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Assessment of Growth Rate and Photosynthetic Pigments of *Saccharum officinarum* L. Plantlet under Polluted Area

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ABSTRACT: *Saccharum officinarum* L. is a valuable crop that produced high content sugar molecules. As we see, traffic and air pollution increased day by day due to anthropogenic activities. In this research record, the effect of traffic air pollution on crop vegetation was investigated. We have chosen traffic road and non-traffic road (control) sites for the comparative study of crop samples. At the traffic road site loss of growth and photosynthetic pigments in the crop, and chlorosis and scars are found on leaves and stems. These are the effect of obnoxious gaseous factors which had been found in multiplied stages within the traffic road site. We observed in our findings, growth terms values (thickness: 41.00-35.66, length: 50.6-42.02 and weight: 44.49-36.01), the photosynthetic pigments values (chlorophyll 'a' 5.84-5.56, chlorophyll 'b' 5.90-4.79, total chlorophyll 11.28-9.93 and carotenoid 4.47-3.14) there was a statistically significant mean difference between control and traffic road sites. Crop vegetation growing in traffic road sites showed reduced growth, and photosynthetic pigments quality and air quality is found to be poor. This study portrays a clear view of the unfavourable results of traffic air pollutants on crop vegetation. Physiological and biochemical results quality show variation in crop vegetation on traffic roads and control sites.

Keywords: *Saccharum officinarum* L., Photosynthetic pigments, Obnoxious, Pollution.

INTRODUCTION

One of the most significant environmental problems in urban areas is air pollution. It results in different types of diseases and reduced the life expectancy of organisms and increases the rate of early mortality in humans, animals, and plants. International repercussions of air pollution include increasing greenhouse gas emissions, global warming, acid rain, and altered weather patterns are some of the effects (Aliyar *et al*., 2020). Automobiles were expanded in tandem with population growth, as was pollution caused by automotive emissions. The first victims of these automobile emissions are roadside plants and roadway greenery. This review provides a quick overview of how automobile emissions might harm plants. On the contrary, the positive perspective of how roadside plants may be able to affect and influence the negative consequences of traffic pollution was also considered. Ways for plants to become potential biomonitors of air pollution were proposed. A major worry was expressed about the nanocarbon particle element of vehicular emissions and their interactions with roadside plants, particularly roadside crops. The importance of developing mitigation strategies to find long-term solutions to these growing challenges has been emphasized (Muthu *et al*., 2021). Traffic air pollution is a major environmental risk to public health. It was proposed that reduziering levels of air pollution may result in a reduction in the global disease burden. Vehicle pollutants influenced the properties of exposed vegetation. Increased automobile pollution may also harm vegetation. It primarily influences photosynthetic pigments and growth components. This review focused on studies on the dust interception capacity of plants, physiological changes in plants in response to air pollution load, elemental distribution in different environmental samples, and the effects of urban dust particulates on plant growth (Swami, 2018). Roadside tree vegetation is essential for decreasing the impacts of air pollutants released from many sources and, as a result, is significant for enhancing human fitness. Roadside tree vegetation also frequently exhibits environmental development (Piscitelli *et al.*, 2019). Modern society's urbanization and growing motor vehicle traffic congestion have caused a significant increase in pollution (Janta and Chantara 2017). The gaseous emissions from road traffic and other trace components that settle on leaf surfaces both affect leaf surfaces. As a result, vegetation beside the road acts as the main receiver and reservoir for all vehicle emissions. Extremely dangerous heavy metal automobile pollution modifies morphological and developmental characteristics (Ahmad *et al.*, 2017). Automobiles contribute 60 to 70% of air pollution by emitting dangerous pollutants such as CO, HC, NO, microparticles, carbon nanomaterials, and organic volatile substances into the atmosphere. Vehicle ageing, subpar performance and poor maintenance increase these emissions. This is made worse by congested areas, narrow roads, frequent traffic jams, bad geometry, and poor design, which have an impact on both the environment and human health. Emissions from two- and three-wheelers are roughly double that of all other sources combined. Researchers estimate that each year, urban air pollution causes 800,000 fatalities (Santra, 2016). It is simple to combine many gases with top-notch air pollution particles. Even in small amounts, the accumulation of heavy metals in the environment has a significant negative impact on both human and ecosystem health (Gajbhiye *et al*., 2016). The global increase in air pollution poses a major threat to the functionality, structure, and variety of natural and semi-natural ecosystems (Darbah *et al*., 2008). The morphology, physiology, and biochemistry of leaves are among the many changes that plants exhibit in polluted areas. As bio-monitors for heavy metal contamination, plant leaves have significant ecological relevance. Through the adsorption of particulate matter and the removal of many gases, in metropolitan cities or other urban areas, trees help to filter the air (Dzierzanowski *et al.*, 2011).

