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THE IMPACT OF AUTO EMISSION ON THE BIOMASS PRODUCTION OF SOME ROADSIDE PLANTS

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ABTSRACT

The biomass of *Alstonia scholaris*, *Pongamia pinnata*, *Cassia siamea* and *Peltophorum pterocarpum* in the term of leaf dry weight was significantly ($p<0.05$) affected in Karachi city. Plants were more affected to pollutants at Gulshan-e-Iqbal, Nazimabad, Shahrah-e-Faisal and M.A. Jinnah road as compared to Karachi University Campus. In periodical studies, the leaves dry weight of all tested species were found lowest at M.A. Jinnah road as compared to Shahrah-e-Faisal, Nazimabad, Gulshan-e-Iqbal and Karachi University Campus, respectively. Leaf dry weight of *A. scholaris*, *P.pinnata* and *C. siamea* were significantly ($p<0.05$) reduced in September-November at the highly polluted sites of M.A. Jinnah road as compared to Karachi University Campus. Whereas, leaf dry weight of *P. pterocarpum* was found significantly ($p<0.05$) reduced at M.A. Jinnah road in June-July as compared to other less polluted sites of the city. In this study, *P. pterocarpum* was found less affected to automobile pollution of the city as compared to other species.

Key Words: Auto emission, leaves dry weight, roadside trees, seasons.

INTRODUCTION

Karachi, the largest city of the country, with a population of more than 10 million people demands a large transport system for carrying people and goods from one place to another. According to Karachi Traffic Engineering Bureau, the total number of all types of motor vehicles on the road of Karachi was estimated to be 930,000 in 1997, which amounts to over 30% of all the vehicles in the country (Ghauri *et al.,* 1999). The buses and minibuses are the primary modes of conveyance. This traffic system in the city is producing hazardous environmental which effects the plants due to incomplete combustion of fuel and badly maintained auto vehicles. The toxic materials such as carbon particles, unburned and partially burned hydrocarbons, fuels, tar materials, lead compounds and other elements which are the constituents of petrol and lubricating oils deposit on the surface of plants. These pollutants in combinations cause greater or synergistic effects to plants (Qadir and Iqbal, 1991).

Trees in cities face a severe limitation of plantable space and an exceptionally stressful growing environment. Environmental degradation, traffic congestion and destruction of trees suppress performance and shorten life span of plant. Many research workers have drawn their attention to the toxic effects of auto vehicular emission on plant growth (Gilbertson and Bradshaw, *19*85; Bhatti and Iqbal, 1988; Sawidis *et al.,* 1995; Chronopoulos *et al., 19*96; Jim, 1996, 1997, 1998; Webb, 1998). Bhatti and Iqbal (1988) and Shafiq and Iqbal (2003) have found that the phenology and productivity of *Ficus bengalensis* L., and *Eucalyptus* sp., was highly affected due to automobile exhausts. They have also concluded that the automobile emission significantly reduced the productivity, leaf area and leaf dry weight of *Guaiacum officinale* L. *F. bengalensis* and *Eucalyptus* sp. A significant ($p<0.05$) decline in leaf dry weight of the roadside plant, *Bougainvillea spectibilis* Willd, was observed by Hussain *et al.* (1997).

Alstonia scholaris (commonly known as Dita bark tree) is a beautiful evergreen tree with a tall stem and dark green shiny leaves in whorls of 4 to 10. It exudes milky juice on cutting. It is found in tropical Australia, Africa, and India to Indonesia and cultivated in Pakistan for ornamental purposes. *Pongamia pinnata* (Charr) is a medium sized, almost evergreen tree and spreading shady crown. It is indigenous to the foothills of the Himalayas, but cultivated in plains for its ornamental value. *Cassia siamea* (Kassod tree) is a moderate sized, well-shaped evergreen tree with a dense crown. It is native to South India. This tree is largely planted for ornamental purposes. The tree grows fairly rapidly, and is easy to cultivate. *Peltophorum pterocarpum* is native to Ceylon and North Australia, commonly cultivated as roadside tree in gardens and in plains of Pakistan. The results of the present study testify this grave situation facing for trees growing at the polluted sites. Trees are dying as a result of prolonged exposure of exhaust emission especially at M.A. Jinnah Road. The leaf growth of *A. scholaris*, *P. pinnata*, *C. siamea* and *P. pterocarpum* was significantly affected at the polluted environment of the city as compared to clean area.

The aim of the present study was to investigate the effects of automobile emission on biomass production of some important plants growing in different areas of Karachi city.

