vehicles, pollution level also increases which polluted the roadside environment severely in future.

An assessment of air pollution concentration from road traffic in Bangalore presented by Mahendra SP, Krishnamurthy (2003) and emits the air pollution concentrations of CO, NOₓ, SO₂ and SPM were measured simultaneously. It is evident that the traffic generated CO concentrations in the study intersections were high and exceeding the permissible standards prescribed by the CPCB and it may be attributed to the interrupted flow of traffic near the intersection due to frequent ‘stop’ and ‘go’ situations. The activity of motor vehicle in India is contributing to serious health and welfare effects due to vehicle emissions, and energy insecurity, acidification, and climate change observed by Badami, M.G. (2004).

In order to study the contribution of the concentration of SPM, NO₂ and SO₂ pollutants from motor vehicles, attention focused on the roadside, street-level concentration by Gadgil AS, Jadhav RS (2004) in Pune city and analyzed statistically gave the results that there is not only high correlation between SPM and NO₂ but also the levels of these pollutants are above the National Ambient Air Quality Standards (NAAQS) laid down by the Central Pollution Control Board (CPCB), India where the SO₂ concentrations are found to be well below the NAAQS. Jain Renu., et al., (2004) gave the study on vehicular air pollutant concentration with regard to CO, NO₂, SO₂ and particulate matter has been made at the four highly congested traffic junctions of Jaipur city based on the Air Quality Index (AQI) and it was remains higher for PM₁₀ followed
by CO at all the places. The climatic conditions and industrial development is experiencing an exponential growth in the vehicular usage and fuel consumption in Coimbatore city reported by Meenakshi P, Saseetharan M.K. (2004) using time series neural network modeling.

Environmental Wind Tunnel (EWT) has emerged as one of the most widely used technique carried out a wide range of air pollution. At present, the investigations are being carried out to understand the complex vehicular pollution dispersion phenomena under urban environmental conditions for Indian traffic and climatic conditions reported by Sharma, N., et al., (2005). Reshu, (2005) summarized the effect of air pollution on road side wheat crop particularly through automobile exhausts discharged by high traffic density on the main Bhagwanpur road of Saharanpur. Mohanraj R., et al., (2005) had been made an attempts to understand by that the traffic growth and emission from vehicles plying in Coimbatore, a fast growing industries and urban centre and identified the bad quality of city roads, unhealthy practices of drivers and resuspension of road dust due to traffic movement are the major problems that can add to vehicular pollution in Coimbatore.

Sarath k Gutlikunda and Rakesh Aggarwal (2009) investigated the contribution levels of transport emissions to ambient air pollution levels via monitoring data, source apportionment of filter samples for particulates and dispersion analysis and presented the results from the ongoing air quality monitoring studies and source apportionment analysis highlighting contribution of transport sector in Hyderabad city. An association between local traffic generated air pollution and preeclampsia and preterm delivery in the south coast air basin of California reported by Jun Wu., et al., (2009) and concluded that exposure to local traffic generated air pollution during pregnancy increases the risk of preeclampsia and preterm birth in southern California women and it is associated with adverse reproductive outcomes.
Pedro M. Torres., et al., (2009) estimated road transportation emissions with a detailed level of disaggregation allowing the evaluation of measures aiming key source groups rather than road traffic in general. Those measures include reduction of speed limits, changes in fleet age or engine capacity, introduction of new technologies, among others. The methodology is coherent with the National Emission Inventory in terms of assumptions, activity data and emission factors. Barman S.C., et al., (2010) estimated the quantitative effect of vehicular emission on ambient air quality during May, 2006 in urban area of Lucknow city and concluded that ambient air quality in the urban area is affected adversely due to emission and accumulation of SPM, RSPM, SO$_2$, NO$_x$ and trace metals.

2.6 Effect of Industrial Pollution

Disposal of various hazardous chemicals due to the rapid urbanization and industrialization environmental pollution has increased tremendously over the past decades. Among them heavy metals and gaseous pollutants play a major role in causing several serious problems to the mankind particularly mutagenicity, carcinogenicity and respiratory problems. The effect of ambient air in and around industries to the human health and plant species related to literature as shown below.

Sidhartha, Goyal P, Bandyopadhyay TK (1999) presented an alternative fuels used in the industrial and domestic sectors in Agra. The receptor oriented Gaussian Plume model has been used to calculate the concentrations of SO$_2$, SPM and NO$_x$ at five vulnerable places. It has been shown that the main sources of SO$_2$ and SPM were those industries that have been using the coal/coke as a source of fuel. An ambient air quality in industrial part of Ib valley area is situated in the south west part of river Ib in Jharsuguda districts of Orissa due to industrial and mining activity of Ib valley area of three seasons that is summer, post-rainy and winter are presented by Sahn D.K., et al., (1999). A well designed ambient air quality network was operated to monitor SO$_2$ concentration.
continuously by increasing air pollution levels due to industrial activities and rapid urbanization and were used in the Industrial Source Complex Short Term (ISCST) dispersion model to predict \( \text{SO}_2 \) concentration profile over space and time in Jamshedpur city located in the eastern part of India observed by Sivacoumar, R., et al., (1999)\(^9\).

