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Variation in vehicular pollutant concentrations on vegetation at Muzaffarnagar, India

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A B S T R A C T

Field study was conducted on vegetation at Muzaffarnagar of Uttar Pradesh. Impact of vehicular pollution on the ambient air quality at six air monitoring sites was selected on vegetation and gaseous and particulate pollutants were recorded for two years (2002-2004). Spatial and temporal variations in concentrations of gaseous and particulate pollutants were observed. Gaseous and particulate pollutants showed significant higher concentrations at D sites situated in the national highway area than A sites situated in the residential area. Gaseous pollutants showed maximum concentrations during summer. In a diurnal cycle gaseous pollutant (SO₂ and NO₂) showed two peaks one between 4.00 to 8.00 am and second between 4.00 to 8.00 pm. Total suspended particulates (TSP) showed peak concentration between 8.00 am to 4.00 pm in a diurnal cycle. Concentrations of toxic metals (Cr, Cd, Ni, Pb, Mn and Zn) were also estimated in settled dust and total suspended particulates. Maximum concentrations of toxic metal were recorded at D sites national highway road. In TSP, Zn showed maximum concentration followed by Mn, Pb, Cr, Ni and Cd the minimum. In settled dust concentration of Cd was more than those of Ni and Cr. Nutrient concentration determined in TSP and settled dust showed that in TSP maximum concentration was recorded for Sulphate-Sulphur whereas in settled dust calcium was present in maximum amount.

Introduction

The atmosphere which makes up the largest fraction of the biosphere is a dynamic system that continuously absorbs a wide range of solids, liquids and gases from both natural and manmade sources. Air pollution is an increasingly important environmental issue in India due to tremendous increase in

size of human population, industrialization, urbanization and increase in the number of vehicles since last few decades. Parallel to the economic transformation the region has also experienced a strong population growth accompanied by concentration of the increasing population in urban areas (Gupta,

2008). Due to increasing population and number of vehicles in urban areas fossil fuel consumption increased from 75 million tonnes per year in 1964 to 245 million tonnes per year in 1990. Consumption of fossil fuels is day by day increasing due to rapid increase in number of vehicles in the urban areas.

The number of vehicles has increased from 1.86 million in 1971 to 53 million in 2000 and is expected to increase further in the coming years. This tremendous increase in the number of vehicles is leading towards more air pollution problems.

Major vehicular air pollutants in India are particulate and gaseous pollutants. Particulate pollutants include total suspended particulates (TSP), metal particles, road dust etc. Gaseous pollutants include sulphur dioxide (SO₂), oxides of nitrogen (NO_x), carbon dioxide (CO₂) etc.(Gupta, 2008).

The Muzaffarnagar city is one of the fastest growing cities (Figure-1) and it is presumed that the population of Muzaffarnagar city may reach up to 2 million by the end of 2003. Vehicular traffic has also increased with higher population density.

The number of vehicles registered at Regional Transport Office, Muzaffarnagar between April 03 March 2004 was 51 Trucks, 54 Buses, 22 Three wheelers and Scooter 1056, Moped 221, Motor cycles 7082 and 28 Trucks, 98 mini buses, 34 Three wheelers and 1809 Scooter, 161 moped 8076 Motor cycles, between April 2004 to February 2005. Roads are ill maintained and narrow; buses and tempos are overcrowded. People use any place as parking or bus stop. Traffic sense is not adequate as people traveling both by personal vehicles or by public transport, follows a short traffic system (Gupta, 2008).

There is tremendous increase in the number of vehicles in the Muzaffarnagar city since last five years, which resulted excessive emission of gaseous and particulate pollutants in the city. Plants growing along major and minor road sides are facing toxic level of gaseous and particulate pollutants, which directly or indirectly effects their growth.

