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USE OF BIOCHEMICAL TECHNIQUES TO DETERMINE POLLUTANTS IN ROADSIDE CEREAL PLANTS

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Abstract

Vehicular Pollution is one of the major culprits in environmental degradation. With rapid urbanization and industrialization of the country, indiscriminate fall out of exhaust sources have ensured suffering of plant life sustaining system. There has been long established use of "green belt" i.e. plants in preventing pollution thereby protecting urban environment from industrial pollution. Since plants are the initial acceptors of pollutants, effects of many air borne particulates from the atmosphere on them cannot be underestimated. This paper assesses the relative sensitivity of four cereal plants: Wheat, Rice, Maize and Oat that are socio economically important plants. The survey is carried out at one of the busiest polluted road of district Saharanpur of Western Uttar Pradesh in India. The samples of four cereal plants of family poaceae were collected from the road side i.e. (20 meter distance away from road side equal to experimental and also away from road side i.e. 200 meter distance away from road side equal tocontrol) at three different stages of growth viz. vegetative stage, flowering stage and at yield stage growing under ambient conditions at the selected sites. For each analysis few individual plants of similar age group having equal height were selected at each site and then dried. Thereafter, various parts were individually mixed, dried and powdered. This powered material was used for analysis of nitrogen and phosphorous content affecting the plants.

Keywords: Exhaust sources, green belt, plant life sustaining system, relative sensitivity, poaceae.

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I. INTRODUCTION

The emerging priority of speed and comfort in modern world is of a great concern to resulting air and soil pollution. Pollution is generally defined as undesirable change in the environment. A number of human activities contribute to the emission of particulates in the atmosphere; however emission from motor vehicle is prime. The major source of air pollution in most town and cities is exhaust released from automobiles. Carbon monoxide (CO) is the most abundant atmospheric pollutant in the troposphere with levels of atmospheric CO being highest during winter season. Road traffic is by and large is source of manmade CO emission.

Daily CO concentration in urban area rises and falls with traffic density and changes in weather conditions. Generally, levels are maximum during morning and evening rush hours. Suspended particulate matter (SPM) is a coaglomerate of chemically heterogeneous substances. The SPM values attain the maximum limit during summer. It has been long recognized that smoke in the air of towns adds an adverse effect on plant biochemistry, by reducing light intensity and hours of bright sun shine per day. Dust and grit also affects plant food synthesis due to reduced light intensity. Thus, automobile exhaust affects plant performances [1].

In addition to automobile exhausts various industrial emissions also increase health threats. The hazardous elements released by vehicles such as gaseous fumes of carbon monoxide, sulphur dioxide, oxides of nitrogen and lead oxides result a huge damage to human health, vegetation, flora and fauna. The heavy metals like nickel, arsenic, cadmium and titanium also propose serious health effects for mankind. The effluent discharge from industrial wastes to land and water resources generate serious soil and water pollution in many parts of the country.

The toxic chemicals, particularly the heavy metals which are disposed in the water bodies though industrial waste and effluent pose long term risk to human health and to the life of other animals. Arsenic causes death of fishes and cattle [2]. Common air pollutant are affecting vegetation includes ozone and PAN (byproducts of automobile exhaust). Thus, all this result is auto-exhaust pollution.

The health of man is being jeopardized in an outreach to achieve modern development. This progress is achieved by the development of social and economic infrastructure concerning agriculture, transportation and industry. The unlimited exploitation of available and existing natural resource to win the mad race of development is largely dependent on automation. The environment is a life sustaining system consisting of both living and non-living entities (e.g. air, water, soil, biota) many of which interact with each other, the environmental pollution caused by man's activities degrades these entities and make them extinct.

The unlimited exploitation of natural resources has unbalanced the ecological balance between living and non-living components of the biosphere. This unfavorable condition is created by man himself. As a result not only human survival is threatened but also of flora and fauna. As concerning this fact it is highlighted that the number of species likely to become rare, threatened, endangered or near extinction are largely increasing with time. The data sheets of same are available in the Red Data Book of the IUCN [2].