Sivacoumar R., et al., (1999)\(^9\) observed that a cluster of 48 stone crushers working at Pammal area, south west of Chennai generates dust pollution in and around the crushers. Laser diffraction technique was employed to analyze the size and distribution of dust particles in the air. The fine inhalable particulate matter concentration was found high in ambient air, indicating its potential to affect human health.

Awasthi Ajay K., et al., (2001)\(^9\) attempted to assess the environmental impacts of lime kilns at Maihar (MP) and concluded that due to lime kilns and ongoing mining and expansion work and also other related activities approximately 56.07\% of the overall environmental quality is negatively affected or likely to be affected while only 3.6\% of the benefits could be sought in improving living standard. Gujral Seema., et al., (2001)\(^9\) reported that suspended particulate matter using high volume air sampler at four different sites in and around the Kota Thermal Power Station situated at the bank of river Chambal in city Kota. Results have suggested that adequate measure should be taken for the efficient running of the electrostatic precipitators and utilization of the wet and dry fly ash and coal dust slurry to check the emission of particulate pollutants and fly ash from the power station.

Air pollution due to brick kilns, has been found to cause serious occupational health hazards, and adverse effects on crops, orchards and buildings by Jain Neeraj., et al., (2001)\(^9\) where Delphi technique has been used to identify the major pollution parameters as well as their specific impacts near a brick kiln. The monitoring of the dust concentration in air from the quarry industries situated at Alibaug (Maharashtra) has been
carried out by Lokhande R.S, Bhave R.P. (2001)\textsuperscript{95} in this study. It is seen that it has nuisance dust and the irrespirable dust. The data is obtained over a year and it is seen that the concentration of nuisance dust is higher than the prescribed limit however, regarding the irrespirable dust it is almost under the permissible limits specified.

Shrivastava KL, Ojha Shrikant (2002)\textsuperscript{96} analyzed the primary parameters chosen for ascertaining the ambient air quality in the industrial areas of Jodhpur city were the SPM concentration, NO\textsubscript{2} and SO\textsubscript{2} content, which are the direct outcome of industrial activities. The ambient air quality of Tantra-Raikela-Bandhal iron ore mines with respect to suspended particulate matter, sulphur dioxide (SO\textsubscript{2}) and oxides of nitrogen (NO\textsubscript{x}) and their level of concentration in different seasons of the year given by Das, S.K., et al., (2003)\textsuperscript{97} and resulted that the concentration of SO\textsubscript{2} and NO\textsubscript{x} are exceeded the limit at few places of the study area.

Ghose Mrinal K, Majee SR (2003)\textsuperscript{98} revealed that high coal production associated with heavy mechanization led to more air pollution problem in areas. The air quality is analyzed in respect of sulphur dioxide and suspended particulate matter in the ambient air in the neighborhood of Neyveli Thermal Power Corporation for finding ideal location of sampling stations was carried out by Sriram, G., et al., (2004)\textsuperscript{99}. The air quality was monitored at four different directions around the thermal power plant and control site at interval of three months during the year 2003-2004 by Kumar Adarsh., et al., (2005)\textsuperscript{100} and concluded that the SPM level was found very high followed by NO\textsubscript{x} and SO\textsubscript{2}.

Adarsh Kumar and Kazmi S. (2005)\textsuperscript{101} determined the air quality index (AQI) around National Thermal Power Corporation (NTPC), Unchahar at four different sites located in four respective directions where the pollutant level have been discussed. Environmental Impact and Utilization of Fly-ash in thermal power plant studied by D.K.Sahoo., et al., (2008)\textsuperscript{102} and deals with various environmental problem related to
generation of fly-ash as negative impact and some of the important fly-ash utilization of management as positive impact techniques with proper remedial measures. Ramesh Singh., et al., (2008) presented the assessment of ambient air quality with respect to respirable suspended particulate matter (RSPM) and trace metals concentrations in RSPM at five locations of Renukoot, an industrial area of Eastern Uttar Pradesh.

2.7 Effect of air pollution on Plants

The burning of hydrocarbons in motor vehicle engines and industrial plants such as chemical works and metal smelting plants give rises to oxides of carbon, nitrogen and sulphur and hydrogen fluoride into the atmosphere. Tall chimney stacks may be used to carry gases and particles to a high altitude and thus avoid local pollution but the pollutants return to earth sometimes hundreds of kilometers from the original source. The literature study related with the effect of air pollution on plants is discussed below.