MATERIALS AND METHODS

Karachi is situated on the coast along the Arabian Sea at a latitude of 24° 48' N and longitude of 66° 55' E. The soil is calcareous and marine in origin. Chaudhry (1961) has characterized the climate of Karachi as subtropical maritime desert. Temperature is mild with no frost. Dew formation is quite common, the relative humidity is high and the differences in day and night temperatures are great. The climatic conditions at the control site (Karachi University Campus) are not different from other sites of the city. An average wind velocity is 12 m sec^{-1} during June and July and 3.5 m sec^{-1} from January to March. During the southwest monsoon season, winds blow from the sea towards the coast, whereas during the northeast monsoon their direction is reversed. Therefore, pollutants are pushed inland during the southwest monsoon season and are blown out to sea during the northeast monsoons (UNEP, *19*92). The site in urban area is disturbed mainly by auto vehicular activities, includes all main traffic network (Gulshan-e-Iqbal, Nazimabad, Shahrah-e-Faisal and M.A. Jinnah Road) whereas, Karachi University is relatively a clean area. Nomenclature of all the plant species was followed according to Stewart (1972).

The common roadside trees like *A. scholaris* R. Br., *P. pinnata* (L.) Merrill, *C. siamea* Lamk., and *P. pterocarpum* D.C. Backer ex K. Heyne, with uniform growth and DBH (Diameter Breast Height) were chosen from each site (A= Karachi University Campus, B=Gulshan-e-Iqbal, C=Nazimabad, D=Shahrah-e-Faisal, E= M.A. Jinnah Road). The samples influenced by traffic were obtained from the road edge at a distance of 1 m at the beginning of each season. Twenty-five fresh leaf samples from each individual of a species were randomly collected from each area at two-meter height throughout the plant canopy to give representative average sample. Leaf dry weight were recorded during four consecutive period periodically at regular interval of three months viz, P1 (June-July-August), P2 (September-October-November), P3 (December-January-February) and P4 (March-April-May). All measurements were based on three replicates. The leaves samples were kept in the oven at 80° C for 48 hours and the dry weight of leaves were taken at Precisa Junior 500 Swiss Quality electric balance.

The data collected for various leaves parameters from different sites statistically analyzed by analysis of variance techniques (ANOVA) (Steel and Torrie, 1961).

RESULTS

The leaf dry weight of *A. scholaris*, *P. pinnata*, *C. siamea* and *P. pterocarpum* was significantly ($p<0.05$) affected in the polluted environment as compared to plants growing at Karachi University Campus (Table 1). Effects of auto emission on leaves dry weight of all species were varied from site to site during four consecutive periods of studies (Fig.**1**-**4**).

The periodical study indicated that the lowest leaf dry weight production of *A. scholaris* was found in June-August at M.A. Jinnah Road (0.032 g) as compared to Shahrah-e-Faisal (0.044 g), Nazimabad (0.057 g), Gulshan-e-Iqbal (0.07 g) and Karachi University Campus (0.094 g), respectively (Fig. **1**). A significant ($p<0.05$) decrease in leaf dry weight of *P. pinnata* was observed at M.A. Jinnah Road as compared to Shahrah-e-Faisal, Nazimabad, Gulshan-e-Iqbal and Karachi University Campus (Fig. 2). Lowest leaf dry weight production of *P. pinnata* were found in December-February at M.A. Jinnah Road (0.080 g) as compared to Shahrah-e-Faisal (0.090 g), Nazimabad (0.100 g), Gulshan-e-Iqbal (0.110 g) and Karachi University Campus (0.120 g), respectively. The present study also reveals that *C. siamea* growing in the polluted site of the city showed reduction in leaflet dry weight as compared to Karachi University Campus in all season (Fig. **3**). However, leaflet dry weight of *C. siamea* was not significantly affected in June-August at all the sites of the city. The leaflet dry weight of *C. siamea* was highly affected in autumn at M.A. Jinnah Road (0.001 g) as compared to Shahrah-e-Faisal (0.002 g), Nazimabad (0.002 g), Gulshan-e-Iqbal (0.003 g) and Karachi University Campus (0.009 g), respectively. *C. siamea* showed low leaflet dry weight in March-May at M.A. Jinnah Road (0.002 g) as compared to other less polluted sites of the city such as Shahrah-e-Faisal (0.002 g), Nazimabad (0.003 g), Gulshan-e-Iqbal (0.003 g) and Karachi University Campus (0.003 g), respectively. The leaflet dry weight of *P. pterocarpum* was significantly low in June-August at M.A. Jinnah Road as compared to other less polluted sites of the city (Fig. **4**). *P. pterocarpum* showed maximum leaflet dry weight in December-February at Karachi University Campus (0.0042 g) as compared to Gulshan-e-Iqbal (0.0028 g), Nazimabad (0.0028 g), Shahrah-e-Faisal (0.0023 g) and M.A. Jinnah Road (0.0022 g). Whereas, this species showed lowest leaflet dry weight in March-May at M.A. Jinnah Road (0.0028 g) followed by Shahrah-e-Faisal (0.0032 g), Nazimabad (0.0042 g), Gulshan-e-Iqbal (0.0050 g) and University Campus (0.0050 g), respectively.