II. LITERATURE REVIEW

The automobile fleet of the country emits over 1.8 million tones of air pollutants of which more than 80% are released in the cities [3]. Automobile include two-wheelers, cars, trucks and buses etc. The air pollution through auto exhausts, unburnt hydrocarbons, oxides of carbon, nitrogen and lead, heavy metals, cadmium and titanium salts etc. has profound influence on flora and fauna. The response of plants to pollution is non adaptive and is largely dependent on the genotype, age, stage of growth, proximity and concentration of individual relative to pollution. It may affect the stomata behavior morphology, anatomy; germination also brings about changes in the chemistry of nearby soil.

The efforts to conserve biodiversity and geodiversity along with eco systems should be made prominent so that our unique heritage is also conserved for future generations. The present study is a step in the direction to attract the attention of people for the same. Several workers have shown their keen interest in studying effect of automobile exhaust on various roadside plants. The symptoms of senescence, thinning of canopy, change in phenology, change in leaf size, leaf damage, dust deposition and deterioration and shoot conditions appeared in some trees under the impact of automobile exhaust [4]. It has been noted that polluted leaves showed quantitative changes of varying degree in a number of leaves surface micro morphological characters i.e. stomatal frequency, epidermal thickness, leaf specific weight trichome density and size etc [5]. Significant reduction in the seed weight and branch length have also been reported [6]. The seed quality is found 53.5% empty seed in unpolluted controlled area, but rose to 63.6% in a moderately and 72.6% in severely polluted area [7]. The impact of automobile exhaust pollution in terms of germination has also been analysed [8-9]. It was observed that seedling growth of *Pongamia pinnata* and *Albezia lebbeck* in a controlled environment was significantly reduced in those raised from polluted sites as compared to those from the seeds from unpolluted site [10]. Studies revealed that auto-exhaust pollution reduces the length, breadth and calculated area of stomata. On contrary, the number of stomata, epidermal cells per unit area and stomatal index were found to be increased [11]. An adverse effect appears on the anatomy of some plants under the impact of auto-exhaust pollution [12]. The tderance in ten plant species reported *Ficus glomerta* as tolerant and *Acacia nilotica* as sensitive species [13]. The effects of increase in leaf area, panicle length and plant height have also been experimented when treated with kinetin and ascorbic acid spray [14]. Ascorbic acid has been suggested as a reliable physiological detoxificant of pollutants by many workers [15-16]. The plants acts as pollution sink and they replenish the atmosphere with much needed oxygen. There can be a possibility of using trees as pollution sink [17]. Studies analyzed the road side soil for different heavy metals and reported higher lead and cadmium contents in soil as well as in plants present along the road side [18-21].

III. MATERIALS AND METHODS

The Present study area includes district Saharanpur of Western U.P., which lies between 29^{o} 34' and 30^{o} 34' north latitude and 77^{o} 7' and 87^{o} 12' east latitude. The area of district is approximately 3000 sq. km. The altitude above sea level varies from 270 to 942 mtr. The region forms the northern most part of Ganga Yamuna Doab. In district Saharanpur summer rains are more frequent as compared to winter rains, so atmosphere remains humid during June to August. Best growth season in this district falls between March to May and then also between March to May and then also between September to November each year. pH of soil and water along various road side ranges between 6.8 to 7.5 in general in district Saharanpur. In this district tropical forests present in the foot hills of Shiwalik which ranges from district Dehradun at one and to district Bijnore at other end [23].

The city of Saharanpur is located at the latitude of 29° 28' and at the longitude of 77° 33' E. It has 270.8 meters above the sea level. A small stream named Dhamola passes through the main city and carries all municipal waste etc that confluence with river, Hindon near Tapri. The main roads run to towns of Behat and Chakrota in the north; Mohand and Dehradun in North-east; to Roorkee and Haridwar in the east; to Deoband and Muzaffarnagar in South-east; to Rampur Maniharan and Delhi in the South; to Nakur and Gangoh in South-east; to Sarsawa and Ambala in West and to Chilkana Sultanpur in North-west. Besides these main roads, there are unmetalled roads join the city with Nagal, Jhabrara and Jarodapanda villages. It is by the side of these roads, there is the cultivation of agricultural crops which is the subject of special observation and investigation in this study.