Imiwari Swarnlata., et al., (1992) carried out the fumigation of one year old Ficus religiosa(L) seedlings with various concentrations of NO in closed top polythene chambers for 4 hrs daily in the morning for three months. Initially the treatment stimulated the growth of plants but later on there was reductions in growth and as significant reductions in root shoot length, fresh and dry weight of plants exposed to NO\textsubscript{2} and it results there were reductions in photosynthetic pigments of pollutant exposed plants. Likewise the effect of various concentrations of SO\textsubscript{2} fumigation on morphological characters in Ficus religiosa L. and Mimusops elengi L investigated by Tiwari S, Bansal S (1996) Where decrease in root-shoot length, fresh and dry weight was recorded in plants exposed to the SO\textsubscript{2} exposure. The reduction in morphological characters increased with the increase in the concentration and period of fumigation.

The effect of urban air pollution on Cassia fistula and Cassia siamea at Indore city observed by Joshi, O.P., et al., (1997) and concluded that Cassia fistula appeared
more sensitive to urban air pollution than *Cassia siamea*. The effect of sulfur dioxide on *Polyalthia longifolia* (L) plant species was analyzed by **Kumar Naresh and Jaishree (1999)**\(^{107}\) and gave the value that Chlorophyll and free amino acid contents showed constancy in their amounts while protein contents were significantly reduced.

**Pal Banashri., et al., (1999)**\(^{108}\) studied the effect of chlorpyrifos, on *Scenedesmus bijugatus*, and determined by observing growth, protein, carbohydrate contents and chlorophyll biomass and concluded that toxic effect was found to be directly proportional to the concentration of the pesticide. Heavy metals such as Ni (II), Cr (VI) and Hg on biochemical and chemical parameters of *Albizia lebbeck* was investigated by **Tripathi Ashutosh Kumar, Tripathi Sadhna (1999)**\(^{109}\) and observed that there was significant reduction (P > 0.001) in chlorophyll, protein, carbohydrate and sugar in leaves was observed which was positively and significantly correlated with leaf area, root-shoot length and biomass of plant. Studies of the foliar epidermal traits conducted by **Aggarwal Preeti (2000)**\(^{110}\) on *Cassia simea* L showed increase in densities of stomata, trichomes and epidermal cells, longer trichomes and reduction in size of epidermal cells at polluted sites as compared to that at reference site.

**Pratibha, Sharma Madhu (2000)**\(^{111}\) investigated the effect of SO\(_2\) on chlorophyll and total free amino acids of gram (*Cicer arietinum* L.) by exposing plants to 1 ppm of SO\(_2\). Chlorophyll and total free amino acids were quantified. Plants developed visible injury symptoms and suffered growth reduction. Exposure to SO\(_2\) depressed chlorophyll. There is an increase in total free amino acid in the leaves of fumigated plants over control. **Prakash Govind., et al., (2002)**\(^{112}\) presented if the concentration of sulfur dioxide increases, there is a maximum decreasing trend of chlorophyll ‘a’ than that of chlorophyll ‘b’ on *Raphanus sativus* and *Brassica rapa*. **Shrivastava Neerja, Joshi Sulekha (2002)**\(^{113}\) identified for healthy environment although more emphasis is now
being given to check air pollution, certain plant species resistant to pollutants, so that such plant can be grown in polluted areas and found that resistant species some morphological parameters of plants, growing in polluted and non-polluted areas are compared.

The effect of different concentrations of manganese sulphate on chlorophyll, carotenoid pigment content and photosynthesis of mungbean seedlings are examined by Sinha Suchita., et al., (2002)\textsuperscript{114} and progressive increase in manganese sulphate concentration upto $5 \times 10^{-3} \text{ M}$ brought about a progressive decrease in total chlorophyll and chl a content. Chlorophyll ‘b’ changed very little by excess manganese treatment. A study was undertaken by Samal Alok Chandra, Santra S.C. (2002)\textsuperscript{115} in Kalyani Township to determine the extent of air pollution and its impact on some dominant local flora by studying their anatomico-biochemical features of leaves in a comparative manner. The total chlorophyll content, epidermal thickness, stomatal length and breadth of the leaves were found to decrease while the leaf thickness, stomatal frequency were found to increase in case of pollution stress plants with respect to control plant population of non polluted habitat.

