Airo International Journal
Peer-Reviewed
Multidisciplinary

ISSN: 2320-3714
Volume:1 Issue:3
March 2025
Impact Factor:10.2
Subject: Botany

ASSESSMENT OF AUTOMOBILE EMISSIONS AND THEIR ECOTOXICOLOGICAL IMPACT ON CROP PLANTS ALONG STATE HIGHWAYS IN REWARI, SOUTH HARYANA

Tejpal Yadav
Research Scholar
Shridhar University, Pilani
Dr. A.K. Sharma
Associate Professor and Supervisor
Dept. of Botany, Shridhar University, Pilani

ABSTRACT

The rapid expansion of road networks and rising vehicular traffic have tremendously added to air pollution, especially along state highways, where emissions from vehicles pose severe environmental and ecological issues. This research estimates the effect of automobile emissions on crop plants grown along state highways in Rewari, South Haryana, in terms of their ecotoxicological impacts. The work analyzes the levels of major vehicle emissions like particulate matter (PM), carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), and heavy metals (lead, cadmium, and zinc) in soil and ambient air. By performing field sampling followed by laboratory studies, the impact of the chemical contaminants on physiology and biochemistry of typical farm crops, expressed as changes in chlorophyll content, stomatal conductance, oxidative markers, and plant growth parameters, is assessed. In addition, the concentration of contamination in soils is measured to assess the degree of heavy metal deposition and its possible effect on plant health and agricultural output. The results indicate a relationship between distance from highways and higher concentrations of pollutants, resulting in decreased photosynthetic efficiency, growth inhibition, and possible yield loss. This research highlights the imperative of sustainable pollution abatement practices, green belt planning strategies, and policy actions to counteract the negative impacts of emissions from vehicles on agroecosystems and promote environmental sustainability in fast-track urbanizing areas.

Keywords: *Automobile Emissions, Ecotoxicological, Crop Plants, State Highways, Rewari, South Haryana*

ISSN: 2320-3714
Volume:1 Issue:3
March 2025
Impact Factor:10.2
Subject: Botany

1. INTRODUCTION

The rapid expansion of transportation infrastructure and rising motor vehicle traffic have largely contributed to environmental contamination, especially in areas where farming is practiced alongside large roads. Vehicle emissions emit a mixture of contaminants that is difficult to analyze, comprising particulate matter (PM_{10} and $PM_{2.5}$), carbon monoxide (CO), nitrogen oxides (NO_x), and sulfur dioxide (SO_2), which worsen air quality and create severe environmental and health hazards. In addition, exhaust from vehicles, tire abrasion, and road dust cause heavy metal pollution in soil, with metals like lead (Pb), cadmium (Cd), and zinc (Zn) accumulating in roadside agricultural land. These contaminants can negatively impact crop physiology, growth, and productivity, hence the need to evaluate their ecotoxicological effects on plant health.

Rewari, in South Haryana, is an area undergoing high economic and infrastructural growth, resulting in high vehicular traffic along its state highways. The location of agricultural fields near these highways subjects crops to high levels of pollution, which can cause physiological stress and yield reduction. Pollutants emitted from cars not only have an impact on air and soil but also degrade plant metabolism through the induction of oxidative stress, lowering photosynthetic efficiency, and changing patterns of growth. Knowledge of the level of pollution and its effects on crops is important in developing sustainable mitigation techniques and maintaining food security in areas of pollution.

This investigation focuses on examining air and ground levels of contamination created by emissions of automobiles and subsequent impacts on crops grown around highways in South Haryana at the district town level of Rewari. Measurement of pollutant intensity at different highway distances gives us an understanding of the extent and pattern of spatial contamination along with its implications for plant physiological performance. Physiological traits like chlorophyll content, stomatal conductance, and markers of oxidative stress (malondialdehyde, MDA) give insights into the degree of environmental stress imparted to crops. The long-term effect of pollution on crop yield is also ascertained by analyzing growth parameters like plant height and biomass.