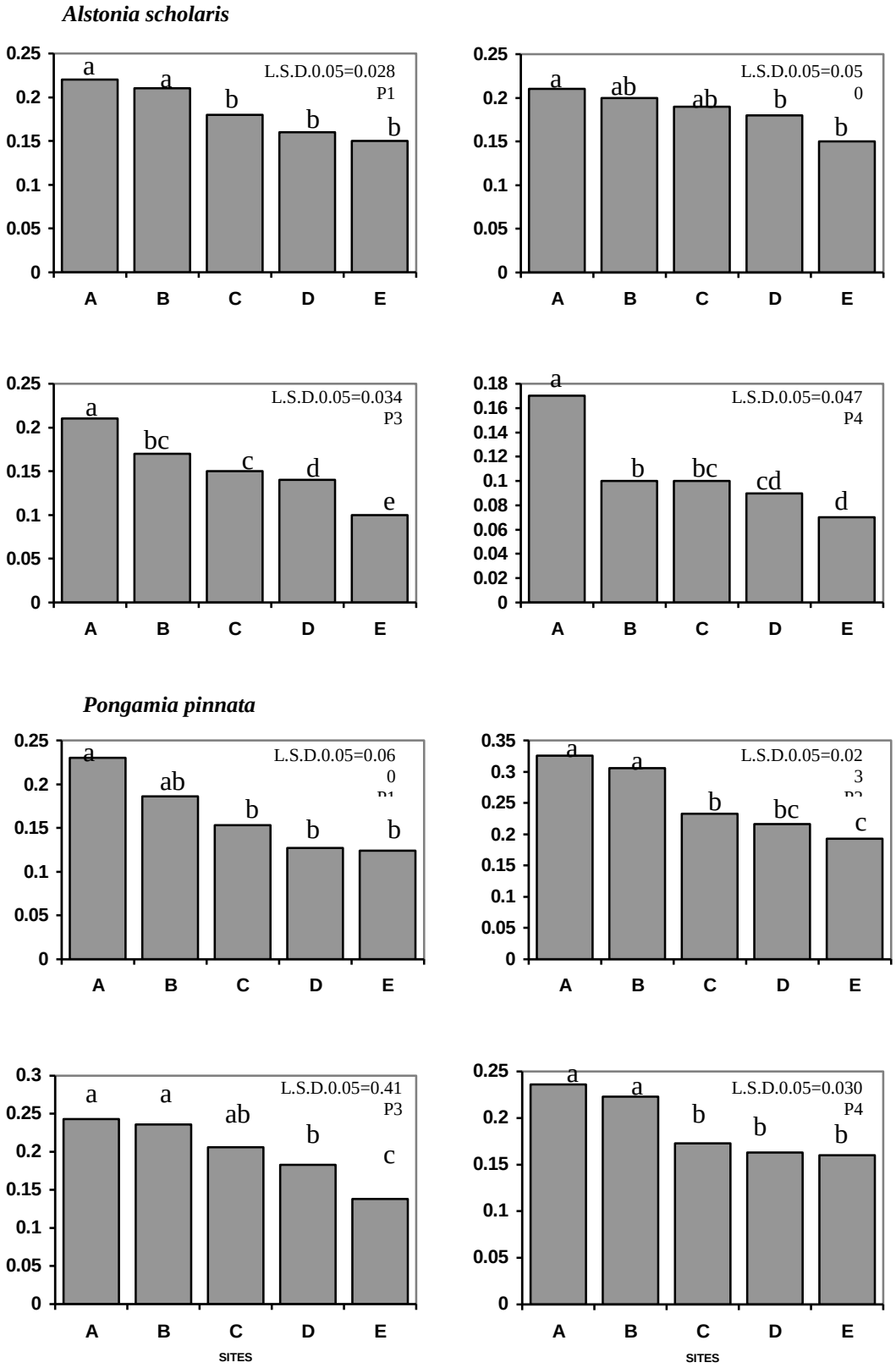