Agrawal M., et al., (2003)\textsuperscript{116} studied the six hour mean concentrations were monitored for SO$_2$, NO$_2$ and O$_3$ and plant responses were measured in terms of physiological characteristics, pigment, biomass and yield. Parameter reductions in mung bean ($Vigna radiata$), palak ($Beta vulgaris$), wheat ($Triticum aestivum$) and mustard ($Brassica compestris$) grown within the urban fringes of Varanasi, India correlated directly with the gaseous pollutants levels. Raj Sonia., et al., (2003)\textsuperscript{117} inferred the plants of $Triticum aestivum$ var. Raj. 3077 tolerated the simulated acid rain exposure down to pH 1 root and shoot lengths and dry weights were reduced due to lowering in pH level. Chlorophyll content, carbohydrate, protein and nitrogen content were also significantly affected.
The effect of un amended and variously amended tailings of Rajpura-Dariba mines, Udaipur, India was studied on certain physiological and biochemical responses of plants observed by Sharma A, Aery N.C. (2004)\textsuperscript{118} and plants grown in un amended tailings showed reduction in shoot-root length, shoot-root dry weight, chlorophyll content and an increase in total phenol contents and peroxidase activity. Among the five localities selected by Sharma Navin Kumar (2004)\textsuperscript{119} in Agra district, maximum air pollution in terms of $SO_2$, $NO_x$ and SPM was obtained at Gwalior road and minimum at Dayalbagh. Analysis of variance of \textit{Kharif} crop-Jawar plant analysis had shown significant values of plants height, number of plants and yield as the determining factor.

\textbf{Trivedi A.K., et al., (2004)}\textsuperscript{120} gave the experimental inference of \textit{Lemna gibba} plants were exposed to two concentrations of chrysotile asbestos and control plants were cultured in medium without chrysotile asbestos. An inhibition effect of chrysotile exposure was found on the number of fronds, root length, and biomass. \textbf{Wanmare DJ, Deshpande Jayashree (2005)}\textsuperscript{121}, gave the effect $SO_2$ on spore germination of 14 fungal species from the phyllosphere of different ornamental plants was studied. There was a drastic reduction in spore germination of different fungal species under $SO_2$ environment.

\textbf{Singh, A., S.B.Agrawal (2007)}\textsuperscript{122} investigated the impact of atmospheric deposition on accumulation and translocation of heavy metals in different parts of wheat plants. Results depicted that metal accumulation was higher at sites with higher pollution load than sites having less pollution. Concentration of metals was maximal in leaves followed by stem and minimum in wheat grains. \textbf{Tripathi, A.K., and Mukesh Gautam (2007)}\textsuperscript{123} reported that variations of biochemical parameters like chlorophyll, protein, soluble sugar and so on of plants as indicators of air pollution due to pollution load dependant for early diagnosis of stress or as a marker for physiological damage to trees prior to the onset of visible injury symptoms.
Santosh Kumar Prajapati and B. D. Tripathi (2008) presented to assess the dust interception efficiency and impact of dust deposition on chlorophyll and ascorbic acid content of leaves of some selected tree species and found that all species have maximum dust deposition in the winter season followed by summer and rainy seasons. Chlorophyll content decreased and ascorbic acid content increased with the increase of dust deposition. Dwivedi, A.K., et al., (2008) presented the relationship between ambient air sulphur dioxide and sulphate content in leaf of selected tropical plant species, Ficus religiosa. It revealed that a positive correlation between ambient air sulphur dioxide and sulphate in the leaves.

Sadhana Chaurasia., et al., (2009) observed the effect of air pollution on stomata of different plant species and health hazards in stone crushers and reported that SPM stays much above than the general accepted norms or permissible limit to lead the environmental pollution in the stone crushers of Chitrakoot area of Uttar Pradesh. Present investigation has been promulgated to study pigment profile and chlorophyll degradation of lichen communities within areas of different degree of disturbances in Cachar district, Assam by Jayashree Rout., et al., (2010). Photosynthetic pigments were measured to estimate the possible damage caused by the metallic pollutants in the lichen, Pyxine cocoeces collected from 25 sites of the study area. Total chlorophyll is highest in Ecoforest whereas carotenoid is lowest.

2.8 Effect of automobile pollution on plants

Air pollution is influenced by automobile exhaust pollution due to rapid increase in population, rapid economic development and high energy consumption. The literature survey that enables to study the literature in related with the effect of automobile pollution on plants is shown below.
Palaniswamy M., et al., (1995) revealed that automobile gases could affect seedling development and growth of crop plants. The affected plants exhibited heavy dust deposition minor injuries and block spots on the leaf surface. Frequencies of epidermal cells, stomata and trichomes were reduced by the pollutants in the test plants but type and size of stomata and trichomes were not altered. The air pollutants caused chlorosis in the test plants. The pollution caused by automobile exhausts on leaves of wheat studied by Kumar Rajesh, Charaya MU (1996) and it was found to be suffer more from the brown rust as compared to those in unpolluted areas.

