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# Assessment of Physical and Biochemical Qualities of *Solanum tuberosum* L. under Roadside Traffic Polluted Area

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**Abstract**

*Solanum tuberosum* L. is an important crop that yields high-quality of vegetables. anthropogenic activities are increasing traffic and road air pollution day by day. The impact of traffic road air pollution on agricultural vegetation was examined in this study work because traffic air pollution has become a life-threatening problem. We selected sites with and without traffic roads (control) in order to compare crop samples. The values of the photosynthetic pigments decreased (chlorophyll 'a', 5.43 > 4.00; chlorophyll 'b', 8.91 > 8.26; and carotenoid, 5.62 > 4.26), and growth also decreased (thickness: 8.4 > 5.6; length: 23.4 > 13.1; and weight: 7.16 > 5.19) that we observed in our record are also statistically significant. Air quality was determined to be low, photosynthetic pigment quality was lowered, and crop vegetation growing near busy roads had stunted development. These were the outcomes of excessive quantities of dangerous gaseous components found at a traffic road site. Physical and biochemical quality results also showed variation in traffic road and control sites grown crop vegetation.

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## Introduction

Transport pollutants (burn or quell emissions) include organic and inorganic substances produced as gases or nanoparticles, and they are the main cause of pollution on the planet.[1] Growth of crops and loss in photosynthetic pigment, as well as chlorosis and scarring on leaves and stems, are all observed at the traffic road site. These are the findings of noxious gases that were discovered at various phases at the location of the traffic route. The quality and quantity of photosynthetic pigments in the crop's plants growing beside traffic roads are reduced.

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Crop vegetation on traffic roads and control sites differs, according to physiological and biochemical findings.[2]

To evaluate the traffic-related air pollution of plants frequently grown in subtropical climates, the investigation was carried out in 2017–2018. To find out how much air pollution from plants there is, research was conducted. Numerous plants were chosen for this investigation, along with ones that contained a range of biochemical indicators, including total chlorophyll concentration.[3] High levels of air pollution from vehicles are present in the surroundings and nearby roadways. In metropolitan areas close to roadways, vegetation is frequently used to reduce air pollution; yet, depending on the situation, vegetation may also have detrimental impacts on air quality. For this investigation, field measurements were conducted to ascertain the impact of roadside vegetation on air quality. Three common types of street vegetation were investigated for concentrations of size-resolved particles and black carbon (dense vegetation, porous vegetation, and clearance). The dense vegetation on the sidewalk and bikeway created an area where particle pollutants accumulated, which is why there was an increase in the amount of pollutants deposited.[4] Apart from its important role in the transportation of individuals and possessions, public transport is without question one of the key foundations of each world's social and economic growth. It can, nevertheless, be considered an effective component in worsening environmental effects due to contaminant formation.[5] The effects of traffic air pollution in Urmia, Iran, due to differences in traffic congestion at intersections and distance from their centers were explored, which also looked at the physiological and biochemical features of Cupressus arizonica L. and *Pinus nigra* L. All crossroads were divided into three categories based on their levels of traffic congestion using data from the Urmia traffic and transport organization, and three intersections from each category were randomly selected. The seeds/cones of C. *arizonica* L. and P. *nigra* L., both of which are routinely sown along the boulevards leading to these crossroads, were gathered at 0, 20, 40, 60, 80, and 100 m from the intersection center.[6] In Himachal Pradesh, India, the BBN industrial area, at National Highway 21-A (Baddi), Baddi-Barotiwala Link Road, Kalka-Charnia Link Road, and 200 meters away from the road the Kalka-Charnia Link Road (Control), was studied for the impact of auto-exhaust emission levels on the physiological parameters of crops growing along the roadside. According to the present study, the physiological quality of the crops was reduced; traffic air pollution was more in the road site crops and less in control sites.[7] The most hazardous class of inorganic chemical pollutants and road vehicle emissions, heavy metals have the greatest effect on the biosphere. Unlike organic pollutants, heavy metals can also degrade through chemical or biological processes and tend to accumulate in the environment and in living things.[8] Air pollution has shown to be one of the largest and most complex environmental concerns. The biotic and abiotic system of an environment is balanced by plants, making them the most important species. Plants are the main, fixed users of air pollution. Several different plant species were taken into consideration from the Noida sector, highly traffic road air polluted roadside. Physical and biochemical quality results also showed variation in many places.[9]