These road side plants absorb the heavy metals and other nutrients from the effluents which are thrown along road side ditches by the overcrowded industries running on almost all the main roads. The smoke and exhaust emitted by these road side factories as well as automobiles creates pollution. It is by the road side some important plants of family Gramineae (Poaceae) also grow of which four plants selected in the present study. Cereals are an integral part of Indian Agriculture, because they fit well in different cropping systems. They are important constituent and source of food for the vegetarian masses. Cereals being rich in carbohydrate and protein also supply essential amino acids. In Saharanpur these crop plants are important Kharif as well as Rabi crops. The 4 plants selected are as follows-

- Wheat *(Triticum aestivum)*
- Rice *(Oryza sativa)*
- Maize *(Zea mays)*
- Jae or Oat *(Avena sativa)*

There are two main functions of plants. Firstly, biosphere stability is achieved which is an essential outcome to maintain stability in climate, water, soil, chemistry of air and overall health. Secondly, plants are the foundation of humans as food, fiber, shelter and medicines are driven by them. Plants mean the diversity of life-forms found in different parts of the world. According to an estimate the life exists on the earth in more than thirty million different forms. For practical purposes life-forms have been grouped into 'species'. The existence of different species of plant, therefore, means the availability of different alternatives to making for utilizing their environment in the best possible manner.

The studies are carried on plants as given above collected from different roadside of Saharanpur at following three stages:-

- Vegetative stage
- Flowering stage
- Yield stage

Samples of these four plants were used for various biochemical estimation. Biochemical estimation of these plants were done under actual field conditions. Side by side all four plant samples were assessed at two different sites i.e. 20M away from roadside (Experimental) and 200M away from roadside (Control). Such studies will probably help to find out automobile exhaust effects on these plants. Side by side these experimental crops were also sown in the polythene bags containing two kg field soil and grown under field condition in the college campus with irrigation done whenever required to obtain control type plant material.

Plants sample for biochemical analysis were taken at 30th day, 60th day and 90th day of seedling emergence. Root/shoot and spikelet with seed/gram were collected. The dry samples of these plants were used for their quantitative estimation of total N, total P and total heavy metals. Simultaneously chlorophyll content such as Chl-a, Chl-b, total chlorophyll, oil estimation and enzyme activity like alpha-amylase, peroxidase, IAA Oxidase and etc. were also done indifferent experimental plant parts. Side by side protein and amino acid estimations also done.

IV. BIOCHEMICAL TECHNIQUES AND RESULTS

To carry out experiments, three different sites were selected. Amongst these, most commonly used Saharanpur Delhi Road has been illustrated in the paper. As experimentally stated, four individual plants were investigated carefully. They were dug out from the unpolluted (200 mt away) and polluted soil (20 mt away) near roadsides keeping the root and shoot system intact at 3 different stages of a growth. The appropriate readings are measured in between 30th to 120th day.

The plants wheat, rice, maize and oat/jae were washed thoroughly to remove any of the soil particles present on their surfaces. The observations are carried out for all the four plants. Three stages of growth viz. vegetative, flowering and yield stage under actual field conditions are carried out on a distant farm. The farm site chosen in study is towards Saharanpur Delhi Road. This farm chosen is 200 mt distance away from road side (unpolluted soil = control) and at 20 mt distance away from road side (polluted soil = experimental).

The plants were fragmented and the roots, shoots, seeds, and fruit parts from same were separated. These fragmented parts were thereafter dried by keeping them in oven at 80 ^{o}C. Similarly, soil samples from polluted and unpolluted lands were also collected from the same fields. These were kept in containers after washing them with nitric acid and deionised water. The washing removes absorption of heavy metals on the container walls if any to preserve the samples for subsequent analysis. Dried samples of different road side plants were mixed separately and then subjected to total Nitrogen analysis.

