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Response of ornamental plants, sites and their interaction to various environmental pollutants to total sugar content a biochemical trait

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ABSTRACT

The present investigation entitled "Response of ornamental plants, study sites and their interaction to various environmental pollutants to total sugar content a biochemical trait" was carried out during the year 2019-2020 at four sites. Already existing and available multiple ornamental plants were selected for investigation at four study sites (same ornamental species in 4 study sites) during three seasons *viz*., winter 2019, summer, 2020 and rainy season, 2020. Plant selection was made uniformly and tagged randomly in all sites. The design of the experiment was 2-way ANOVA with 24 ornamental plants and three replications. Corresponding to biochemical traits, total sugars registered was maximum in OP-16 (2.34, 2.21, 2.41%) among plants, S_1 (0.88, 0.78, 0.93%) among locations and OP-16 X S_1 (3.05, 2.62, 2.91%) among interactions in three seasons i.e., during winter 2019, summer 2020 and rainy season 2020.

KEYWORDS

Total Sugar Content, Ornamental Plants, Environmental Pollution

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Plants have a very close interrelationship with the environment, and any altered condition of the atmosphere plays strong impact on its physiology and biochemistry. Plants exposed to the atmospheric pollution alter their physiological activity by expressing changes in its biochemical parameters. Some of the plants can be used as a bio-indicator to monitor the local air quality. Avenue trees, ornamental plants and shrubs are capable of removing a significant amount of air pollutants from the atmosphere and hence should be considered an integral part of any sustainable plan intended at improving air quality as dust filters to check the rising urban dust pollution level. Different plant species vary considerably in their susceptibility to air pollutants. Screening of plants for their sensitivity to air pollutants is of vital importance (Badamasi, 2017). The variations in physiological and biochemical traits in the leaves can be used as indicators of air pollution for early diagnosis of stress.

The plants response to air pollution varies from species to species and also in terms of type of pollutant, its reacting mechanism, concentration and duration of exposure (Thambavani and Sabitha, 2011). In India 30-35% of air pollutants comprises of dust particles. Activities such as coal mining, quarrying, stone crushing, thermal power plants, cement industries etc., adds huge quantities of dust to the environment (Rupnarayansett, 2017).

Automobile vehicles are continuously adding toxic gases to the environment. It has been observed that plants particularly growing in the urban areas affected greatly due to varieties of pollutants like oxides of nitrogen and sulphur, hydrocarbon, ozone, particulate matters, hydrogen fluoride, peroxyacyl nitrates (PAN), sulphur dioxide (SO_2), nitrogen oxides (NO_x) and CO_2 as well as suspended particulate matter (Jahan and Iqbal, 1992). The importance of avenue, ornamental plants and shrubs in city and town environment is now heavily accepted that they too purify the air pollution from the dust particulates.

Very meagre or no work has been done on the development of landscaping with appropriate ornamental plants based on the pollution level in Rayalaseema region of Andhra Pradesh. Mangampeta (rural) in YSR Kadapa district of Andhra Pradesh is known for the emission of dust particles and different pollutants whereas, Tirupati (Urban) is well known for heavy vehicular movement and air pollution level is high and hence "To find out the efficacy of available existing plant species in trapping the pollutants / dust particle delivered the present investigation is planned with the objective, to determine the variation in biochemical parameters and to select appropriate plants which can be grown and expected to perform well for the development of greener environment and for landscaping.

Materials and Methods

Already growing, existing and commonly occurring multiple ornamental plants at four study sites were selected for investigation. In all four study sites, same ornamental plant species were selected uniformly and tagged randomly as per replication and fully matured leaves were collected during morning hours to assess the impact of air, vehicular pollution and dust particles from road sides and from control site (Akilan and Nandhakumar, 2016). The leaf samples were collected from all 24 treatments in polythene covers and were carried to the laboratory for analysis in the ice box.