Methodology

The Present study has been conducted in and around Muzaffarnagar district. The district Muzaffarnagar is a part of Meerut division of Uttar Pradesh, India. It is situated at an elevation of 268 meters above mean sea level and at 77⁰, 53'E Longitude and 29⁰, 51'N Latitude in the center of the Doaba region. The Muzaffarnagar is surrounded by the district Meerut and Saharanpur in the South and North side. In the East side river Ganga forms the boundary between district Muzaffarnagar and Bijnor. In the West side river Yamuna separate it from Panipat and Thaneshar Tehsil of the district Karnal of the Haryana State. Climatologically the area is characterized as tropical monsoonal. The year is divisible in to a mild winter (November- February) a hot summer (April-June) and a warm rainy season (July-September).

Air monitoring

Six air monitoring site were selected on vegetation at Muzaffarnagar namely A, B, C, D, E, and F site. Such as Site A is situated in D.A.V. College Campus, Site B State highway, Site C National highway and Site D, E and F minor road site. Air quality data were collected for the year 2002-2004 air sampling were collected for 24 hours every fifteen days at each site and concentration were expressed as µgm⁻³. TSP was majored by using High Volume

Sampler (ENVIROTECH model APM 410, India and KIMOTO, model 121 A, Japan) Located at 2.5 m above the ground level. Settled dust was measured by placing settling jars of known area at different sites at 3m height for known period of time. Dust fall rate was calculated by $\text{gm}^{-2}\text{d}^{-1}$. Air born sulphate and metals in TSP and settled dust were extracted by acid digestion and contents were determined by turbidimetric method given by Rossum and Villaruz (1961) and Atomic Absorption Spectrophotometer (Model-2380, Perkin Elmer, USA). Gaseous pollutants such as SO_2 and NO_2 were scrubbed separately in tetrachloromercurate and NaOH (0.1N) + 1% sodium arsenite, respectively. These observing solution were analyzed colorimetrically for SO_2 (West and Gaeke, 1956) and NO_2 (Merryman *et al.*, 1973) pollutants.

Result and Discussion

Ambient air quality status monitoring on vegetation at Muzaffarnagar indicated significant spatial and temporal variation in concentration of gaseous and particulate pollutant (figure-2) not significant variation for the air quality status between the two years. Highest concentration of SO_2 and NO_2 varied between 14.0, 42.5, 46.0, 23.3, 18.6 and $17.7\mu\text{gm}^{-3}$ respectively A, B, C, D, E and F site during 2002-2003 and NO_2 10.33, 29.61, 36.06, 18.31, 15.34 and 14.04 respectively during same year. However, SO_2 concentrations were significantly lower during rainy season compared to summer season. This shows that vegetation cover in green belt area efficiently removes SO_2 from the atmosphere during favorable growth period (rainy season). The major sources of SO_2 and NO_2 are from blasting, combustion fossil fuels and movement of heavy duty vehicles.

Maximum concentration of SO_2 and NO_2 during winter may be due to frequent temperature inversions especially during height and early morning hours which restrict pollutant concentration at ground level. Low wind velocity during winter months further reduced the dispersion in a wide area. During summer SO_2 and NO_2 concentration were comparatively low due to high wind velocity which disperse and dilute the pollutants. Minimum concentration of gaseous pollutants during rainy season may be attributed to their washing out during frequent rains.

Particulars pollutants (TSP and settled dust) showed maximum concentration during summer and minimum during rainy season (figure- 4 & 5) due to high wind velocity and low relative humidity during summer season which also bring surface soil from bare area and loose dust particles along with particulates generated during vehicles activity and thus increase particulate load. During rainy season frequent rain and remove particulate from the atmosphere. Maximum concentration of pollutant were recorded at site C followed by B, C, E, F and minimum at A control site. High level of pollutant at state highway, road site may be attributed to continuous movement of heavy duty vehicles, traffic combustion of fossil fuels. Site B, C, D, F and A received comparatively less gaseous as well as particulate pollutants an important reason to this may be national highway road site, presence of patches of green belts therefore less affected so minimized the pollutant load at these sites.