Heavy metal toxins produced in the environment by automotive traffic are dispersed by a variety of methods including dusty, moist, and drying airborne testimony, air transport, and adsorbed suspension particles in roadside surroundings. In general, the concentration of these components along the roadside is influenced by traffic conditions, road traffic, and external factors. Vehicle exhaust emissions contribute to pollution, which has negative effects on plants and other forms of life. This study was conducted along two main highways in Punjab, Pakistan (Pindi Bhattian to Lillah and Faisalabad to Sargodha) to determine the impact of vehicle exhaust pollutants on the growth of *Parthenium hysterophorus* L. at various places along these routes for control, samples were also obtained at a distance of 100 meters from the other place. Biochemical and physiological parameters show huge disturbance. Chlorophyll a, Chlo. b, total chlorophyll and carotenoid levels were all shown to be significantly lower in P. *hysterophorus.* Pigment loss was also seen leading to diminished photosynthetic pigments.[10] Different species of plants, mostly taller plants, are now taken into consideration for monitoring environmental toxins due to their widespread distribution in most habitats, simplicity of detection, and availability of samples. As a consequence, various parts of herb and woody vegetation can be utilized as passive bioindicators.[11] Roadside crops are constantly revealed to transport emission levels and receive highly variable quantities of heavy metals, based on the surroundings in which they are found and their physical properties.[5] Traffic pollution is a serious challenge and one of the most severe ecological challenges in towns, pathogenic to death in flora and fauna. Global effects on air quality include increased emissions of greenhouse gases, climate change, global warming, and air pollution.[6] Roadside vegetation is important in reducing the impact caused by pollutants emitted from various causes, therefore, as a consequence, in improving human health. Also, roadside vegetation usually improves the environment, enhances the aesthetic, and regulates the surface.[12] Contaminations including the level of exposure to traffic pollutants have dramatically increased over the last decade, especially in developing countries such as India.[13,14] Traffic pollutants may harm biochemical parameters, leading to a decrease in the general development and growth of plants. The impact of air pollution from traffic on crop vegetation is examined in this research report. For the comparative analysis of crop samples, we have selected sites near traffic roads and those farther away from them (controls).

The record objective is to determine the physical and biochemical quality of *Solanum tuberosum* L., under traffic road and non-traffic road sites (control).

## Materials and Methods

### Study Area

In the northwest of Uttar Pradesh is the city of Hapur. The humid climate of Hapur, which covers latitude 28.730579 to longitude 77.775879, is impacted by the monsoon and features cold seasons and sweltering summers.[15]

### Collection of Plant Sample

A traffic road and non-traffic road sites are chosen for crop sampling near Morepur on NH-235; the control site is 1000 meters away. In this experiment, *Solanum tuberosum* L., a crop plant, is utilized. The crop sample had been verified and taxonomically recognized by the Department of Botany at the C.C.S. University in Meerut, Uttar Pradesh, India; Bot/PB/261 is the number of the authenticated and taxonomically identified sample.

### Air Quality Index at the Sampling Site

Total air quality, temperature, humidity, CO, NO, $NO_2$, $SO_2$, $O_3$, and UV concentrations are measured at the sample sites using the Aeroqual Series 500 (S500) gas monitoring equipment (Hapur district, NH-235). For many months, the ambient air quality at each site is recorded from 7 a.m. to 3 p.m.

### Growth Rate

Including sites, the collected crop parts are examined for morphological characteristics thickness, length, and weight.[16]

### Biochemical Analysis

### Estimation of Chlorophyll and Carotenoid Contents

The sample collected from the polluted and control site is subjected to the measurement of chlorophyll and carotenoid content by using the spectrophotometric method. 100 mg of leaf samples are crushed for 15 minutes in a mortar and pestle with 10 ml of an 80% acetone solution. In the different test tubes, the homogenate plant sample was taken and at 5000 rpm it was centrifugated. After that, the supernatant was pipetted into a cuvette with the help of a micropipette and it was then subjected to the different wavelengths (663, 645, and 470 nm) to check the absorption spectra with the help of a UV-visible spectrophotometer. The content is calculated using the formula below.

