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Effects of Road Side Pollution on Vegetation – A Mini-Review

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Abstract: Emissions from vehicles possess various pollutants which cause worst form of environmental pollution. Various pollutants of vehicles altered parameters of exposed vegetation. Increase in vehicles pollution may also increase effect of vehicles-emitted pollutants on vegetation. It affects mainly the photosynthetic pigments, respiratory activities, enzymatic activities, uptake of water etc. Present review highlights the impacts of road side pollutants like sulphur dioxide, carbon mono oxide, nitrous oxide, lead compounds and some heavy metals e.g. cadmium, copper, chromium and zinc on aerial parts of plants. Cited literature reveals that the commonly affected plants by road-side traffic pollution are *Azadirachta indica*, *Dalbergia sissoo, Cassia surattensis, Leucaenaleu cocephala* and *Parkinsonia aculeate*s, *Alstonias cholaris, Cassia siamea*, *Allium sativum* etc. in Pakistan. It is concluded that vehicles emission had significant effect on the various parameters of the plants.

Key words: Road side pollution, Vehicles, Environment, Vegetation

Introduction

Environmental contamination is the emission of material or energy into water, land or air that cause disturbance in the environment. Contaminations disrupt the environmental balance or it may alter the food network. Various sources causes environmental pollution like anthropogenic as well as spontaneous sources like volcanic ejection, forest fire, construction of factories, auto exhaust gases, wearing of tires and smelter etc. More than 3,000 substances that are not part of the atmospheric composition, added in the atmosphere can be considered environmental contaminants. Also certain substances that are normally present in certain layers of the atmosphere e.g. ozone in the stratosphere, once arrived in the troposphere is pollutant (Gheorghe et al., 2011). An environmental contamination is an issue of great concern and greatly affect the life of organisms (Fereidoun et al., 2007). Similarly, increase in the contamination reaches to the threat in the big cities of developed countries due to increase in the consumption of fossil fuels in power plants, industries, transportation, mining, construction of buildings, stone quarries etc. Volcanic ejection and forest fire are the spontaneous source of

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environmental contamination (Kromm, 1973). Among the sources of anthropogenic activities causing environmental pollution, vehicular emission is the major source which causing road side traffic pollution. Road side traffic pollution increases day by day due to increase in number of buses, minibuses, car, motorcycle, wagons, rickshaw and trucks. Present review is the first systematic attempt to highlights the overall effects of roadside traffic pollution on nearby exposed plants with special reference to Pakistan.

Vehicle as Source of Environmental Pollution

Natural and anthropogenic activities are the two major sources of environmental pollution. It has been noted hundreds of year ago that these sources harming the environment. Most of the contaminations occur in the form of smoke which is releases from domestic and industrial uses of fossil fuels (Srivastava and Jain, 2007). Similarly, environmental contamination is more significant in the regions of high traffic and industries. Vehicle emits various atmospheric related toxic pollutants. Environmental pollutants due to vehicles exist in the form of liquid, solid and droplets or gases. Road side traffic pollutants like suspended particulate matter, volatile organic compound, oxide of nitrogen (NO) reduce the use of fossil fuel (Respir, 2000).Various heavy metals like copper, zinc, cadmium, chromium and lead releases from vehicle during combustion of fossil fuel, that affect the surrounding atmosphere (Harrison, 1980). Lead is present near the road side in the form of lead sulfate. High level of lead concentration has been observed near the road (Cool, 1980).

Effect of traffic pollution on road side plants

Plant present nearby road sides are always exposed to various pollutants which exhaust from vehicles by burning the fossil fuel. It affect the the growth of photosynthetic pigments in the plants. Various gases such as nitrous oxide (NO), suspended particulate matter and volatile organic compound deposit on the surface of leaves and affect the out put of plants (Bell et al., 1992). These contaminants affect individual plant more as compared to collective plants. Mostly taller plants are the best depositer of the different contminant of the environment (Moonen et al., 1999). Among the released pollutants from vehicles, gases enter to leaves through epicuticle and cuticlar layer and affect the stomatal performance hence disrupt the gaseous exchange process. The gaseous pollutants destroy the epicuticle layer which decrease the action of stomata (Babu, 1993). It has been noted that the gaseous sulphur dioxide (SO_2) released by auto exhaust play a role in the closing of stomata depending on concentation and environmental condition (Chappelka and Smith, 1995). The road side pollutants may also change the morphology, physiology and biochemistry of the sensitive plants. High exposure of the plant to SO_2 causes bleaching of leaves pigment and conversion of chlorophyll *a* to Phacophytin which reduce the plant productivity. High concentration of Nitrogen dioxide (NO_2) damages the leaves, photosynthetic activity and causes chlorosis. Photochemical oxidants inhibit photosynthesis and cause falling of the leaves. Similarly, Ishaq et al. (2012) stated that plants present near to the roads having dry leaves due to stress condition posed by environmental pollution.