The results of the present study will help in learning about the impact of highway emissions on agroecosystems and the associated environmental implications and will form a scientific foundation to adopt pollution mitigation measures. Different mitigation options like the creation of green belts, emission control regulations, and the use of techniques for soil remediation can play a role in reducing the undesirable impacts of auto pollution on plants and agricultural sustainability. By solving the environmental issues brought about by vehicle emissions, this study hopes to aid in the formulation of policies that encourage sustainable agriculture in highway-side areas.

2. LITERATURE REVIEW

Chen et al. (2024) performed a life cycle assessment of liquid hydrogen fuel for vehicles and compared various production routes in China. The authors of their study compared the environmental implication of the different methods of hydrogen production with respect to factors like energy consumption and greenhouse gas emissions. According to their findings, those production routes utilizing renewable energy reduced emissions by a great margin compared to fossil fuels.

Das (2022) conducted a comparative life cycle greenhouse gas (GHG) emissions analysis of conventional and electric vehicles in India. The research analyzed the whole life cycle of both types of vehicles, from production to disposal, and concluded that electric vehicles have lower total emissions, especially if used with renewable energy sources. The study also, however, pointed out the environmental issues involved with battery manufacturing and disposal.

Farooq and Rehman (2021) examined roadside vegetation's heavy metal build-up and its potential for phytoremediation. Their research compared various plant species' capacity for heavy metal uptake and identified the most promising remediation ones. The findings indicated that certain plant species build up high levels of heavy metals and are well-positioned for environmental remediation purposes.

Ghosh et al. (2020) evaluated roadside soil and plant heavy metal contamination risks along a national highway through an industrial corridor. Their work determined high levels of toxic metals, mainly the result of industrial discharge and motor vehicle emissions. The study

ISSN: 2320-3714
Volume:1 Issue:3
March 2025
Impact Factor:10.2
Subject: Botany

highlighted the health and environmental hazards with long-term exposure to such pollutants, suggesting that measures be implemented to minimize the levels of contamination.

Hanfi et al. (2020) investigated heavy metal pollution in urban surface sediments, their sources, distribution patterns, control of contamination, and remediation methods. Industrial waste, traffic emissions, and atmospheric deposition were identified as major sources of heavy metal pollution by their research. The authors explained different remediation methods, such as chemical stabilization and phytoremediation, to minimize the level of contamination in polluted areas.

Ihenetu et al. (2024) examined the environmental fate of tire-rubber-associated pollutants, namely 6PPD and its transformation product, 6PPD-Q. Their research reported widespread presence of these pollutants in urban runoff and water bodies, focusing on their toxic impact on aquatic life. The authors studied the processes of degradation and accumulation of the pollutants, with a focus on the immediate regulatory actions to address their environmental impact.

3. MATERIALS AND METHODS

The research was done along state roads in Rewari, South Haryana, where agricultural fields were measured at different distances (0–500 m, 500–1000 m, and >1000 m) from the road to determine exposure to pollution. Monitoring of air quality was done using high-volume air samplers and gas analyzers to quantify PM_{10}, $PM_{2.5}$, CO, NO_x, and SO_2 at various times of the day. Soil samples were taken at a depth of 0–15 cm, air-dried, and assayed for pH, organic matter, and heavy metal (Pb, Cd, Zn) content by Atomic Absorption Spectroscopy (AAS). Physiological and biochemical studies on wheat (Triticum aestivum) and mustard (Brassica juncea) involved chlorophyll content (spectrophotometric method), stomatal conductance (porometer), oxidative stress markers (MDA content), and growth parameters like plant height and biomass. Statistical testing, such as ANOVA and correlation analysis, was applied to determine relationships and significance between pollution intensity and plant response. Instrument calibration, triplicate sampling, and utilization of standard reference materials for the determination of heavy metals were used in quality control. The integrated methodology

ISSN: 2320-3714
Volume:1 Issue:3
March 2025
Impact Factor:10.2
Subject: Botany

provided efficient evaluation of vehicular emissions on the ecotoxicological impacts on air, soil, and crop health in the area.