- Chl a(mg $g^{-1}$FW) = [12.7 (OD 663) -2.69 (OD 645)] x V/1000 xW
- Chl b(mg $g^{-1}$FW) = [22.9 (OD 645) -4.68 (OD 663)] x V/1000 x/W
- Total Chl a+b(mg $g^{-1}$FW) = [20.2 (OD 645) -8.02 (OD 663)] x V/1000 xW
- Carotenoids (µg $g^{-1}$FW) = [(00470) + 11.4 (00663) - 6.38 (00645)] x V/1000 xW

Here, the letters V and W stand for the sample extract's volume and weight, respectively.[17]

### Statistical Analysis

An analysis of variance (ANOVA) with two factors is carried out on the plant samples. According to the established approach, the least significant difference is determined at the values of 0.01, 0.02, and 0.04.[18]

## Results

### Analysis of Air Quality at the Sampling Sites

The concentrations of CO, NO, $NO_2$, $SO_2$, $O_3$, and UV at the major traffic road and control sites respectively, are shown in Figs. 1 and 2. It is found that the air quality concentrations on the traffic road are higher than those at the control sites. There is a statistically significant difference between the means of the overall air quality index values (159.1<269.2) at the control and traffic road sites.

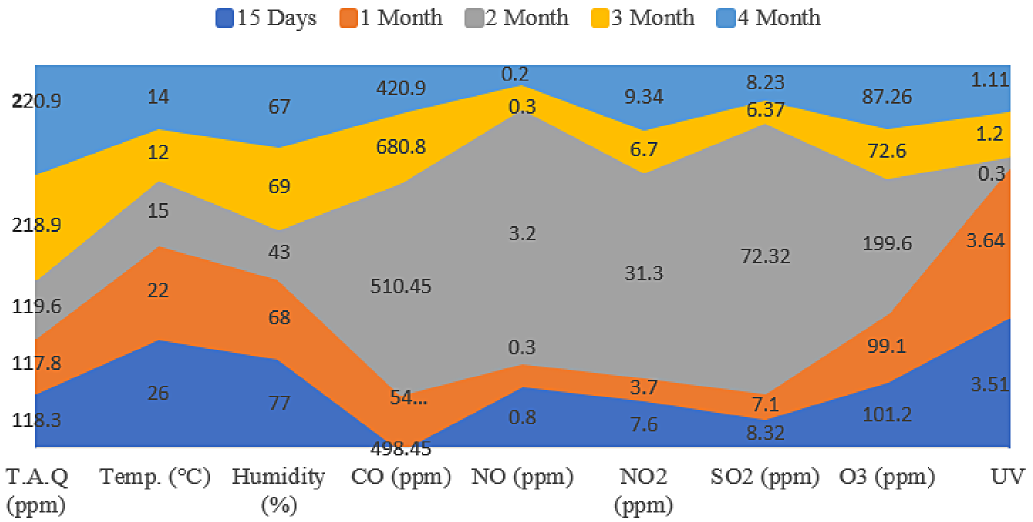



**Fig. 1: The control site has various gas concentrations.**

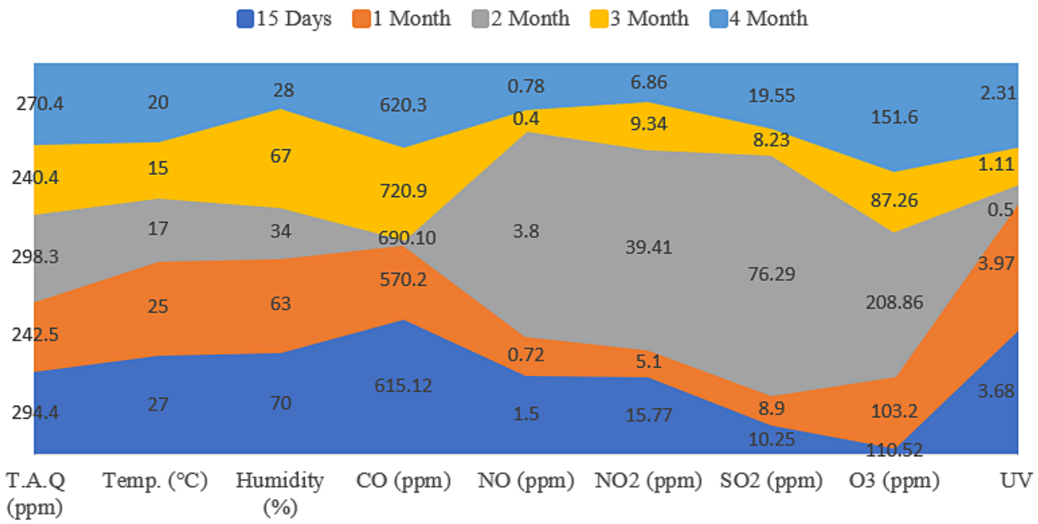
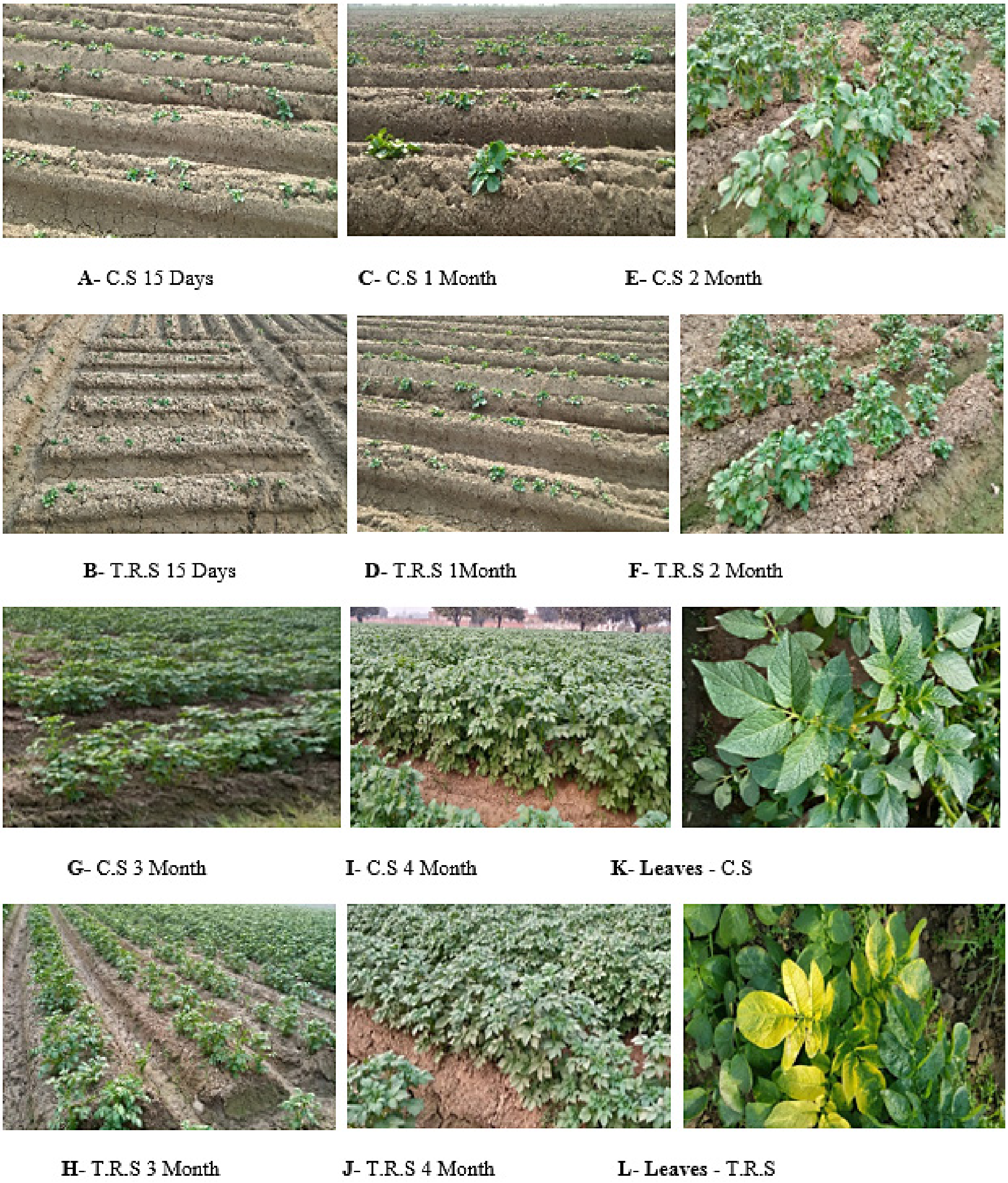