Air contaminants released by automobile exhausts affect the internal chemical reaction like metabolisms in plants. Visible symptoms not shown on the plant body directly (Viskari et al., 2000). Big trees and urban forest show positive

relation in cleaning as well as improving of the air quality to the road side environment. Therefore, trees act itself as an obstacle for contaminant release from vehicle. On the other hand these exposed plants affect slowly due to the environmental pollutants and remove from the soil surfaces (Beckett et al., 2000). Traffic pollution influences the chlorophyll and peroxidase reaction of leaves of the plants growing near by the road (Baycu et al., 2006).

Road traffic discharge causes variation in morphology, anatomy and also cause clear injury in different plant near the road side. (Ghouse et al., 1980; Jahan and Iqbal, 1992; Pandey and Agrawal, 1994; Verma et al., 2006; Joshi and Abhishek, 2007). Particulate matter correlates with falling of leaves near the road (Ricks and Williams, 1974; Lerman et al., 1975), might be cause stomatal closer and reduced photosynthetic activity (Williams et al., 1971). Plant leaf is the most sensitive part to be affected by air pollutants as major physiological processes are concentrated in the leaf (Rejini and Janrdhanan, 1989). Plants near road ways have relative increase of Pb deposition due to vehicles using leaded petrol (Bu-Olayan and Thomas 2002).

Table. 1. Effects of traffic pollution on different aspects of plants growing on road side

Plant species	**Source**	**Effect**	**References**
Populus tremula, Betula pendula, Alnus glutinosa, Fraxinus exselsior	Road pollution	Stomata block and reduce diffusion resistance of the leaf	Fluckiger et al., 1993
Rhododendron catabiese,	Road pollution	Increase absorption isolation	Eller et al., 1974
Popular tremula, Betula pendula, Acer campestre, Prunus avium, Quercus spp, Alnus glutinosa	Road pollution	Increase leaf temperature of the leaves	Fluckiger et al., 1993
Aadirachta indica, Ficus religiosa, Ficus benghalensis, Terminalia catapa	Road pollution	Reduce total chlorophyll, protein of leaves	Wagh et al., 2006
Abies alba	Road pollution	Reduce growth by Pb and No of the leaves	Fluckiger et al., 1998
Pongamia pinnata	Road pollution	The length and width of guard and epidermal cells reduced	Rai and Mishra, 2013

Robinia pseudoacacia	Road pollution	Mesophyll cell of leaves effected	Rashidi et al., 2012
Platanus orientalis	Road pollution	Reduce chlorophyll concentration of the leaves	Alaimo et al., 2000 Baycu et al., 2006
Ficu sreligiosa, Polyalthia longifolia, Delonix regia	Road pollution	Reduction in Chlorophyll a and b of the leaves	Chauhan, 2010
Robinio pseudo-acacia	Road pollution	Anatomy of the leaves effected	Çelik et al., 2005
Allium sativum	Road pollution	Reduced shoot growth Cd accumulation	Panda and Choudhury, 2005
Pisum sativum	Road heavy metal pollution	structure of chloroplast, photosystem II of the leaves activity; reduced plant growth	Doncheva et al., 2001
Spinacia oleracea	Traffic pollution	Effect stomata structure	Delbari and. Kulkarni, 2013

Effect of road traffic pollution on plants in Pakistan

The vehicles toxic metals negatively affect the morphology, anatomy and closing of stomata of the leaves (Shafiq and Iqbal, 2005). Automobile exhaust contamination consist of various gases affect not only the human health but also affect the growth of the plants in different ways (Hussain et al., 2013). There is an increase of 37 % in motor vehicle has been reported annually (Ilyas, 2007). It has been observed that 20-90 % cadmium thrown to environment from vehicles which reduce the leaf chlorophyll content (Trividy, 1995). Similarly, the eco-physiological characters of the plant *Azadirachta indica* growing near road side has been found to affect due to stress condition posed by road traffic pollution (Dzomeku and Enu-Kwesi , 2006).

Seed germination is adversely influenced by the pollutant discharge from automobile (Türkan, 1988; Mehmood and Iqbal, 1989). Quantity of metal enhance due to vehicle activity in the surrounding which affect the germination of seed (Abdullah and Iqbal, 1991; Hussain et al., 2013; Alam and Ahmad, 1998; Aksoy and Sahln, 1999; Aksoy et al., 2000; Shafiq and Iqbal, 2007). Seed of road polluted area of *Dalbergia sissoo* represent significant decrease in germination as compare to less polluted area (Mehmood and Iqbal, 1989).