The objective of the study was to find out the assessment of the physiological and biochemical quality of *Saccharum officinarum* L. under traffic road and non-traffic road sites (control).

MATERIAL AND METHOD

A. Study area

The district Hapur (Panchsheel Nagar) is situated in the northwest of Uttar Pradesh. From latitude 28.730579 to longitude 77.775879, the humid subtropical climate of Hapur is monsoon-influenced, with cold winters and extremely scorching summers (Joshi and Swami, 2007).

B. Collection of plant sample

Sites were chosen for crop sampling near Brajnathpur on NH-235; the traffic road site was where the control site was 1000 meters away. In this study, *Saccharum officinarum* L. was one of the crop species used. The crop sample was taxonomically identified and authenticated by the Department of Botany, C.C.S. University, Meerut, Uttar Pradesh, in India. The taxonomically identified and authenticated sample was number Bot/PB/260.

C. Monitoring of air quality at the sampling locations

The Aeroqual Series 500 (S500) gases detection equipment was used to measure the samples sites, CO, NO, NO_2, SO_2, O_3, temperature, humidity, total air quality, and UV concentrations. Traffic road and control site's air quality were observed for several months between the hours of 7 a.m. and 3 p.m.

D. Growth rate

Physiological investigation was the collection of crop parts from sites, with characteristics such as thickness, length, and weight (Blackman, 1919).

E. Biochemical Analysis

(i) Estimation of Chlorophyll and Carotenoid Contents. The measurement of the carotenoid and chlorophyll content was done using the spectrophotometric technique. 100 mg of leaf samples were homogenized for 15 minutes in a mortar and pestle with 10 ml of an 80% acetone solution. The homogenate was transferred to a test tube, where it was centrifuged at 5000 rpm for 10 minutes. The supernatant was transferred to a cuvette using a pipette, and absorbance readings at wavelengths of 663 nm, 645 nm, and 470 nm were taken using a 2600 UV-Visible spectrophotometer (Arnon., 1949). The following calculation was used to determine the content.

$$Chl_a\ (mg\ g^{-1}FW) = [12.7\ (OD\ 663) - 2.69\ (OD\ 645)] \times V/1000 \times W$$

$$Chl_b\ (mg\ g^{-1}FW) = [22.9\ (OD\ 645) - 4.68\ (OD\ 663)] \times V/1000 \times W$$

$$Total\ Chl_{a+b}\ (mg\ g^{-1}FW) = [20.2\ (OD\ 645) - 8.02\ (OD\ 663)] \times V/1000 \times W$$

$$Carotenoids\ (\mu g\ g^{-1}\ FW) = [(OD470) + 11.4\ (OD663) - 6.38\ (OD645)] \times V/1000 \times W$$

Here, the letters V and W stand for the sample extract's volume and weight, respectively (Zahoor *et al.*, 2017).