In a diurnal cycle both SO_2 , NO_2 showed two peak one between 4 to 8 am and second between 4 to 8 pm during winter (Figure- 2 & 3) this appears to be due to low wind velocity during night and early morning.

Table.1 Average heavy metal concentrations ($\mu\text{g}\cdot\text{g}^{-1}$) in settled dust at different study sites at Muzaffarnagar during 2002-2003 (Mean \pm SE)

Sites	Heavy metal					
	Cd	Ni	Mn	Cr	Pb	Zn
A	7.99 \pm 0.51	8.50 \pm 0.18	56.86 \pm 0.22	7.20 \pm 0.48	8.00 \pm 0.57	122.00 \pm 0.61
B	32.72 \pm 0.07	28.79 \pm 0.53	159.09 \pm 2.58	26.70 \pm 0.11	40.42 \pm 0.47	492.02 \pm 20.36
C	37.07 \pm 1.16	34.27 \pm 2.20	162.00 \pm 2.44	30.32 \pm 0.58	43.10 \pm 0.54	510.08 \pm 30.06
D	22.11 \pm 0.63	24.20 \pm 0.86	119.97 \pm 2.03	21.07 \pm 0.52	33.46 \pm 0.73	451.48 \pm 5.36
E	20.27 \pm 0.08	23.00 \pm 0.10	116.20 \pm 1.22	19.10 \pm 0.05	32.23 \pm 0.03	411.28 \pm 2.38
F	18.20 \pm 0.36	19.13 \pm 0.26	107.61 \pm 0.62	15.03 \pm 0.09	20.00 \pm 1.32	360.70 \pm 11.63

Fig.2 Annual average of So2 and No2 concn (2002-03)

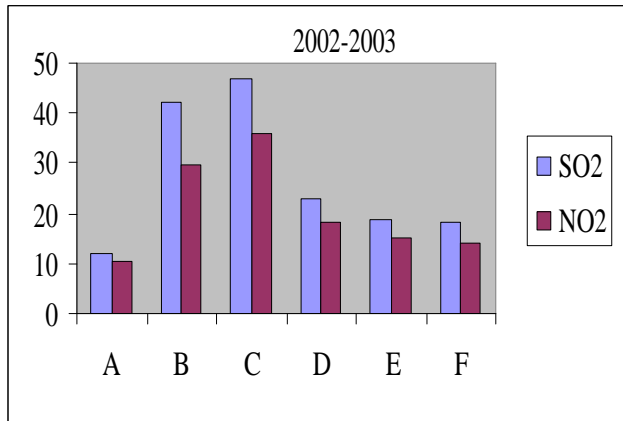


Fig.3 Annual average of So2 and No2 concn (2003-04)