Mandal Madhumanjari, Mukherji, S. (2000) analyzed the effects of long term exposure to automobile exhaust on chlorophyll content, chlorophyllase activity and observed photosynthetic CO$_2$ uptake, sugar and starch contents of plants growing on the edge of Delhi Road (NH 2) near Dankuni, West Bengal, and from the nearby village at least 300 m away from the road served as control. Naik V.B, Deshpande, U.P (2000) collected the various plant leaf samples from the plants near the densely populated high density automobile traffic roads of the Nanded city and was screened for the accumulation of lead and it was found to be Ployalitha longifolia leaves are maximum accumulation of lead and revealed that P. longifolia is a sensitive plant and responds to atmospheric lead levels.

Pal Amit., et al., (2000) gave the effect of automobile exhaust emissions on two common avenue trees, Azadirachta indica A and Polyalthia longifolia has been studied with special reference to their cuticular and epidermal characteristics. In plants collected from heavy traffic density areas (HTDA) the epicuticular wax was severely damaged and its morphology altered. Significant changes in cuticular and epidermal structures were also observed in the two species and a two-fold increase in stomatal frequency was recorded. High soil contents of toxic or total heavy metals have been observed by
Bhargava, A.K., et al., (2003)\textsuperscript{133} in the proximity of road side grown sugarcane as compared to plant grown at 100 mt. distance away from road side. Like wise, level of total nitrogen and phosphorous also showed variations in different plant samples depending upon the extent of automobile exhaust released along road side.

Biological monitoring of roadside plants exposed to vehicular pollution in Jalgaon city, Maharashtra observed by Wagh, N.D., et al., (2006)\textsuperscript{134} where significant decrease in total chlorophyll and protein content with reduced leaf area and is concluded that plants can be used as indicators for urban air pollution and there is need to protect the roadside plants from air pollution. The roadside plant can easily avoid the effects of air pollution by altering their physiological pathways pertaining to photosynthesis and respiration observed by Mandal Madhumanjari (2006)\textsuperscript{135} and resulted that increased activity of the enzyme Phosphoenol Pyruvate Carboxylase (PEPCase) belonging to C\textsubscript{4} pathway helps Nerium and Boerhaavia (both C\textsubscript{3} plants) in carbon fixation under stress condition.

Joshi, P.C and Abhishek Swami (2009)\textsuperscript{136} determined the changes in the concentration of different photosynthetic pigments (Chlorophyll and carotenoids) in the leaves of six tree species exposed to air pollution due to vehicular emissions and concluded that the vehicular induced air pollution reduces the concentration of photosynthetic pigments in the trees exposed to road side pollution. Avnish Chauhan (2010)\textsuperscript{137} carried out to assess the impact of automobile exhaust on some selected tree species grown at Dehradun city, in Northern India. The plant species selected for the study were Ficus religiosa, Mangifera indica, Polyalthia longifolia, Delonix regia. Reduction in chlorophyll ‘a’, chlorophyll ‘b’, total chlorophyll content, ascorbic acid, carotenoid, pH, relative water content and APTI was recorded in the leaf samples of all selected trees collected from polluted site when compared with samples from control area.
2.9 Photosynthetic pigments through reflectance

The literature survey was carried out to study the literature relevant to the non-destructive estimation of chlorophyll content of plant leaves through reflectance as discussed below.

Indices for the non-destructive estimation of chlorophyll content were formulated using various instruments to measure reflectance and absorption spectra in visible and NIR as well as chlorophyll contents from several non-related species from different climatic regions and new algorithms are proposed and reported by Gitelson A.A and M.N. Merzlyak (1997). Spectral indices for prediction of leaf pigment content that are relatively insensitive to species and leaf structure variation and thus could be applied in larger scale remote-sensing studies without extensive calibration for each species and proposed new spectral index that reduces the effect of differences in leaf surface reflectance were able to significantly improve the correlations with chlorophyll content developed by Daniel A. Sims and John A. Gamon (2002). This opens up new possibilities for assessment of vegetation health in heterogeneous natural environments.

Gitelson Anatoly A. and Merzlyak Mark N. (2004) investigated the spectral behavior of the relationship between reflectance and pigment content and developed techniques for non-destructive pigment estimation in leaves using reflectance in a few spectral bands. They found that three spectral bands either 550±20 nm or 715±20 nm, 450±20 nm and an NIR band above 750 nm sufficient for total chlorophyll content estimation. For anthocyanin-containing leaves, spectral bands 715±20 nm, 450±20 nm and an NIR band above 750 nm are recommended. For carotenoids estimation, three spectral bands, 510±5 nm either 550±15 nm or 700±7.5 nm and an NIR band above 750 nm are needed. Reflectance in two spectral bands, 550+/−15 nm and 705+/−5 nm are sufficient to estimate anthocyanin content non-destructively. Chaoyang Wu., et al.,
reported that the integrated indices TCARI/ OSAVI[705,750] and MCARI/OSAVI[705,750] are most appropriate for chlorophyll estimation with high correlation coefficients $R^2$ of 0.8808 and 0.9406, respectively, because more disturbances such as shadow, soil reflectance and non photosynthetic materials are taken into account. The high correlation between the vegetation indices obtained in the developmental stages of wheat and Hyperion data ($R^2$ of 0.6798 and 0.7618 for TCARI/OSAVI[705,750] and MCARI/OSAVI[705,750] respectively) indicated that these two integrated index can be used in practice to estimate the chlorophylls of different types of corns.