F. Statistical Analysis

An analysis of variance (ANOVA) with two factors was carried out on the plant samples. According to the established approach of Gomez and Gomez (1984), the least significant difference was determined at the values of 0.01, 0.02, and 0.03.

RESULTS

A. Air quality analysis at the sampling sites

Fig. 1 and 2, show the lowest and highest amounts of CO, NO, NO_2, SO_2, O_3, and UV for the major traffic road and the control sites, respectively. It was observed that the traffic road air quality concentrations were greater than those at the control sites. The difference between the means of the total air quality index values (131.28-276.12) at the control and traffic road sites was statistically significant.

B. Growth Terms

Fig. 3, 4 and 5, A to J, show that all across the observation period, we showed that the growth terms (thickness, length and weight) were found to be lower in the crop growing along the traffic road and greater in the control sites. In fig. K and L, it is shown that chlorosis, scars, and colour quality were seen on the leaves and stem on the traffic road and these activities were not seen on the control sites. Indicating that there was a statistical mean difference between 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. The control and traffic road site data were statistically significant ($P<0.05$).

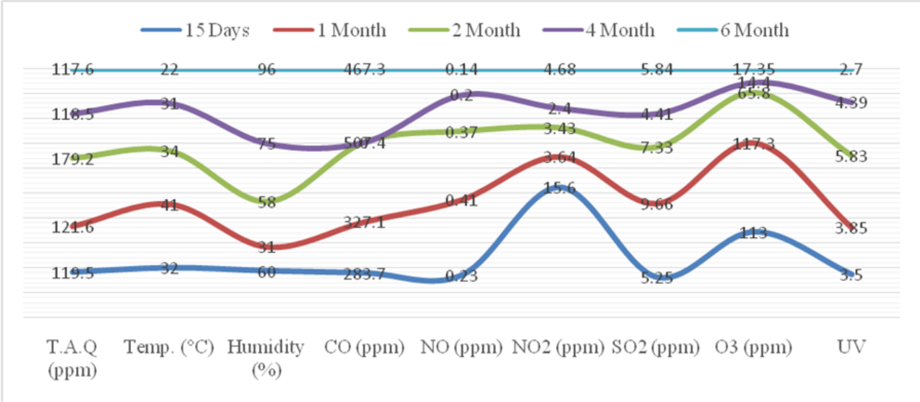


Fig. 1. Different gas concentrations in the Control site.