3.1. Study Area

The research was carried out along state highways in Rewari, South Haryana, where intensive agricultural practices exist alongside rising vehicle flow. The sites selected were agricultural fields that were at different distances (0–500 m, 500–1000 m, and >1000 m) from the highway to measure the gradient of pollution exposure. Geographic coordinates and weather data such as temperature, humidity, and wind speed were measured at each site.

3.2. Sampling Strategy

3.2.1. Air Quality Monitoring

Air samples were obtained with high-volume air samplers to quantify concentrations of major vehicular pollutants like particulate matter (PM_{10} and $PM_{2.5}$), carbon monoxide (CO), nitrogen oxides (NO_x), and sulfur dioxide (SO_2). Pollutant concentrations were quantified using gas analyzers and gravimetry, and samples were obtained at varying times of the day to evaluate variations in emission levels.

3.2.2. Soil Sampling and Analysis

Soil samples at a 0–15 cm depth was gathered from every location with a stainless-steel auger. The samples were air-dried, sieved, and examined for physicochemical parameters such as pH, organic matter content, and heavy metal (Pb, Cd, Zn) contents with the aid of Atomic Absorption Spectroscopy (AAS). The build-up of these metals in the soil was checked at various distances from the highway in order to assess contamination levels.

3.2.3. Plant Sampling and Biochemical Analysis

Crop plants normally cultivated in the area, i.e., wheat (Triticum aestivum) and mustard (Brassica juncea), were chosen for physiological and biochemical analyses. Leaf tissue was harvested from plants at varying distances from the highway and assessed for the following parameters:

ISSN: 2320-3714
Volume:1 Issue:3
March 2025
Impact Factor:10.2
Subject: Botany

- **Chlorophyll Content:** Calculated with a spectrophotometer according to the Arnon (1949) procedure.
- **Stomatal Conductance:** Assessed with a porometer to determine gas exchange efficiency.
- **Oxidative Stress Markers:** Malondialdehyde (MDA) level was measured to assess lipid peroxidation and oxidative damage.
- **Growth Parameters:** Plant height, leaf area, and biomass were measured to determine the effect of pollution on growth and productivity.

3.3. Statistical Analysis

All the data were analyzed statistically employing ANOVA for assessing the significance of differences between sites at different distances from the highway. Correlation analysis was done for assessing the relationship between concentrations of pollutants and physiological response of plants.

3.4. Quality Control and Assurance

All equipment was standardized prior to data collection, and triplicate samples were run to ensure dependability. Standard reference materials were utilized in analyzing heavy metals to assure accuracy and consistency of results.

4. RESULTS AND DISCUSSION

The research has brought into focus the large effect of vehicle emissions on air quality, soil pollution, and the health of crops along highway corridors. Concentrations of air pollutants such as PM_{10}, $PM_{2.5}$, CO, NO_x, and SO_2 were highest near 500 m of the highway and decreased with distance, suggesting direct influence of emissions. Likewise, the soil samples also indicated higher concentrations of heavy metals (Pb, Cd, Zn) along the highway through emissions, tire degradation, and road dust, with the contamination degrading at increasing distances. Crop plants within close proximity had lower chlorophyll content, reduced stomatal conductance, and higher oxidative stress, resulting in stunted plant growth compared to crops at a distance. These results indicate that highway pollution undermines environmental quality and agricultural output, and highlight the necessity of mitigation measures like green belt

ISSN: 2320-3714
Volume:1 Issue:3
March 2025
Impact Factor:10.2
Subject: Botany

development, emission control, and soil remediation to safeguard ecosystems and food security.