2.10 Effect of Industrial Pollution on Plants

Industries are emitting toxic substances which adversely affect human food supply by polluting nearby growing plants. Ambient level of air pollution has been shown to affect stomatal conductance, photosynthesis and root morphology on plants. In the context of environmental pollution abatement, green belt has been defined as mass plantation of pollutant tolerant trees for mitigating the air pollution by filtering, intercepting and absorbing pollutants in a sustainable manner. A scant number of literatures showed that there is a relation between industrial pollutant deposition and physiological process on plants. A literature survey is to study the literature is related with the effect of industrial pollution on plants are discussed below,

Agrawal S, Tiwari S. (1996) studied the effect of steel kiln's pollution on Ficus and Termenalia species in Patrapali region of district Raigarh (MP). Results indicate a considerable loss of total chlorophyll content. 57.55 % the maximum in Termenalia ehebula and 8.03 % the minimum in Termenalia bellerica. The leaf area dry weight ratio was higher in Ficus religiosa. 67.89 % and lower 2.75 % in Termenalia bellerica.

Tripathy Anuradha, Sahu (1997) observed a pot experiment to study the effect of the Talcher Thermal Power Station fly ash on growth and yield of wheat. Data of the pot
experiment on growth and yield reveal that 50% fly ash applied to soil increased seedling height, plant height, girth, leaf number, leaf area, spike length and dry weight. The soil application of fly ash not only has the potential for improving their production but also for solving of the flyash disposal problem.

Agrawal S and Tiwari S.L (1997) inferred that Iron and steel industry kiln dust emanating is a mixture of aluminium, calcium, iron, magnesium, silica and sulphur oxides which affects plant growth adversely. Attempt has been made to evaluate the level of dust deposition on leaf surface and its correlation with photosynthetic pigment and leaf area dry weight ratio. Trees of Mangifera indica growing around industrial premises of Baroda region (India) were selected by Gavali Jitendra G., et al., (1998) and variations in phenology were observed which are evidenced by erratic growth pattern. ANOVA showed that the variation seen in the measured growth parameters for different periods and for different localities are significant. Interactions between period and localities were also found significant.

Panday, D.D., et al., (1999) studied the maize crop situated in the prevailing wind direction of stone crusher, Karwandiya, Rohtas, Bihar to know the impact of dust on the biomass and chlorophyll content. The biomass was found to be higher at each sampling date of the control maize plant than the polluted ones. Srivastava PK, Pandey GS (1999) observed the effect of a fertilizer factory effluent on total chlorophyll content and biomass of some aquatic macrophytes has been studied. The total chlorophyll content and biomass of Eichhorma crassipes, Pistia stratiotes and Hydrilla verticillata were reduced significantly with an increase in treatment durations from 7, 14 and 21 day of exposure in different fertilizer effluent concentrations.

Dhir Bhupinder., et al., (1999) reported that the air pollutants emitted from the Badarpur Thermal Power Station, New Delhi influenced the form and function of
*Achyranthes aspera*, a perennial weed of the family Amaranthaceae. Chlorosis and necrosis were common foilar symptoms. Morphological features showed little variation such as leaf size, however, increased considerably under the pollution. The regenerative and morphogenic capacity was low in plants exposed pollution stress. Pandey D.D. *et al.,* (1999)\(^{149}\), dealt the wheat crop situated in the prevailing wind direction of stone crusher, Karwandiya, Rohtas, Bihar to assess the impact of stone crusher dust pollution on wheat. Biomass, primary productivity, growth parameters, chlorophyll, nitrogen, phosphorus and potassium were comparatively low in polluted wheat plant.

Somasekhar, R.K., *et al.,* (1999)\(^{150}\) assessed the biological characteristics of some plant species in and around quarrying and crushing areas of Bangalore District was carried out. 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. Kashyap MK., *et al.,* (2000)\(^{151}\) assessed the effect of thermal power plant emission on the morphology and biochemical composition of different forest species. Depending upon the capacity of plant species to withstand the damage due to pollution, a sensitivity index was worked out. The most tolerant species was *Ficus religiosa* followed by *Ficus bengalensis* and *Azadirachta indica* and the most sensitive species was *Syzygium cumini*. The most tolerant species may provide a natural sink for air pollutants and may be planted in large scale around industrial areas like Korba.