**Fig. 2: The traffic road site has various gas concentrations.**

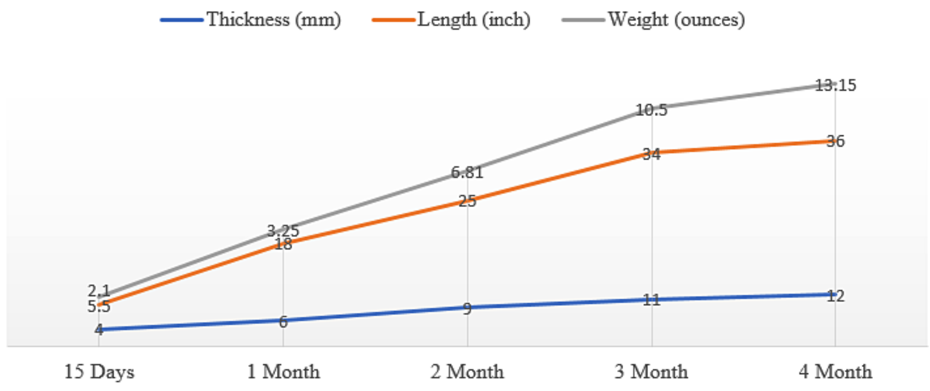
### Growth Terms

As shown in Figs. 3, 4, 5, and A to J, we observed that the growth terms (thickness, length, and weight) are lower in the crop growing near the road (Fig. B, D, F, H, J, and L) and higher in the control sites (Fig. A, C, E, G, I, and K) throughout the observation. As shown in figures K and L, the control did not show chlorosis and scarring on the leaves, while similar conditions were present on the traffic road sites. Showing a statistical difference in the mean values of the growth parameters (thickness: 8.4 > 5.6, length: 23.4 > 13.1, and weight: 7.16 > 5.19) between the control and traffic road sites. The control and traffic road site data are statistically significant (P<0.05).




**C.S – Control Site**
**T.R.S – Traffic Road Site**

**Fig. 3: The crop grows at intervals in the traffic road and Control sites.**




Significant at: P=0.04 (P<0.05 is considered significant).

**Fig. 4: The different weight, length, and thickness measurements at the control site**

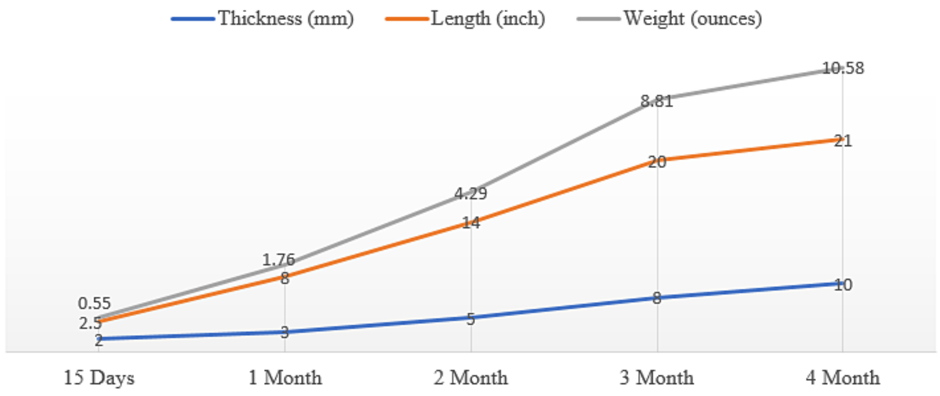
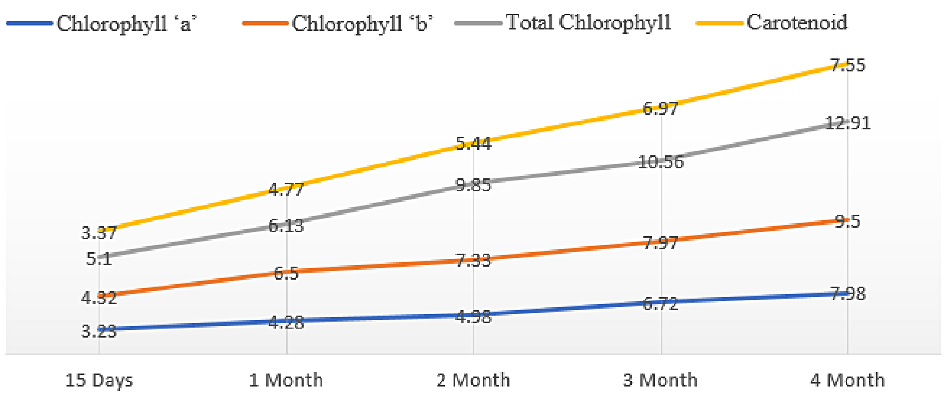