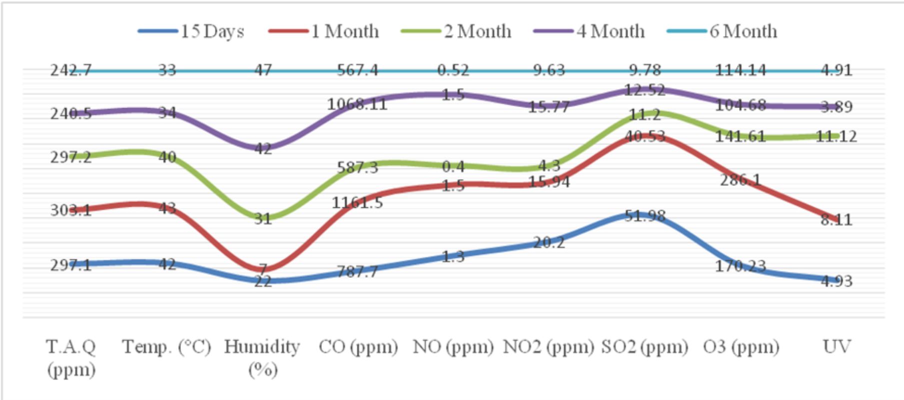
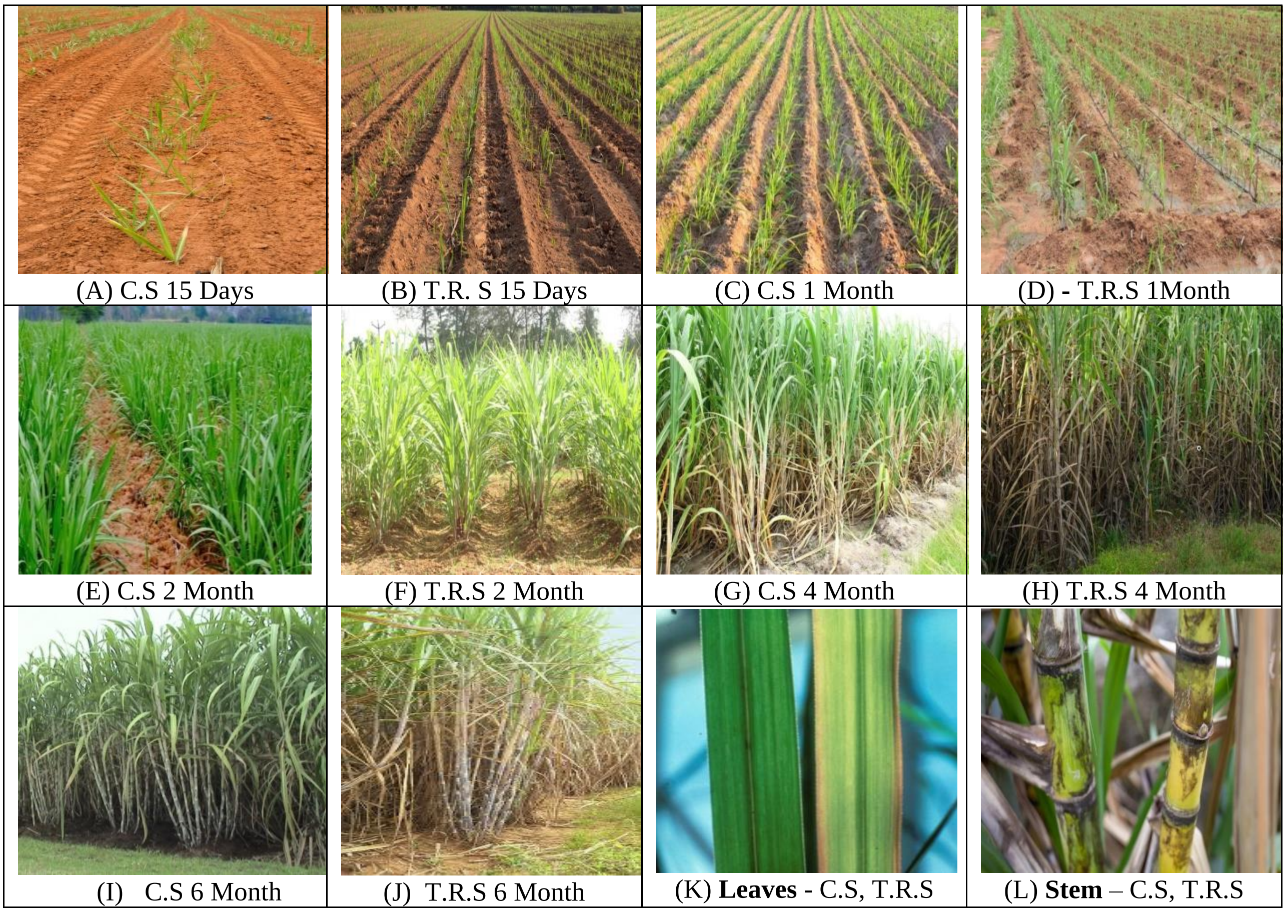
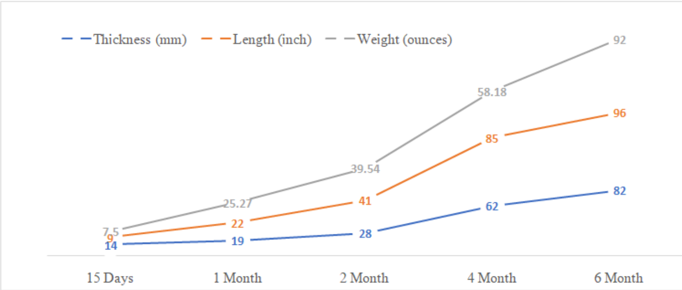


Fig. 2. Different gas concentrations in the traffic road site.