Seed of *Cassia surattensis*, *Leucaenaleuco cephala* and *Parkinsonia aculeate* collected from polluted area show successful decrease in growth as compare to the seeds of the plants of non-polluted area (Siddiqui and Iqbal, 1994). Toxic metals are

Table. 2. Effects of traffic pollution on plants growing on road side in Pakistan

Plant species	Source	Effect	References
Azadirachta indica, Millettiathonningii	Road pollution	Effect physiology , morphology and growth	Dzomeku and Enu-Kwesi., 2006
Dalbergia sissoo	Road pollution	Seed germination	Mehmood and Iqbal, 1989
Leucaenaleuco cephala, Parkinsonia aculeate, Sesbania sesban	Road pollution	Seed growth	Siddiqui and Iqbal, 1994
Vitis vinifera	Road side pollution	Morphology, physiology effected and concentration of chlorophyll reduce	Laghari et al., 2013
Alstonia scholaris	Road pollution	Moisture ,physiology and biochemical characteristic of leaves are effected	Muhammad et al., 2014
Fraxinus americana, Platanus acerifolia	Road pollution	leaf morphology , structure and anatomical features	Shafiq and Iqbal, 2005
Alstonia scholaris	Road pollution	Reduce photosynthetic rate, Reduce transpiration rate, Reduce stomatal conductance	Muhammad et al., 2014
Cassia siamea	Road pollution	Growth and germination of seed reduce	Shafiq and Iqbal, 2007
Calotropis procera, Cenchrus ciliaris, Parthenium hysterophorus	Road pollution	Cd^{+2}, respectively. The photosynthetic rate, transpiration rate, stomatal conductance, internal CO_2 of plants were highly decreased	Nawazish et al., 2012
Prosopis juliflora	Road pollution	Reduction in germination percentage; suppressedgrowth; reduced plantbiomass; decrease in plant protein content	Naveed et al., 2010
Orange, Guava, Epricot, Eucalptus	Road pollution	Chlorophyll a, b and carotenoid reduction	Durrani et al., 2004
Maize (Zea mays)	Road pollution	Reduction in germination percentage; suppressed growth; reduced plant biomass; decrease in plant protein content	Hussain et al., 2013
Oat (Avena sativa)	Road polluted	Inhibition of enzyme activity which affected CO_2 fixation	Khalid et al., 1980
Alstonia scholaris, Pongamia pumata	Road pollution	Reduce leaf size	Shafiq and Iqbal, 2003

required in small quantity for plant germination. Excess concentrations of heavy metals cause reduction in metabolic activities and growth of plants. Toxic metals like cadmium cause closing of stomata, photosynthetic pigment and physiological behavior of the plant (Heckathorn et al., 2004; Kambhampati et al., 2005; Hedaya, 2008). According to Azmat et al. (2009), road traffic pollutants also affect the morphological characteristic of plants like glabrous structure (hairs). Similarly, the leaves of some plant like cauliflower, cabbage, okra, radish, spinach and brinjal are affected due to automobile discharge (Ozturk and Turkan, 1993; Screbo et al., 2002; Aslan et al., 2011). Incomplete combustion of petrol release sulphur dioxide, nitrous oxide, carbon monoxides, lead and suspended particulate matter that affect the plant leaves (Rejini and Janrdhanan, 1989).

Ahmad et al. (2012) stated that among the various aspects of plants, growth and morphological characteristics are effected highly when exposed to automobile released heavy metals. Cadmium show toxicity for root and shoot growth when their concentration exceeds 5 mg/L. Contamination near the road side is increasing in Quetta due to rapid increase in automobile use which strongly affect morphology and physiological aspects of plants such as *Vitis vinifera* (Laghari et al., 2013). Road pollution affect leaves of the plant (Steubing and Fangmeier, 1989). Contamination absorbed by leaves cause reduction in chlorophyll contents which results in reduced plants productivity. Leaf surface is affected due to different trace element and gaseous discharge of automobile. Therefore road side plants are main receiver of all discharge pollutant and consequently can be effected directly by leaves. In Pakistan, due to low life standard people mostly using vehicles that have been considered expired/non-functional in developed countries. These types of automobiles frequently produce smoke that contain toxic compound which ultimately effect the growth of road side vegetation.

Recommendations

It is recommended that there is a need of a proper monitoring system and to strengthen the laws of environmental protection in Pakistan to ensure the reduction of roadside pollution that affect the animals, plants but also the human population.

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