**Fig. 5: The different weight, length, and thickness measurements at the site of the traffic road**

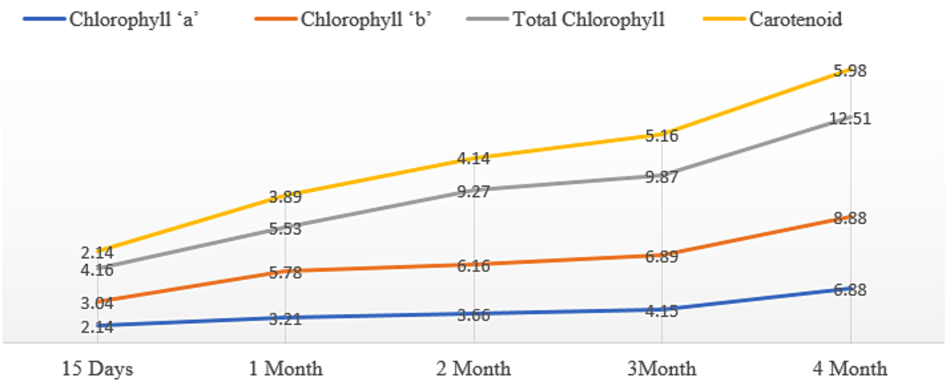



Significant at: P= 0.01 (P<0.05 is considered significant).

**Fig. 6: The calculated photosynthetic pigment value for the control site**

## Pigments

Figures 6 and 7 demonstrate that during the observation period, the concentration of traffic road air pollution gases in the traffic road is higher than that at the control locations, leading to a greater flow of air quality. There is a statistically significant difference between the two sites, as shown by the lower values of chlorophyll 'a', chlorophyll 'b', total chlorophyll, and carotenoid in the crop growing next to the road and higher values in the control sites (chlorophyll 'a', 5.43 in control and 4.00 in roadside, chlorophyll 'b', 8.91 in control and 8.26 in roadside, and carotenoid, 5.62 in control and 4.26 in roadside). The control and traffic road site data are statistically significant (P<0.05).




Significant at: P= 0.02 (P<0.05 is considered significant).

**Fig. 7: The calculated photosynthetic pigment value for the traffic road site**

## Discussion

In comparison to the control, the traffic road sites had higher concentrations of CO, NO, $NO_2$, $SO_2$, $O_3$, and UV. According to this research record, traffic air pollution has become life-threatening. We observed major changes in S. *tuberosum* L. growth and photosynthetic pigments quality as a result of higher concentrations of these transportation pollutants. Crop vegetation quality is shown to have decreased considerably.

Show that, throughout the entire report, we demonstrated the difference between the crop growing alongside the traffic road and the control sites in terms of growth terms (thickness, length, and weight). It is established that the leaves on the traffic road had chlorosis, scars, and poor colour quality, but the control locations do not. Demonstrating that the growth terms values (thickness: 41.00 > 35.66, length: 50.6 > 42.02, and weight: 44.49 > 36.01) between the control and traffic road sites differed statistically. The findings from the traffic road locations and the control sites are statistically significant P<0.05. Every aspect of the study showed that in comparison to the control and traffic road location concentration of air pollution gases is higher, and as a result, the flow of air quality is higher. We observed that there is a statistically significant difference in the levels of the photosynthetic pigments chlorophyll 'a', chlorophyll 'b', total chlorophyll, and carotenoid between the crop growing alongside the traffic road and the control sites (chlorophyll 'a' 5.84 > 5.56, chlorophyll 'b' 5.90 > 4.79, total chlorophyll 11.28 > 9.93 and carotenoid 4.47 > 3.14). Data from the traffic road sites and the control site are statistically significant P<0.05.[2] Recently more attention has been focused on global environmental problems.[19] Some researchers have examined the biochemical parameters of the leaf of *Triticum aestivum* L. crop collected from a polluted site. Throughout the entire growing season, the chlorophyll 'a' concentration of crop leaf samples taken from the polluted location is consistently lower than that of those taken from the control site.[20]