Readings obtained from experimental studies carried out on four road side plants are indicated below:

A. WHEAT: TRITICUM AESTIVUM

Total Nitrogen is calculated for control and experimental fields given in Table 1.

Table 1: Total Nitrogen of soil and plant parts of Triticum aestivum

Study site	Farm soil	Root shoot	Root shoot	Spikelet	Grain
Mg/gm dry weight					
Vegetative stage					
Control	41.20± 4.00	10.80± 1.60	12.60± 1.30	--	--
Experimental	42.00± 2.40	12.10± 1.30	14.80± 1.42	--	--
Flowering stage					
Control	40.00± 3.60	12.60± 1.26	13.80± 1.40	--	--
Experimental	42.10± 4.20	14.40± 1.80	18.60± 1.60	--	--
Yield stage					
Control	33.00± 2.40	14.00± 1.00	16.80± 1.40	8.70± 0.86	8.80± 0.88
Experimental	34.80± 4.00	16.20± 1.80	20.10± 1.60	10.40± 0.68	10.45± 0.70

The respective three stages, vegetative, flowering and yielding are shown in Fig. 1.

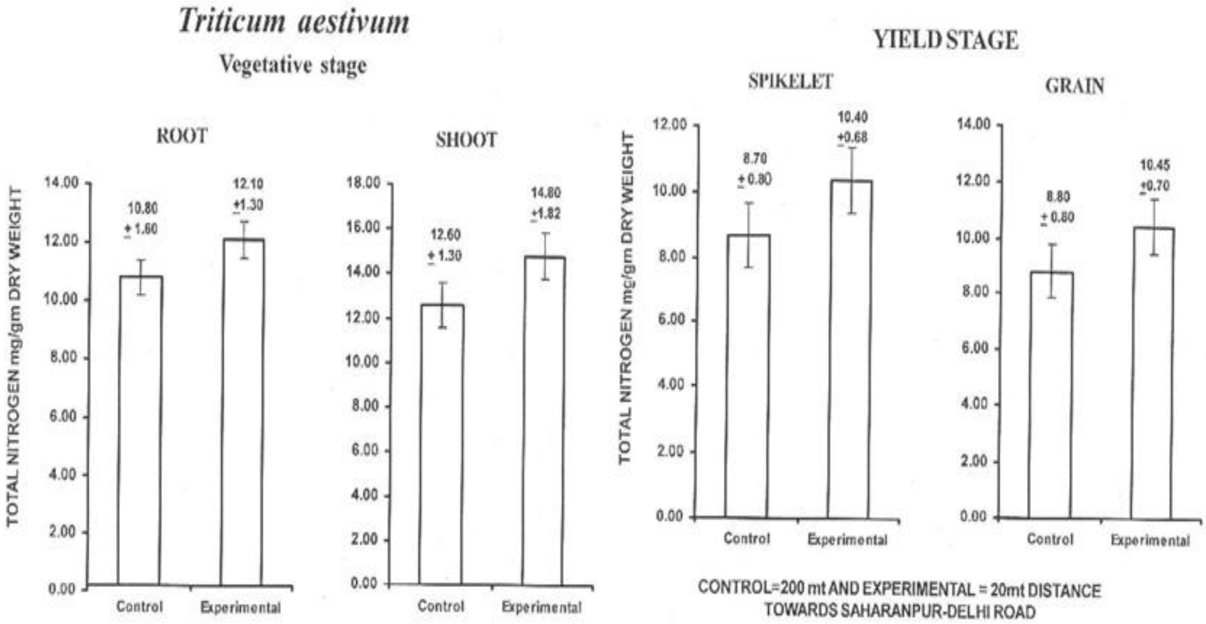

Fig. 1**:** Total Nitrogen of soil and plant parts at different stages of growth of Triticum aestivum

Results indicate that total nitrogen content is increased in farm soil and plant parts present near soil (20 meter distance). This indicates that heavy metals present in pollutants might damage root membrane. Since excessive Nitrogen cannot be fully absorbed by roots, it hampers growth of plant thereby increasing permeability of top soil attached to plant.