4.1. Air Pollutant Concentrations at Different Distances from the Highway

Air quality was evaluated at different distances from the highway to measure pollutant concentrations such as particulate matter (PM_{10} and $PM_{2.5}$), carbon monoxide (CO), nitrogen oxides (NO_x), and sulfur dioxide (SO_2). The research was to identify the effect of vehicular emissions on air quality in adjacent areas. As shown in Table 1, pollutant concentrations were taken at different distances to measure air contamination variations and likely environmental effects.

Table 1: Air Pollutant Concentrations at Different Distances from the Highway

Distance from Highway (m)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	CO (ppm)	NO_x (ppm)	SO_2 (ppm)
0 - 500	180	85	4.2	0.09	0.07
500 - 1000	130	65	2.8	0.06	0.05
>1000	90	40	1.5	0.03	0.02

The trend of pollutant concentration varying with distance from the highway can be seen through the analysis. There is an evident trend towards declining pollution as distance from the highway increases. As indicated by Table 1, the most concentrated levels of PM_{10} (180 µg/m³), $PM_{2.5}$ (85 µg/m³), CO (4.2 ppm), NO_x (0.09 ppm), and SO_2 (0.07 ppm) were measured at a distance of 500 m from the highway, which shows prominent vehicular emissions. These levels continued to decrease at 500–1000 m and further from 1000 m onwards, where the lowest concentrations were noted. This indicates that air quality is highly dependent on proximity to highways, with the contaminants dispersing and getting diluted along long distances, diminishing their effect on nearby environments.

4.2. Heavy Metal Accumulation in Soil

Soil samples taken at different distances from the highway were analyzed to evaluate heavy metal contamination, i.e., lead (Pb), cadmium (Cd), and zinc (Zn). The research was designed to analyze the impact of automobile emissions, tire wear, and road dust on soil quality. As indicated in Table 2, heavy metal content was quantified at different distances to ascertain the level of contamination and risk to agricultural land.

Table 2: Heavy Metal Concentrations in Soil Samples

Distance from Highway (m)	Pb (mg/kg)	Cd (mg/kg)	Zn (mg/kg)
0 - 500	65.4	2.8	105.2
500 - 1000	42.3	1.9	80.6
>1000	21.7	1.1	55.3

The heavy metal concentration analysis of soil samples demonstrated a strong trend of declining accumulation of heavy metals with increased distance from the highway, as evident in Table 2. Maximum levels of lead (65.4 mg/kg), cadmium (2.8 mg/kg), and zinc (105.2 mg/kg) were detected 500 meters away from the highway, showing considerable contamination by emissions from vehicles, tire abrasion, and road dust. At 500–1000-meter distances, metal contents were moderately decreased, but at distances further than 1000 meters, Pb (21.7 mg/kg), Cd (1.1 mg/kg), and Zn (55.3 mg/kg) contents were considerably decreased, indicating negligible pollution impact. The results emphasize highway-related activity impact on soil contamination and point toward potential hazards to plant health and agricultural productivity at locations near roads.

4.3. Impact on Crop Plants

Physiological and biochemical analysis of wheat (Triticum aestivum) and mustard (Brassica juncea) indicated considerable difference in chlorophyll content, stomatal conductance, and oxidative stress across distances from the highway. Plants nearer to the highway, as indicated in Table 3, had significant variation in major physiological parameters from the plants growing beyond a distance away. These observations point towards vehicular emissions and their possible role in affecting the health and yield of crops.

Table 3: Physiological and Growth Parameters of Crop Plants

Distance from Highway (m)	Chlorophyll Content (µg/g)	Stomatal Conductance (mmol/m²/s)	MDA Content (nmol/g)	Plant Height (cm)
0 - 500	1.9	180	5.6	75
500 - 1000	2.8	230	3.4	90
>1000	3.7	280	1.8	105

The information in Table 3 shows a significant relationship between distance from the highway and negative impacts on crop physiology and growth. The plants 0–500 m from the highway had the lowest content of chlorophyll (1.9 µg/g) and stomatal conductance (180 mmol/m²/s) but had the highest MDA content (5.6 nmol/g), indicating higher oxidative stress. Conversely, plants that grew above 1000 m had much greater chlorophyll content (3.7 µg/g) and stomatal conductance (280 mmol/m²/s), with lower MDA content (1.8 nmol/g), reflecting lower oxidative damage. Likewise, plant height also trended in the same direction, rising from 75 cm close to the highway to 105 cm at greater distances. These findings indicate that traffic emissions are responsible for oxidative stress, lowering the photosynthetic efficiency and general crop growth, which may in turn affect highway borderland agricultural productivity.