Experiment Details

In order to conduct the present study, a preliminary survey of all the four locations was done repeatedly to select commonly occurring ornamental plant species in all four study sites. Three plants were selected in each treatment (ornamental plant) at random and labeled properly for recording observations. The study was conducted during three seasons *viz*., winter 2019 (December), summer 2020 (April) and rainy season 2020 (August). At four locations such as: 1. College of Horticulture, Anantharajupeta (Control site - S_1), 2. Mangampeta (Barytes mining area and road traffic area - S_2), 3. Railway Kodur (Town – main road traffic area - S_3) and 4. Tirupati (City – main road heavy traffic area - S_4) with 3 replications each for all the treatments.

Table 1. Treatment (ornamental plants) details

S. N.	Botanical Name	Notation
1	*Azadirachta indica*	OP-1
2	*Bauhinia purpurea*	OP-2
3	*Delonix regia*	OP-3
4	*Peltophorum pterocarpum*	OP-4
5	*Polyalthia longifolia*	OP-5
6	*Ficus benjamina*	OP-6
7	*Conocarpus erectus*	OP-7
8	*Pongamia pinnata*	OP-8
9	*Nerium oleander*	OP-9
10	*Acalypha hispida*	OP-10
11	*Duranta repens*	OP-11
12	*Tabernaemontana divaricate*	OP-12
13	*Hibiscus rosa-sinensis*	OP-13
14	*Pandanus sanderi*	OP-14
15	*Tecoma stans*	OP-15
16	*Bougainvillea glabra*	OP-16
17	*Dieffenbachia amoena*	OP-17
18	*Sansevieria trifasciata*	OP-18
19	*Furcraea foetida*	OP-19
20	*Roystonea regia*	OP-20
21	*Wodyetia bifurcate*	OP-21
22	*Cycus cercinalis*	OP-22
23	*Catharanthus roseus*	OP-23
24	*Polianthes tuberosa*	OP-24

Note: OP-Ornamental plant

Observation Recorded
Total Sugars (%)

A total sugar was estimated as per the methodology of (Franscistt *et al*., 1971) by anthrone method.

Statistical Analysis

Variation of biochemical parameter, pattern and their significance level were computed using analysis of variance technique (two-factor analysis) with ornamental plants and different sites as two factors for analysis. The significance of the analyzed data was tabled at 5 per cent level of significance.

Results and Discussion
Total Sugars (%)

Total sugars varied significantly due to the influence of ornamental plants, locations and their interactions in three seasons (table 2). During winter 2019, among the ornamental plants, OP-16 observed to have the highest total sugar content (2.34%) which was found significantly superior to other ornamental plants and which was followed by OP-4 (1.42 %) and this was on par with OP-2 (0.97 %) and OP-9 (0.96%). The lowest sugar content (0.27%) was recorded in OP-22. Among study sites, S_1 had higher sugar content (0.88%) which was on par with S_4 (0.87%). However, the moderate values for total sugar contents (0.59% and 0.64%) were recorded in S_3 and S_2, respectively. In treatment combinations, the interaction of OP-16 X S_4 recorded significantly highest total sugars (3.05%) followed by OP-16 X S_1 (2.81 %) and this was on par with OP-16 X S_2 (1.77%) and OP-16 X S_3 (1.75%). Lowest total sugar content of 0.16 per cent was recorded in OP-22 X S_3 (0.16%) which was on par with OP-22 X S_2 (0.18%).

During summer 2020, among ornamental plants investigated, significantly higher total sugar content of 2.21 per cent was recorded in OP-16 which was followed by OP-4 (1.28%). Intermediate value of 0.91 per cent was observed in OP-9 and is significantly independent treatment among all. While, the treatment OP-21 (0.85%) is on par with OP-8 (0.84) and OP-2 (0.83%). The lowest value of 0.26 per cent was recorded in OP-22 which was on par with OP-5 (0.29%).