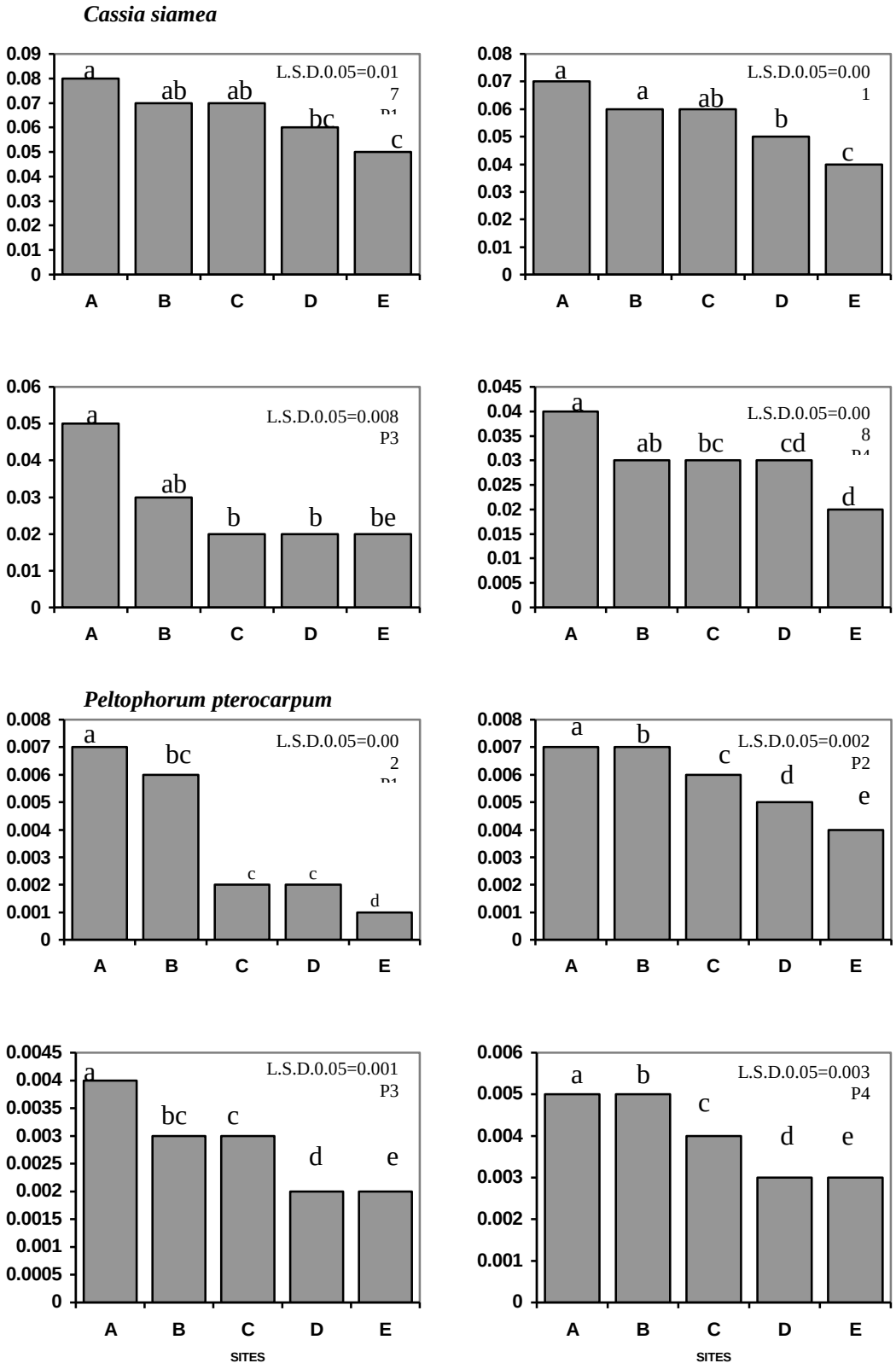