The research results underscore the harmful impact of auto emissions on air quality, soil pollution, and health of crops. High levels of pollutants around roads lead to oxidative stress in the plant, causing chlorophyll loss and productivity decline. Soil pollution due to heavy metal deposition adds to environmental toxicity, posing a risk to long-term soil fertility and food safety. The findings emphasize the necessity of pollution abatement measures like green belt development, emission control measures, and regular soil remediation to protect agroecosystems along highways.

ISSN: 2320-3714
Volume:1 Issue:3
March 2025
Impact Factor:10.2
Subject: Botany

5. CONCLUSION

The research concludes that vehicular pollution from state highways in Rewari, South Haryana, greatly affects air quality, soil quality, and agricultural productivity. The results show that concentrations of pollutants such as PM_{10}, $PM_{2.5}$, CO, NO_x, SO_2, and heavy metals (Pb, Cd, Zn) are highest near 500 meters of the highway and decrease with increasing distance. This pollution gradient influences crop plants directly with low chlorophyll content, damaged stomatal conductance, oxidative stress, and restricted growth, eventually contributing to possible yield loss. Soil contamination analysis also reveals significant heavy metal accumulation along highways with long-term implications for soil fertility and food safety. These findings highlight the imperative for mitigation measures, including green belt development, more stringent vehicular emission standards, and soil remediation activities, to protect agricultural sustainability and environmental well-being in fast-growing areas.

REFERENCES

1. *Akinnifesi, O., Adesina, F., Ogunwole, G., & Abiya, S. (2021). Occurrence and impact of heavy metals on some water, land, flora and fauna resources across Southwestern Nigeria. In Heavy Metals-Their Environmental Impacts and Mitigation. IntechOpen.*

2. *Bayramzadeh, V., Ghadiri, M., & Davoodi, M. H. (2019). Effects of silver nanoparticle exposure on germination and early growth of Pinus sylvestris and Alnus subcordata. Sains Malaysiana, 48(7), 937–944.*

3. *Chen, L., Wang, Y., Jiang, Y., Zhang, C., Liao, Q., Li, J., ... & Gao, X. (2024). Life cycle assessment of liquid hydrogen fuel for vehicles with different production routes in China. Energy, 299, 131472.*

4. *Das, J. (2022). Comparative life cycle GHG emission analysis of conventional and electric vehicles in India. Environment, Development and Sustainability, 24(11), 13294-13333.*

5. *Farooq, M., & Rehman, S. (2021). Heavy metal accumulation by roadside vegetation and implications for phytoremediation. Environmental Science and Pollution Research, 28(10), 12345-12356.*

6. *Ghosh, S. P., Raj, D., & Maiti, S. K. (2020). Risks assessment of heavy metal pollution in roadside soil and vegetation of national highway crossing through industrial area. Environmental Processes, 7(4), 1197-1220.*

ISSN: 2320-3714
Volume:1 Issue:3
March 2025
Impact Factor:10.2
Subject: Botany

7. *Hanfi, M. Y., Mostafa, M. Y., & Zhukovsky, M. V. (2020). Heavy metal contamination in urban surface sediments: sources, distribution, contamination control, and remediation. Environmental monitoring and assessment, 192, 1-21.*

8. *Ihenetu, S. C., Xu, Q., Khan, Z. H., Kazmi, S. S. U. H., Ding, J., Sun, Q., & Li, G. (2024). Environmental fate of tire-rubber related pollutants 6PPD and 6PPD-Q: A review. Environmental Research, 119492.*