Among study areas, S_1 had highest total sugar content (0.78%) which was followed by S_4 (0.74%), S_2 (0.67%) and S_3 (0.62%). In interaction effect of ornamental plants and sites, the combination of OP-16 X S_1 recorded significantly highest total sugar content (2.62%) followed by OP-16 X S_4 (2.40%), OP-16 X S_2 (1.97%), OP-16 X S_3 (1.85%) and OP-4 X S_1 (1.38%). Significantly minimum total sugar content (0.19%) was recorded in OP-5 X S_1 which was on par with OP-22 X S_3 (0.21%) and OP-22 X S_2 (0.24%).

Among different ornamental trees and shrubs tried, during rainy season 2020, the ornamental plant i.e. OP-16 recorded significantly maximum total sugar content (2.41%) and this was followed by OP-4 (1.49%), OP-9 (1.06%) and this was on par with OP-8 (0.92%) and OP-2 (0.91%). The lowest total sugar content of 0.34 per cent was recorded in OP-22. Among multiple locations investigated, the site S_1 recorded significantly highest total sugars (0.93%) which was followed by S_4 (0.88%), S_2 (0.77%) and S_3 (0.68%).

In interaction, the combination of OP-16 X S_1 showed significantly highest total sugars (2.91%) followed by OP-16 X S_4 (2.81%), OP-16 X S_2 (2.05%), OP-16 X S_3 (1.88%) and OP-4 X S_1 (1.58%). Lowest total sugar content of 0.22 per cent was recorded in OP-22 X S_3 which was on par with OP-22 X S_2 (0.28%). The results depicted that to investigate the total sugars among all ornamental plants tried; *Bougainvillea glabra* (OP-16) at control site (S_1) had maximum sugar content. The remaining multiple sites *viz.*, S_2, S_3 and S_4 exhibited minimum values. The reduction in total sugar content at higher pollution level at different sites (S_2, S_3 and S_4) may be due to less activity and higher consumption of synthetic food for mitigating pollution stress. The results are corroborated with the findings of (Tripathi and Gautam, 2007, Seyyednejad *et al*., 2011).

The decrease in total sugar content of damaged leaves probably corresponded with the photosynthetic inhibition or stimulation of respiration rate (Tzvetkova and Kolarov, 1996). Kapoor (2016) depicted that the reduction in total sugar content at higher pollution level at multiple sites due to less activity and higher consumption of synthetic food for mitigating pollution stress.

Table 2. Response of ornamental plants (OP), sites (S) and their interaction to various pollutants in respect of total sugar content during three sampling seasons