In January, February, and March, the reduction was 20.31, 12.26, and 15.20%, respectively. Similar to this, for January, February, and March, the chlorophyll 'b' concentration in leaf samples of crops from polluted locations was 18.71, 16.11, and 18.80% less than that of samples from the control site. The leaf samples taken from the polluted site usually have less total chlorophyll, and in January, February, and March, respectively, the drop in total chlorophyll content is 19.64, 13.95, and 16.60%. Carotenoid serves as an accessory pigment in crops and is crucial to the photosynthesis process. Comparing leaf samples from the control site to those from the polluted site, carotenoid concentrations was higher in the control site during January, February, and March by 15.45, 14.89, and 16.67%, respectively. There are some harmful contaminants present that get accumulate in the shoot system and cause a decrease in photosynthetic pigments.[21] All of the photosynthetic pigments in C. *procera* L. were negatively impacted by vehicle pollution throughout the investigation. Chlorophyll levels in *Eucalyptus citriodora* L. and *Mangifera indica* L. have previously been found to be declining.[15] To ascertain how much chlorophyll and carotenoid a plant contains, measurements of these substances are crucial. Due to its fundamental function in plant metabolism, a decrease in chlorophyll concentration has a direct impact on the growth of plants.[22] The crop was kept under various climatic conditions, changes in the way plants grew could be related to atmospheric contaminants.[23] When compared to the control and polluted locations, the length of the stem of *Triticum aestivum* L. increased statistically in 30 days, 60 days, and 90 days, the values in the report were 33. 50±0.92**<37.00±0.89, 69.90±0.91***<73.80±1.10, and 86.20±0.42****<90.60±0.49. Due to greater SO2, NO2, SPM, and RSPM concentrations at polluted sites. Lengths of mung and palak decreased in urban environments with varied levels of air pollution stress.[24] The analysis of growth over a gradient of ambient air pollution, and plant growth in and around London during the middle of the 1980s was significantly influenced by air pollutants.[25] The growth phases of crops are the most vulnerable. Road air pollution and traffic can have a direct impact on crops.[26] However, because crops are a component of the food chain, they may endanger both people and animals by supplying tainted food. In major cities throughout the world, automotive activities have raised the concentrations of heavy metals and other pollutants such as CO, VOC, NOx, PM, $CO_2$, $CH_4$, and $N_2O$, which harm crops.[21] The growth of *Thespesia populnea* L. in terms of length, thickness, and weight decreased with rising pollution concentrations.[27] Ganatsas and colleagues observed significant variations in crop physiological behaviour when they examined the effects of traffic-related air pollution on the qualitative traits of *Pinus brutia* L. Pollutants from vehicle emissions inhibited the growth of roadside plants, which had shorter shoots, internodes, and overall linear growth.[28]

(**/***/**** denotes highly significant observation).

## Conclusion

The findings of this research work demonstrated that traffic road site crop vegetation has higher concentrations of CO, NO, $NO_2$, $SO_2$, $O_3$, and UV. Traffic air pollution has become life-threatening. From this research record, we identified major changes in S. *tuberosum* L. growth and photosynthetic pigment quality as a result of elevated amounts of these transportation pollutants. Crop vegetation quality is shown to have significantly decreased. This should serve as a warning to humans to reduce traffic and air pollution from vehicles and conserve agriculture for their survival.

## Future Perspectives

This location also has a record of quantitative data and information. Such data would be useful for analyzing the impact of emissions of gases on a variety of crops. This may aid in assessing the environmental risk of traffic air pollution. Traffic-related air pollution affects roadside crops. To reduce traffic air pollution, automobiles should be utilized in fewer numbers, electric vehicles should be used, and crops should be grown further away from traffic roads. Because the quality of the crops will be good and economic value safe for the farmers.

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**Conflict of Interest**
The authors do not have any conflict of interest.

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