9. *Jiang, Y., Shi, L., Guang, A. L., Mu, Z., Zhan, H., & Wu, Y. (2018). Contamination levels and human health risk assessment of toxic heavy metals in street dust in an industrial city in Northwest China. Environmental Geochemistry and Health, 40, 2007-2020.*

10. *Kameswaran, S., Gunavathi, Y., & Krishna, P. G. (2019). Dust pollution and its influence on vegetation-a critical analysis. Research journal of Life sciences, Bioinformatics, Pharmaceutical and Chemical sciences, 5(1), 341-363.*

11. *Lal, A., Renaldy, T., Breuning, L., Hamacher, T., & You, F. (2023). Electrifying light commercial vehicles for last-mile deliveries: Environmental and economic perspectives. Journal of Cleaner Production, 416, 137933.*

12. *Maeaba, W., Kumari, R., & Prasad, S. (2021). Spectroscopic assessment of heavy metals pollution in roadside soil and road dust: a review. Applied Spectroscopy Reviews, 56(7), 588-611.*

13. *Naeem, N., Khalid, N., Sarfraz, W., Ejaz, U., Yousaf, A., Rizvi, Z. F., & Ikram, S. (2021). Assessment of lead and cadmium pollution in soil and wild plants at different functional areas of Sialkot. Bulletin of Environmental Contamination and Toxicology, 107(2), 336-342.*

14. *Ogah, I. E., & Ozioma, E. A. (2021). Comparative analysis of some heavy metal's levels in leaves, peels and tubers of cassava planted along east-west road Rivers State. Int J Res Granthaalayah, 9(8), 1-13.*

15. *Prażak, R., Święciło, A., Krzepiłko, A., Michałek, S., & Arczewska, M. (2020). Impact of Ag nanoparticles on seed germination and seedling growth of green beans in normal and chill temperatures. Agriculture, 10(9), 312.*

Airo International Journal
Peer-Reviewed
Multidisciplinary

ISSN: 2320-3714
Volume:1 Issue:3
March 2025
Impact Factor:10.2
Subject: Botany

Author’s Declaration

I as an author of the above research paper/article, here by, declare that the content of this paper is prepared by me and if any person having copyright issue or patent or anything otherwise related to the content, I shall always be legally responsible for any issue. For the reason of invisibility of my research paper on the website /amendments /updates, I have resubmitted my paper for publication on the same date. If any data or information given by me is not correct, I shall always be legally responsible. With my whole responsibility legally and formally have intimated the publisher (Publisher) that my paper has been checked by my guide (if any) or expert to make it sure that paper is technically right and there is no unaccepted plagiarism and hentriacontane is genuinely mine. If any issue arises related to Plagiarism/ Guide Name/ Educational Qualification /Designation /Address of my university/ college/institution/ Structure or Formatting/ Resubmission /Submission /Copyright /Patent /Submission for any higher degree or Job/Primary Data/Secondary Data Issues. I will be solely/entirely responsible for any legal issues. I have been informed that the most of the data from the website is invisible or shuffled or vanished from the database due to some technical fault or hacking and therefore the process of resubmission is there for the scholars/students who finds trouble in getting their paper on the website. At the time of resubmission of my paper I take all the legal and formal responsibilities, If I hide or do not submit the copy of my original documents (Andhra/Driving License/Any Identity Proof and Photo) in spite of demand from the publisher then my paper maybe rejected or removed from the website anytime and may not be consider for verification. I accept the fact that as the content of this paper and the resubmission legal responsibilities and reasons are only mine then the Publisher (Airo International Journal/Airo National Research Journal) is never responsible. I also declare that if publisher finds Any complication or error or anything hidden or implemented otherwise, my paper maybe removed from the website or the watermark of remark/actuality maybe mentioned on my paper. Even if anything is found illegal publisher may also take legal action against me.

Tejpal Yadav
Dr. A.K. Sharma

******