B. RICE: ORYZA SATIVA

The Nitrogen content were analysed for shoots for control samples respectively at 3 stages of growth. These investigations were also done with the spikelet parts of this crop plant at yield stage. Thus, total N level in spikelet was determined in control samples at maturity stage of growth. The results of observations are shown in Table 2 followed by graphs in Fig. 2.

Table 2: Total Nitrogen of soil and plant parts of oryza sativa

Study Site	Farm Soil	Root	Shoot	Spikelet	Grain
Mg/Gm Dry Weight					
Vegetative Stage					
Control	40.00± 2.40	10.00± 0.86	10.30± 1.00	--	--
Experimental	41.60± 2.00	12.00± 0.68	10.60± 1.30	--	--
Flowering Stage					
Control	37.00± 2.80	12.00± 0.80	11.60± 1.60	--	--
Experimental	39.80±	14.10±	12.80±	--	--

	3.60	1.10	2.00		
Yield Stage					
Control	38.10± 1.60	13.00± 0.86	12.80± 1.80	8.60± 0.88	10.10± 1.20
Experimental	40.00± 1.80	15.60± 0.98	14.20± 1.60	10.00± 0.96	12.00± 1.00

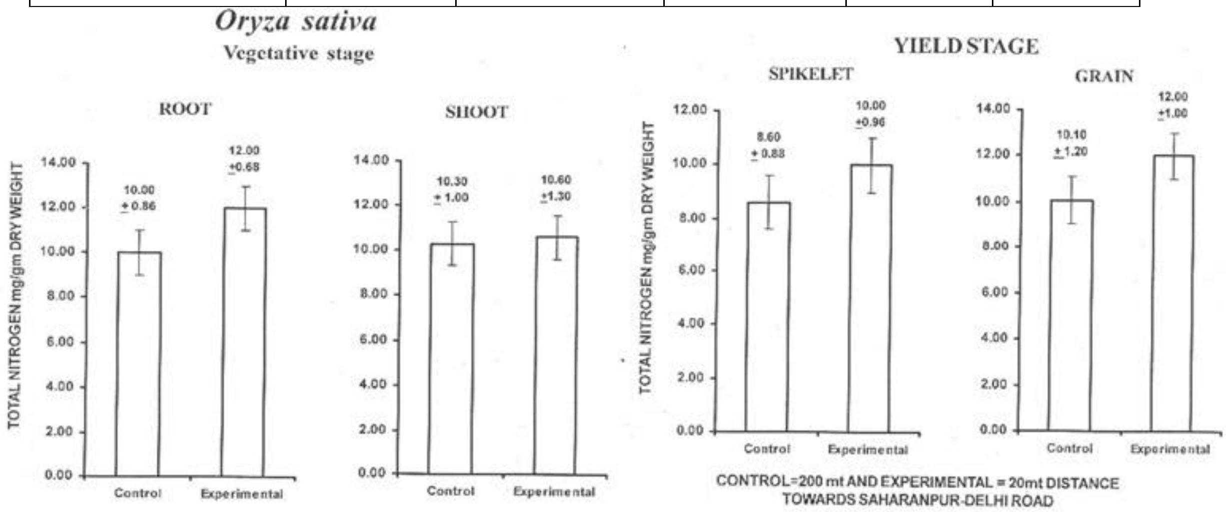

Fig. 2**:** Total Nitrogen of soil and plant parts at different stages of growth of Oryza Sativa

These parameters of Nitrogen in shoot of control sample investigations were also done with the spikelet parts of this crop plant at yield stage.

C. MAIZE: ZEA MAYS

Table 3 and Fig. 3 shows the results of total N, estimated in *Zea mays* plant parts and soils collected from control and polluted site.