Fig.2. Effects of autoemission on leaf dry weight (g) of different plants. Values followed by the same letters are not significantly different ($p<0.05$) by using L.S.D. A= Karachi University Campus, B=Gulshan-e-Iqbal, C=Nazimabad, D=Shahrah-e-Faisal, E= M.A. Jinnah Road. P1 (June-July-August), P2 (September-October-November), P3 (December, January-February, P4 (March-April-May)



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P1 (June-July-August), P2 (September-October-November), P3 (December-January-February), P4 (March-April-May).

DISCUSSION

Emissions from automobile poss most of air pollution problems. Trees in cities are subjected to a widespread pressure of auto vehicular emission. In plant organs, the leaf is the most sensitive part to be affected by air pollutants. Therefore, the leaf at its various stages of development, serves as a good indicator to air pollutants. Pollutants derived from the auto emission can directly affect the foliage of plants by entering the leaf, destroying individual cells, and reducing plant ability to produced food. Reduction in the leaf dry weight of roadside plants was the witness of bad effects of the city environment. It was found that the plants growing close to the busy road of the city were highly affected by auto emission. The inhibitory effects on the growth of plants are due to the presence of toxic material in the auto emission. Decreased dry weight of plants under pollution stress was an indication of depressing effect of pollution on vital metabolic processes.

Weight is an important indicator of adaptational mechanisms, higher is the weight at the time of investigations; lower is the tension adaptational compensatory mechanism. Leaf dry weight of all the species reduced progressively depending on the level of pollution at the city. During the present investigation, it was observed that trees were more sensitive to air pollutants at M.A. Jinnah road as compared to other less polluted areas of the city. In March-May, the leaf dry weight of *A. scholaris* was significantly ($p<0.05$) affected at M.A. Jinnah road as compared to other trees and seasons. Significant reduction in leaf dry weight was also found in *P. pinnata* in autumn at M.A. Jinnah road as compared to other less polluted sites of the city. The reduction in leaf dry weight of *A. scholaris* and *P. pinnata* might be due to the large surface area of their leaves that is available to exposure to any pollutant.

The leaf dry weight of *C. siamea* and *P. pterocarpum* were highly affected at the polluted sites of the city as compared to campus. The presence of various types of pollutants derived from the automobiles might be responsible for the reduction in leaf dry weight of plants. Low leaf dry mass of all the species at polluted sites might be due to carbon exchange becomes limited and hence photosynthesis reduced. Light intensity at the polluted area was low (Shams and Iqbal, 1986) which could result in less photosynthesis and eventually less growth of plants. The productivity of a plant mostly depend on the rate of photosynthesis and respiration but at the polluted areas, all these vital processes are disturbed which results in reduction of tree growth and biomass production. The leaf dry weight of *C. siamea* was highly decreased in autumn season at M.A. Jinnah road as compared to other sites of the city. The reduced in leaf parameters could be attributed to high level of automobile pollutants in the environment and excessive fall of auto dust on their aerial parts. Excessive quantities of air borne particulate matters cover the leaves, clogg the stomata, thereby both reducing the absorption of carbon dioxide from the atmosphere and the intensity of light reaching the interior of leaf, and suppressing the growth of plants. Bhatti and Iqbal (1988) reported reduction in leaf length of *F. bengalensis* L., at the polluted sites. Atmospheric pollutants after making their entry through stomata of leaves causes reduction in leaf size of plants due to damage of photosynthetic tissues. Plant growth and production depend on photosynthetically functional leaves. The automobile pollutants have also reduced the leaf dry weight of *P. pterocarpum* significantly ($p<0.05$), in June-August ($p<0.05$) at M.A. Jinnah road.

It is concluded that the pollutants emitted from the automobile activities influenced on the production of leaf dry weight. Vehicles passing through the busy roads of the city produce different types of toxic pollutants thus affecting the leaf growth. Leaves sample of all the investigated species responded differently in their dry weight production. The effect of autoemission on leaf dried weight also varied from site to site and species to species. No significant reduction in leaf dry weight of *C. siamea* was observed in summer season. Whereas, *A. scholaris, P. pinnata* and *P pterocarpum* were found highly affected in the same season at all polluted sites of the city. The deposition of lead and soot particles on the surface of leaves from automobile activities could cause low production of leaves dry weight. The leaves growth of *P. pterocarpum* was found less affected to auto exhaust emission than *A. scholaris, P. pinnata* and *C. siamea*. The degree of effectiveness could be due to their genetic ability. In few cases, the resistance might be provided by nature, particularly in *P. pterocarpum*, due to the presence of small leaf size. It is therefore, suggested that *P. pterpcarpum* should be given more preference over other species in further plantation in the city, particularly along the busy roads.

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