Singh A.K., *et al.,* (2000)\(^{152}\) gave the following observation that ambient air quality monitoring has been conducted at four sampling locations around Sindri Fertilizer Complex for SPM, SO\(_2\) and NO\(_X\). The observations indicate that there is a marked safety in the computation methodology. The observations also indicate that the fugitive emissions have significant impact on the ambient air quality. Rampal Raj Kumar,
Sharma Deepshikha (2001) carried out to investigate the impact of stone crusher dust on the qualitative and quantitative micro-morphological features of leaves of *Magnifera indica* L. and *Psidium guajava* L.

Flower of *Cassia fistula*, *Delonix regia* and *Peltophorum inerme* collected from polluted areas (textile mills, industrial area and roadsides) by Joshi, O.P, Sikka J (2002) and the reference area (Agriculture College Campus) were studied for fresh and dry weights and per cent pollen germination. Maximum reduction in flower weights (fresh and dry) was noted in textile mill area and minimum at roadsides.

Banerjee Saikat., et al., (2003) studied the impact of fly ash generated from Shaktinagar (UP) Thermal Power Plant on foliar chemical and biochemical parameters of *Ipomea cornes*, *Cassia tora* and *Acacia nilotica* naturally growing on fly ash dyke. It is apparent that fly ash severely affects the plants by changing the chemical and biochemical compositions. Protein, carbohydrates, chlorophyll and ascorbic acid decrease significantly with a significant increase of phenols of the plant species grown on fly ash. A greenhouse experiment was conducted by Singh Lamabam P, Siddiqui Zaki A (2003) studied the effect of *Alternaria triticina* with and without foliar dusting of fly ash on the growth, yield, photosynthetic pigments, protein and lysine contents of three cultivars of wheat, *Triticum aesticum*. Dusting of 2.5 and 5.0 g fly ash caused a significant increase in growth, yield, photosynthetic pigments, and protein and lysine contents of all the three cultivars.

Barik, R.N., et al., (2005) studied the tree species *Ficus relegiosa*, *Ficus benghalensis*, *Psidium guyava*, *Ziziphus mauritina* and *Calotropis procera* plants were selected in the IB valley area to find out dust fall on the leaves in an open cast coal mine area. From the result, it is observed that *Psidium guyava* has the maximum dust trapping efficiency followed by *Ficus benghalensis*. At the same time *Ziziphus mauritina* has shown the minimum dust trapping efficiency. Naik, D.P., et al., (2005) studied the
selected quarry locations of Bangalore district for the determination of protein and chlorophyll contents in *Calotropis gigantia* (L) R. Br, *Muntingia calabura* and *Annona squamosa* located in the vicinity near stone crushing units during summer, monsoon, and winter seasons. A significant reduction in protein and chlorophyll contents of the sampled leaves was observed compared to control, which may be attributed to the high emission and leaf deposition of dust which adversely affects the metabolic activity of the plant.

*Maria Magdalena., et al., (2008)* investigated the morpho-anatomical and physiological effects of the industrial polluting agents from Moldavian industrial areas, Romania, on *Populus tremula* (L) and observed that the state of the leaves surfaces and physiological changes of the leaves under the influence of the atmospheric gaseous pollutants. From this fact, it is concluded that the structure of all the leaves is severely altered which leads to the degradation of the photo-assimilating structures and ultimately to the death of the entire plant due to air pollution. *Yashoda Saini., et al., (2011)* described the effect of marble dust on plants in and around Viswakarma industrial area, Jaipur, Rajasthan, India. The results of this study indicated a decline in chlorophyll content in trees growing in industrial area. The reduction is due to degradation of chlorophyll into phaeophytin by the loss of magnesium ions.

**2.11 Effect of cement dust pollution on plants**

Air pollution is a significant factor in morbidity and mortality within industrial areas. Hazardous substances are distributed widely in ecosystem due to diverse human activities such as energy usage, agriculture, and urbanization and industrialization high demand of infrastructure due to population increase. Cement production is one of the sources of air pollution and the main impacts of the cement activity to the environment are the broadcast of dusts and gases. The effect of dust emitted by the building materials industry on plants may be neutral, stimulating or toxic depending on the type,
concentration of components, level of deposition and meteorological conditions. The literature survey is related to the literature about the effect of cement dust on plants are presented as below,

**Ignacimuthu S, Muralaytharan V (1994)**\(^{161}\) studied the cytogenetically effects of cement kiln dust in *Allium cepa* L. Mitotic index decreased as concentration increased. Different kinds of chromosomal abnormalities were recorded. There was a direct relationship between the frequency of aberration and cement kiln dust treatment. The results indicate that cement kiln dust has cytotoxic properties and even acts as a mutagen.

**Urna Ch, Ramana Rao TV (1996)**\(^{162}\) presented the impact of cement kiln dust pollution on the morphobiochemical and epidermal features of *H. cannabinus* plants grown under simulated cement kiln dust pollution.