Table 3: Total Nitrogen of soil and plant parts of Zea Mays

Study Site	Farm Soil	Root	Shoot	Cob	Grain
Mg/Gm Dry Weight					
Vegetative Stage					
Control	41.60± 0.80	8.80± 0.80	10.00± 0.80	--	--
Experimental	42.80± 0.90	9.80± 0.66	12.00± 0.46	--	--
Flowering Stage					
Control	38.00± 0.70	9.60± 0.70	10.45± 0.80	--	--
Experimental	39.00± 0.80	10.80± 0.80	12.60± 0.48	--	--
Yield Stage					
Control	38.00± 0.40	10.80± 0.86	10.40± 0.85	--	10.60± 0.80
Experimental	39.60± 0.46	12.60± 0.98	13.50± 1.00	--	10.80± 0.70

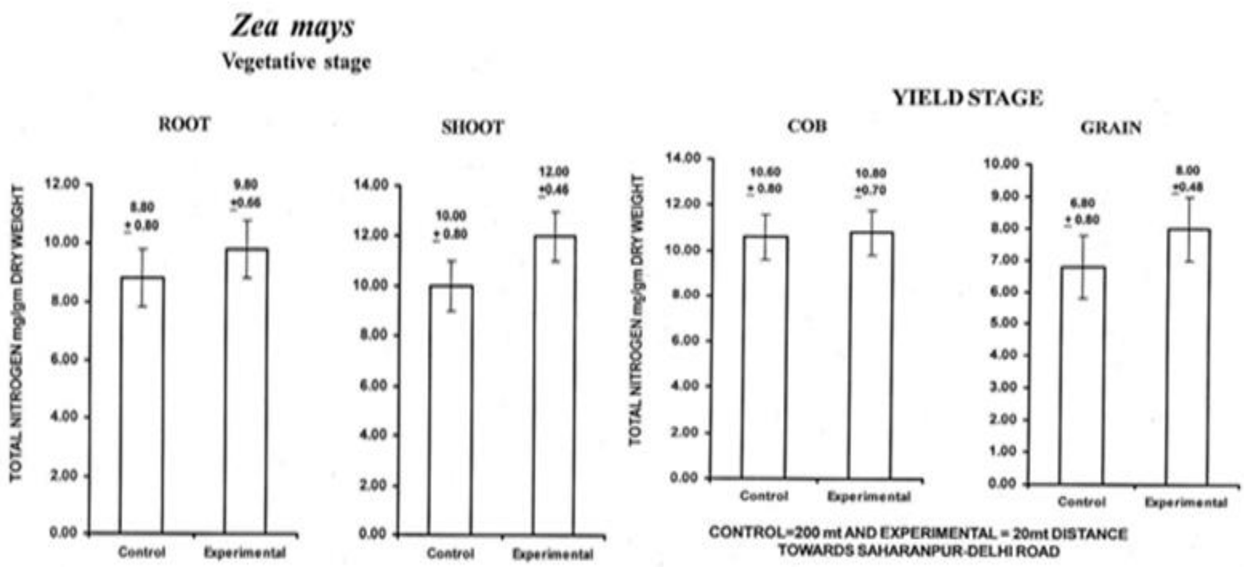

Fig. 3**:** Total Nitrogen of soil and plant parts at different stages of growth of Zea Mays

It can be seen from observations that total Nitrogen levels are increased in the plant parts and soils collected from polluted site in comparison to those plant parts tissue collected from control site of same road. The readings obtained for plant parts collected at three stages of growth viz. vegetative, flowering and yield stage evaluates the effect of automobile exhaust released from vehicular density. The accumulation of Nitrogen content is analysed based on comparative biochemical characteristics of soil and plant parts tissue of Avena Sativa and Triticum aestivum.

D. JAE OR OAT: AVENA SATIVA

Like other crop plants this plant is also tested to determine Nitrogen content. Table 4 and Fig. 4 shows the result that total N, level increases in most plant parts grown on polluted soil near 20 mt. distance away from road sides as compared to control soil.