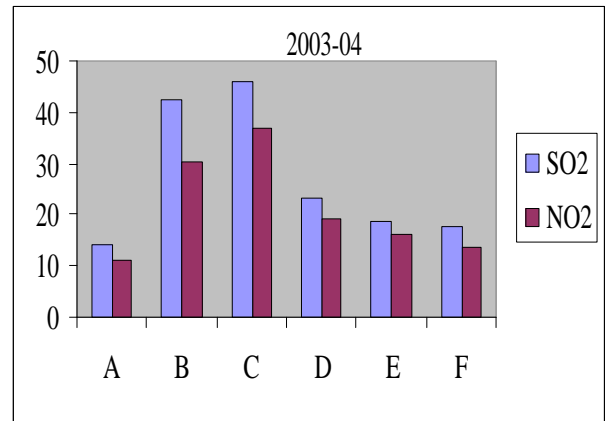


Fig.4 Annual average concentrations of TSP

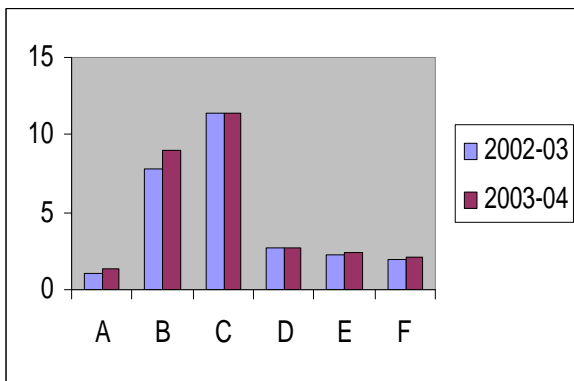
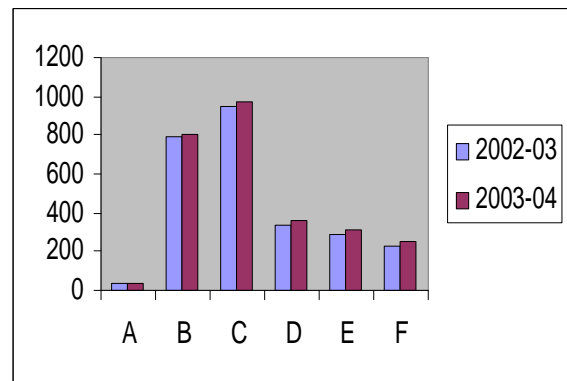


Fig.5 Annual average Dust fall rate



Basin topography also plays a role by restricting the pollutants dispersion over a wider area during calm weather. TSP showed peak concentration between 8 am to 4 pm in a diurnal cycle during fore noon of sunny summer days wind velocity is generally low, Low wind velocity restrict long range transports of particulate pollutant.

All the metals showed maximum concentration at state highway sites C followed by B, D, E, F and minimum at residential A site (figure-1) as heavy metals are the important constituent of the soil dust particles and existing parent rocks, mining operations lead to substantial increase in the amounts of these toxic substance in the environment. The sources of heavy metals in the study area are soil dust also in which the elements such as Mn, Ni Zn etc. are present. Emissions from combustion of fossil fuels. Process add Cr, Mn, Ni, Zn, Cd and Pb in the environment in between state highway and national highway deposition of heavy metals particulate in this area has increased.

In air samples, Zn showed maximum concentration followed by Mn, Pb, Cr, Ni and Cd. The minimum (Figure...) Zn and Mn are the constituent is parent rocks and are commonly present in the soil dust particles. Combustion of oil, fossil fuels also emit these metals in the environment. Pb concentration was quite high in the area because of combusting of leaded gasoline. Extensive road building and use of leaded gasoline have been shown to add enormous amount of lead in the soil and street dust (Culbard *et al.*, 1988, Hewitt and Candy, 1990). Cr, Ni, and Cd concentration were low in comparison to Zn, Mn and Pb in total suspended particulates. This is because these metals have no specific sources in the study area other than emission from combustion of fossil fuels, oils etc.

In settled dust concentration of metals were in the following order $Zn > Mn > Pb > Cd > Ni > Cr$ (Table-1) TSP in settled dust concentration of Cd was more than those of Ni and Cr this is probability due to differences in particle size of these metals. Smaller size particles possess larger surface area per unit weight as compared to the larger size particles. Concentration of Ca, K, Na and SO_4^{2-} -S in the TSP have been found in the following order SO_4^{2-} -S > Ca > Na (Table-1)

However, in settled dust Ca showed more concentration than SO_4^{2-} -S it is well known that ions like sulphate sulphur are directly emitted in the atmosphere. Conversion of SO_2 in the SO_4^{2-} (Dems *et al.*, 1975) and their deposition on fine particulate matter further increases SO_4^{2-} -S concentration in the TSP. High humidity favours the conversion of SO_2 to SO_4^{2-} by oxidation (Durga Prasad *et al.*, 1983, Reiter *et al.*, 1976).

It showed that in the study area concentration of gaseous pollutant are below prescribed standard set by Indian Pollution Control Board, but concentration of particulate pollutants exceeded specially during summer and winter seasons.

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