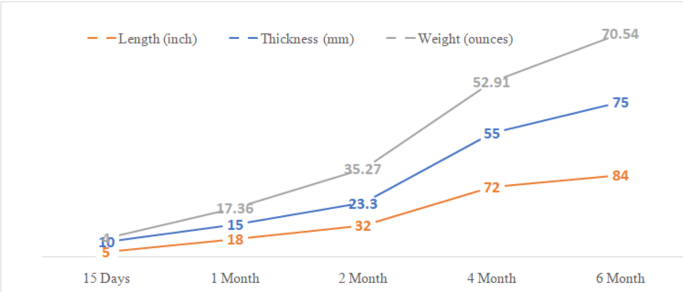
C.S – Control Site; T.R.S – Traffic Road Site

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



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

Fig. 4. The various terms for value (thickness, length and weight) in the Control site.

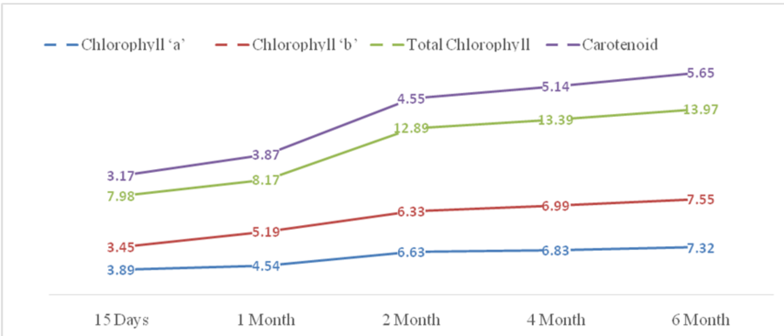


Significant at: P=0.01(P<0.05 is considered significant).

Fig. 5. The various terms for value (thickness, length and weight) in the traffic road site.

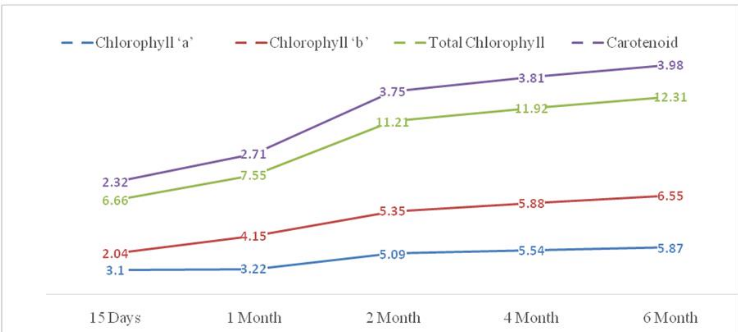
C. Pigments

Fig. 6 and 7, The entire observation period showed that the concentration of traffic road air pollution gases at the traffic road was higher than that at the control sites and as a response, the flow of air quality was greater. We observed in our findings, there was a statistically significant difference in the values of the photosynthetic pigment's chlorophyll 'a', chlorophyll 'b', total chlorophyll, and carotenoid between the crop growing along 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) on the traffic road and the control sites. The control and traffic road site data were statistically significant (P<0.05).



Significant at: P= 0.03(P<0.05 is considered significant).

Fig. 6. The calculated photosynthetic pigment value in the Control site.



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

Fig. 7. The calculated photosynthetic pigment value in the traffic road site.