Table 4: Total Nitrogen of soil and plant parts of Avene Sativa

Study Site	Farm Soil	Root	Shoot	Fruit	Grain
Mg/Gm Dry Weight					
Vegetative Stage					
Control	40.00± 2.60	8.00± 0.75	6.50± 0.86	--	--
Experimental	41.50± 2.45	10.80± 0.80	7.10± 0.60	--	--
Flowering Stage					
Control	38.45± 2.45	10.00± 0.80	6.80± 0.70	--	--
Experimental	40.12± 2.80	11.20± 0.90	8.10± 0.80	--	--
Yield Stage					
Control	36.20± 2.00	10.10± 0.40	7.40± 0.45	6.10± 0.48	8.24± 0.80
Experimental	38.50± 2.90	10.80± 0.60	8.90± 0.86	7.40± 0.76	10.30± 0.76

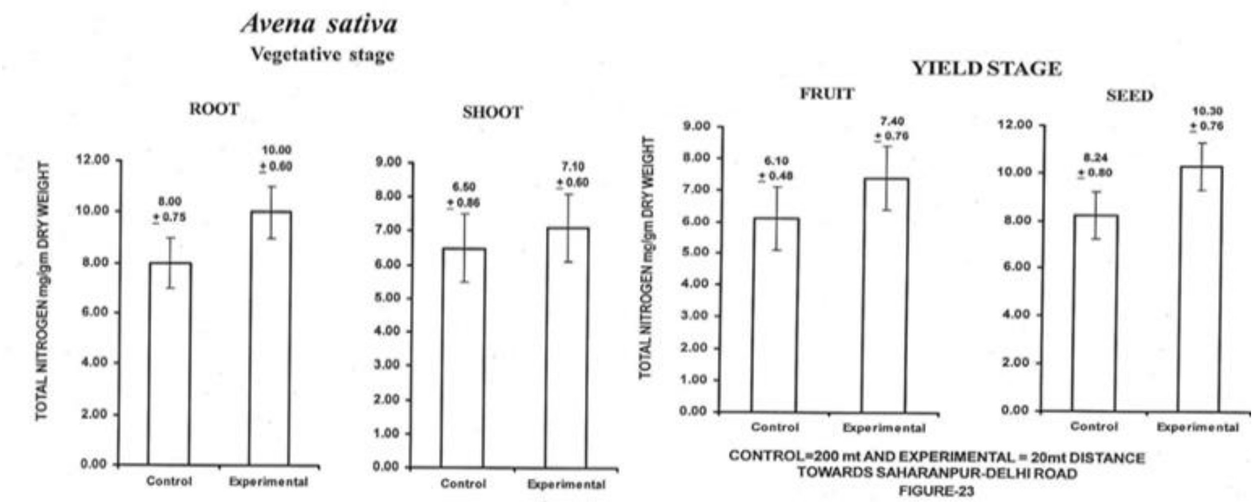

Fig. 4**:** Total Nitrogen of soil and plant parts at different stages of growth of Avena Sativa

Again it can be concluded from readings and graphs so obtained that the level of total Nitrogen, in soil and plant parts of *Avena sativa* grown under soil conditions near road side (20 m = experimental) and also away from road side (200 mt = control) towards Saharanpur Delhi road (Road side) is increased.

V. CONCLUSION

The paper describes the impact of automobile exhaust on some road side cereal plants of Saharanpur. The calibration graphs obtained after experiments for plant soil for conditions near road side (20 m = experimental) and also away from road side (200 m = control) assess the effect of biochemical performances of four important cereal plants. The studies have helped to some extent the limit of Nitrogen tolerance with respect to pollution. As concerns bio diversity that is rapidly changing, it is feared that plants growing along road sides may disappear in future. Thus, if we work out on determining the status of some socio economically important crops growing along road side, than it may be possible to recommend some measure to conserve these in future. The research tends to create awareness for future researchers in protecting plants against pollution.

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