Name of the Ornamental Plant	Total Sugar Content (%)														
	Winter Season 2019					Summer Season 2020					Rainy Season 2020				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
OP-1	0.80	0.81	0.67	0.79	0.77	0.74	0.65	0.58	0.69	0.66	0.86	0.79	0.71	0.81	0.79
OP-2	1.39	0.84	0.76	0.90	0.97	1.00	0.77	0.69	0.86	0.83	0.97	0.91	0.82	0.93	0.91
OP-3	0.76	0.63	0.57	0.76	0.68	0.66	0.57	0.52	0.61	0.59	0.80	0.70	0.62	0.77	0.72
OP-4	1.57	1.33	1.26	1.53	1.42	1.38	1.23	1.19	1.31	1.28	1.58	1.46	1.35	1.55	1.49
OP-5	0.27	0.43	0.33	0.54	0.39	0.19	0.31	0.28	0.36	0.29	0.61	0.51	0.46	0.58	0.54
OP-6	0.70	0.62	0.57	0.74	0.66	0.67	0.57	0.53	0.61	0.59	0.77	0.69	0.62	0.75	0.71
OP-7	0.77	0.66	0.76	0.90	0.78	0.69	0.76	0.69	0.79	0.74	0.95	0.84	0.79	0.93	0.88
OP-8	1.02	0.70	0.67	0.93	0.83	0.96	0.79	0.74	0.87	0.84	1.10	0.87	0.72	0.99	0.92
OP-9	1.25	0.72	0.69	1.15	0.96	1.02	0.87	0.79	0.94	0.91	1.28	0.91	0.85	1.18	1.06
OP-10	0.94	0.66	0.63	0.87	0.77	0.81	0.69	0.66	0.76	0.73	0.96	0.84	0.75	0.90	0.86
OP-11	0.76	0.60	0.58	0.81	0.69	0.72	0.67	0.66	0.70	0.69	0.87	0.74	0.62	0.83	0.76
OP-12	0.71	0.43	0.38	0.69	0.55	0.60	0.51	0.47	0.57	0.54	0.76	0.61	0.52	0.72	0.65
OP-13	0.60	0.41	0.37	0.62	0.50	0.54	0.44	0.41	0.50	0.47	0.66	0.52	0.46	0.64	0.57
OP-14	0.67	0.50	0.46	0.71	0.59	0.66	0.57	0.50	0.60	0.58	0.77	0.67	0.57	0.74	0.69
OP-15	0.66	0.52	0.48	0.77	0.61	0.65	0.58	0.51	0.60	0.58	0.81	0.67	0.58	0.79	0.71
OP-16	2.81	1.77	1.75	3.05	2.34	2.62	1.97	1.85	2.40	2.21	2.91	2.05	1.88	2.81	2.41
OP-17	0.60	0.48	0.40	0.67	0.54	0.58	0.53	0.47	0.57	0.54	0.61	0.58	0.48	0.60	0.57
OP-18	0.51	0.28	0.25	0.47	0.38	0.43	0.33	0.30	0.38	0.36	0.55	0.45	0.38	0.50	0.47
OP-19	0.67	0.55	0.44	0.71	0.59	0.66	0.60	0.57	0.63	0.61	0.69	0.62	0.57	0.67	0.64
OP-20	0.68	0.50	0.46	0.72	0.59	0.67	0.58	0.55	0.64	0.61	0.71	0.64	0.52	0.69	0.64
OP-21	0.94	0.76	0.69	0.91	0.83	0.94	0.82	0.77	0.87	0.85	0.96	0.82	0.74	0.93	0.86
OP-22	0.41	0.18	0.16	0.33	0.27	0.30	0.24	0.21	0.27	0.26	0.47	0.28	0.22	0.38	0.34
OP-23	0.74	0.43	0.38	0.66	0.55	0.60	0.50	0.47	0.57	0.53	0.79	0.61	0.53	0.76	0.67
OP-24	0.81	0.52	0.50	0.70	0.63	0.69	0.60	0.58	0.65	0.63	0.87	0.63	0.58	0.75	0.71
Mean	0.88	0.64	0.59	0.87		0.78	0.67	0.62	0.74		0.93	0.77	0.68	0.88	
	OP	S	OP x S			OP	S	OP x S			OP	S	OP x S		
CD (P=0.05)	0.03	0.01	0.07			0.03	0.01	0.06			0.03	0.01	0.07		

The reduction in total sugar content of the plant at polluted site occurred due to chlorophyll destruction, which leads to decreased carbon dioxide fixation and increased respiration rate. SO_2, NO_2 and H_2S also cause the depletion of total soluble sugar content and low soluble sugar content indicate the sensitivity of plant to pollution. Tripathi and Gautam (2007) in their study revealed significant loss of soluble sugar in all tested species at all polluted sites. The concentration of soluble sugars is indicative of the physiological activity of a plant and it determines the sensitivity of plants to air pollution. Reduction in soluble sugar content in polluted stations (S_2, S_3, S_4) can be attributed to increased respiration and decreased CO_2 fixation because of chlorophyll deterioration. It has been mentioned that pollutants like SO_2, NO_2 and H_2S under hardening conditions can cause more depletion of soluble sugars in the leaves of plants grown in polluted area.

Conclusion

An information made available in the results showed that total sugars observed to be highest in OP-16 (*Bougainvillea glabra*) among plants, S_1 (control) among sites and OP-16 X S_1 among interactions during winter 2019, summer 2020 and rainy season 2020, respectively. On the environmental point of view *Bougainvilea glabra* (OP-16) were evaluated as good performer and highly beneficial for mitigation and minimization of air pollution load and also for landscaping purpose of the area as they tend to serve as barriers and act as sink for air pollutants.

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