**Vijayawar Anjali, Pandey G.P. (1996)**\(^{163}\) gave the report on the effect of cement dust pollution on soybean (*Glycine max* (L.) Merrill cv. PK 472) leaves from dusted and undusted plants till their physiological maturity. Due to cumulative accumulation and encrustation of cement dust on leaves, a gradual decline in chlorophyll content was observed. Although chlorophyll a was found relatively more sensitive to the cement dust than chlorophyll b. Quantitative estimation of certain metabolites such as protein, starch and sugar content also showed a considerable decrease. the periodical effect of cement dust pollution on the growth of some plant species was presented by **Muhammad Zafar Iqbal and Muhammad Shafiq (2001)**\(^{164}\) where a significant reduction in plant cover, height and number of leaves of *Caissa caranda*(L) was observed and there is no significant changes of *Azadirachta indica*(L) in plant cover and height with the exception of number of leaves(p<0.001). A pronounced effect also found in *Delonix regia*(L) at p<0.01 and p<0.05 significance levels respectively. It was concluded that the cement dust had a significant effect on the plant growth.
Mehrotra GK (2001)\textsuperscript{165} reported the ambient air quality in and around lime and cement producing regions of Madhya Pradesh state, namely the districts of Rewa, Satna, Maihar and Katni has been made. Dust fall and visibility loss measurement at a distance of 100 m at important places have shown marked deterioration in air quality at various points. This has been attributed to the physical and chemical characteristics of the raw materials and coal used in the manufacturing of lime and cement. The high resistant and sensitive plant species were identified by Thangarasu S., et al., (2002)\textsuperscript{166} in the vicinity of a cement factory in Ariyalur, through the determination of air pollution tolerance index (APTI) using four leaf parameters. The result indicated that out of fifteen woody plant species only eight were found to be resistant to cement kiln dust pollution.

Vijaywargiya Anjali, Pandey GP(2003)\textsuperscript{167} investigated the cumulative encrustation of cement dust on the leaves of soybean and maize, a quantitative reduction in the absorption of light by these plants was observed, which affected fluorescence yield.

Tijani, A.A., et al., (2005)\textsuperscript{168} examined cement production externalities and profitability of crop enterprises in two local government areas of Ogun state, Nigeria and reported that negative effects on agricultural production due to soil and air pollution in the selected area. Sabah A. Abdul-Wahab(2006)\textsuperscript{169} estimated the impact of fugitive particulate emissions from a cement plant on a nearby community using an air quality model (fugitive dust model, FDM). The emission rates of dust from various activities of the cement plant were estimated by using the emission factors technique. The results of the study showed that the agreement between the 24-hour averages predicted and measured dust concentrations were excellent and the plant that are at risk of approaching or exceeding guideline TSP concentrations.

Swiercz, A. (2006)\textsuperscript{170} presented the application of pine bark to indicate the level of air contamination by cement-lime dust and determined the impact range of cement
plants. The pine bark was analyzed in the forested formed around three cement plants in the Swietokrzyski district of south Poland and compared with control and resulted the high alkalinity range in the bark of polluted pine tree. The climate-growth relationships and the variation of the radial growth of Norway spruce and Scots pine stands in conditions of different cement dust loads were investigated by *Henn Parn (2006)*\textsuperscript{171} and it is concluded that cement dust emissions had a small effect on the radial growth of selected plants.

Similarly an assessment of cement dust impact on the soil using principal component analysis and GIS evaluated by *Zerrouqi, Z., et al., (2008)*\textsuperscript{172} and demonstrated the preliminary results that this dust are especially basic and contain a high free lime (43% CaO). *O.E. Ade-Ademilua and D.A. Obalola (2008)*\textsuperscript{173} investigated the effect of cement dust pollution on *Celosia Argentea* and resulted it may discourage the practice of vegetable gardening in areas under cement dust pollution.

Air pollution is one of the most serious environmental problems in Tehran and it is evaluated and predicted by *Siamak Boudaghpour and Alireza Jadidi (2009)*\textsuperscript{174} that the rate of pollutants being generated in the cement production industries and discussed the approaches to eliminate and control pollutants. The variation in the degrees of exposure to elements in cement dust and health implications arising from working or living within the vicinity of a cement company was monitored and investigated by *Yahaya Tajudeen and Joy Okpuzor (2011)*\textsuperscript{175} and resulted highlight the hazards of prolonged exposure to cement dust and underscore the need for urgent action for the protection of animals and plants. *Amal M. Abdel- Rahman and Mohamed M. Ibrahim (2012)*\textsuperscript{176} studied the pollution by the cement dust has caused adverse effects on the photosynthetic pigments, the pH of the cell sap, metabolism of soluble amino acids and soluble sugars.
2.12 References