DISCUSSION

Air quality in particular sample locations in comparison to the control, the traffic road sites had 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. officinarum* L. growth and photosynthetic pigments quality as a result of elevated amounts of these transportation pollutants. Crop vegetation quality was shown to have significantly decreased. According to Saxena *et al.* (2012), one of the major sources of emissions in urban areas is traffic flow. As a consequence, the traffic road may have had higher levels of vehicular pollution in the air than the control sites. *Ficus religiosa* showed the greatest decrease in chlorophyll 'a' content of the samples taken from contaminated areas compared to control sites (43.36%), whereas *Mangifera indica* showed the least (26.57%). The drop in chlorophyll 'a', 'b', and total chlorophyll levels of *F. religiosa*, *M. indica*, *Polyalthia longifolia*, and *Delonix regia* was significant at the 0.001% level, according to a two-way ANOVA Chauhan and Joshi (2008). Observed that the concentrations of chlorophylls 'a' and 'b', total chlorophyll, and carotenoid were always lower at polluted sites compared to control sites. The lowest decreases in carotenoid concentration were found in *M. indica* (18.47%), and the highest decreases were seen in *P. longifolia* (30.99%). Chlorophyll is shielded by carotenoids from oxidative damage (Siefermann-Harms, 1987). It was discovered that various crop plants' carotenoid concentrations decreased in response to CO, NO, NO_2 and SO_2 (Pandey, 1978; Singh and Rao 1983; Nandi, 1984). The carotenoid content of several plants growing in contaminated areas has also been significantly reduced, according to Joshi and Swami (2007). The growth characteristics of rice after exposure to traffic air pollution in many gasses have been assessed (Saheed and Ikhajiagbe 2020). According to Urriago-Ospina *et al.* (2021), the physiochemical constraints are not well adapted to the growth and development of plants. This is particularly true as a result of traffic pollution. However, their analysis concluded that restrictions on traffic pollution had shown to be effective and reported the growth of economic plants (Sadak, 2019). The growth patterns that we observed are consistent with the findings of Hao *et al.* (2016); Thuesombat *et al.* (2014) where it was said that exposure to road pollution does not promote shoot growth.

When compared to non-roadside air pollution plants *V. vinifera* roadside air pollution had a substantial impact on the growth of *V. vinifera* Reduced plant growth and total chlorophyll levels in *V. vinifera*. Revealed that the losses were mainly due to the roadside dust, which contained a variety of potentially dangerous substances. The findings obtained closely match those stated by Prajapati (2012). In a report, Leghari and Zaidi (2013) observed that traffic gases significantly reduced the amount of chlorophyll and growth in plants. In comparison to the control site, the road site's traffic has a significant adverse effect on the growth of the roadside plants in various ways, which were the subjects of similar reports. Fewer roadside crops may be growing now, which will lead to polluted plants. According to Rai and Kulshreshtha (2006), a similar outcome was obtained. Pollutants from vehicle emissions inhibited the growth of roadside plants in terms of length, thickness, and weight (Tiwari *et al.*, 2006).

CONCLUSIONS

The findings of this research work demonstrated that traffic air pollution caused by various forms of automobile traffic congestion has an adverse effect. Traffic air pollution has become life-threatening, from this research record, it was found that some gases (CO, NO, NO_2, SO_2, O_3, and UV) harm crops and air quality is found to be poor. Showing the impact of the under-traffic road air pollution on growth qualities and photosynthetic pigments along with changes in the of *S. officinarum* L., as we know, traffic air pollution is responsible for the growth qualities and photosynthetic pigments of crops.

FUTURE SCOPE

There is also a record of quantitative data and information in this area. Such information would be useful in identifying the precise impact of plant emissions as well as analyzing the impact of emissions on diverse plants. This may help in evaluating the risk of pollution to the environment. Air pollution from traffic harms roadside crops. To avoid this traffic air pollution, vehicles should be used in less quantity and electric vehicles should be used and crops should be cultivated on more distance than traffic road.

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Conflict of Interest. None.

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