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STUDIES ON AIR POLLUTION TOLERANCE INDEX IN *AMARANTHUS* AND *EUPHORBIA* SPECIES

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Plants are the integral basis of all ecosystems and are identified as the most potent to receive the stress caused by pollution. The aim of the present study is to determine the APTI values of *Amaranthus* and *Euphorbia* species in Medhipatnam area and to find out their tolerance/ sensitivity when exposed to vehicular pollution. The collected samples were analysed for total chlorophylls, ascorbic acid content, relative water content and leaf extract pH. Total chlorophyll was found to be higher in *E. hirta* compared to *A. viridis*. Ascorbic acid content showed higher levels in *A. viridis* than in *E. hirta* for which low values were recorded showing a susceptible nature. Plants having higher index value are tolerant to air pollution and can be used as sink to mitigate pollution while plants with low index value are less tolerant and can be used as indicators of air pollution.

Keywords: APTI; Ascorbic acid; Pollution indicators; Relative water content, Total chlorophyll.

Introduction

Air pollution is due to the presence of undesirable solid or gaseous particles in the air, in quantities that are harmful to human health or other living organisms or damage the environment. Pollutants are emitted directly by natural events and also by human activities. Air pollution is a major global problem arising mainly from industrialization and continuously increasing vehicular traffic especially in the urban areas. Plants are good indicators of air pollution and act as tools to evaluate the effects of air pollution.

Plants are the integral basis of all ecosystems and are identified as the most potent to receive the stress caused by pollution. Pollutants can enter the plants directly through stomata on the leaves or indirectly through soil which gets acidified during precipitation[1]. A number of studies show that air pollution can alter physiological and biochemical processes of the plants, thereby adversely effecting the growth. Air pollutants can damage the leaf cuticles and effect stomatal conductance, photosynthetic systems, leaf longevity and patterns of carbon assimilation within plants[2]. The extent of injury or damage depends on the concentration of atmospheric gases, duration of exposure and the existing environmental conditions[3]. Inspite of adverse affects of these pollutants there are a few reports on pollution tolerant plants[4]. Plants play an important role in monitoring and maintaining the ecological balance.

The possibility to remove pollutants from the air by plants, which act as sinks for air contaminants have been reported by Sunitha and Rao[5]. To screen plants for their sensitivity /tolerance level to air pollution, large number of parameters were considered like leaf stomatal conductance[6], membrane permeability[7], glutathione (GSH) concentration[8,9], δ^{13} C of leaf tissue[10], ascorbic acid content, relative water content, peroxidase activity, chlorophylls and leaf extract pH[11-14]. These separate parameters gave conflicting results for some species[15]. To provide a clear picture of air pollution tolerance index (APTI) based on four parameters *i.e.* ascorbic acid, total chlorophyll, relative water content and leaf extract pH are computed together in a formulation to obtain empirical value signifying the APTI which has been used for identifying tolerance levels of plant species[16-19].

The aim of the present study is to determine the APTI values of two plant species and to find out their tolerance/ sensitivity when exposed to vehicular pollution.

Material and Method

Mehdipatnam a high traffic prone area is situated in Hyderabad, a Deccan plateau region of Andhra Pradesh exhibiting a semi arid type of climate. During the study period the mean daily maximum temperature was 36±2°C and mean minimum temperature was 22±2°C. The annual mean humidity was 47%. The air environment of this region is contaminated with different concentrations of SO_2, CO_2 and NO_2. The major source of pollution in this

Table 1. Air Pollution Tolerance Index (APTI) for plant species from Mehdipatnam area of Hyderabad, A.P.

S.No.	Plant Species	Total Chlorophyll (mg/gr.fr.wt.) ±SD	Ascorbic Acid (mg/gr.fr.wt.) ±SD	pH±SD	RWC %±SD	APTI±SD
1	*Amaranthus viridis*	2.073±0.37	14.57±1.71	4.55±0.63	73.1±5.11	17.26±1.33
2	*Euphorbia hirta*	2.956±0.39	6.96±0.61	5.68±0.29	64.70±0.99	12.51±0.88

SD = Standard deviation

region is automobile exhaust.

Plants like *Amaranthus viridis* and *Euphorbia hirta* were selected from the highly polluted zones of Mehdipatnam and were investigated with respect to their physiological and biochemical parameters to calculate the air pollution tolerance index.

The fully matured leaves were collected from the selected plants in the morning hours from four different zone/regions from the road side and were taken to the laboratory in an ice box and were stored in a refrigerator for further study. Utmost care was taken to see that the plants had isoecological conditions. The collected samples were analysed for total chlorophylls, ascorbic acid content, relative water content and leaf extract pH. Analysis was carried out in triplicates.

Determination of ascorbic acid content: Ascorbic acid content was estimated according to the method of Roe[20] which is based on the reduction of 2,6-dichlorophenol indophenol (2,6-DCIP) by ascorbic acid. One gram leaf tissue was macerated with 10 ml of 5% metaphosphoric acid using a mortar and pestle. The homogenate was filtered through filter paper and the filtrate was made up to 20 ml with 5% metaphosphoric acid. The samples of 10 ml aliquots were titrated with 0.025% 2,6-DCIP reagent until a pink end point that persists for 15 seconds was obtained. The quantity of ascorbic acid was calculated by comparing with the values obtained by the known quantities of standard ascorbic acid.

Estimation of Chlorophyll: Chlorophylls were estimated by the method of Arnon[21]. 200 mg of fresh leaf material was taken in a mortar and ground with help of a pestle using 10 ml of 80% acetone. The homogenate was centrifuged at 2500 rpm for 15 minutes. The supernatant was saved. The residue was re-extracted with 80% acetone. The supernatant was collected and utilized for chlorophyll estimation. Absorbance was read at 663, 645 and 480 nm in the UV-spectrophotometer.

Chlorophyll 'a' (mg/g FW) = (0.0127) × (OD 663) - (0.00269) × (OD 645)

Chlorophyll 'b' (mg/ g FW) = (0.229) × (OD 645) - (0.00488) × (OD 663)

Total chlorophyll (mg/ g FW) = (0.0202) × (OD 645) + (0.00802) × (OD 663)

where, FW = Fresh weight, OD = Optical density

Relative water content (RWC): RWC was determined according to the method described by Liu and Ding[16] and calculated with the formula:

RWC = [(FW - DW)/ (TW - DW)] × 100

where, FW = Fresh weight, DW = dry weight, TW = Turgid weight

Fresh weight was obtained by weighing the fresh leaves. The leaves were then immersed in water over night, blotted dry and then weighed to get the turgid weight. Then, to determine the dry weight the leaves were dried in an oven at 80°C for 48hrs and reweighed.

Leaf extract pH: 5gms of the leaf material was homogenized in 10ml of deionized water. This was then filtered and the pH was determined after calibrating pH meter with buffer solution of pH 4 and 9[22].

APTI calculation: The APTI was computed by the method suggested by Singh and Rao[23] using the equation,

APTI= [A (T+P) +R]/10

where, A = ascorbic acid content (mg/gr.fr.wt); T= total chlorophyll (mg/gr.fr.wt); P = the leaf extract pH and R = relative water content of the leaf (in %).

Results and Discussion

APTI is calculated for two plant species growing in the highly polluted region of Hyderabad and the data is presented in Table 1. All biochemical parameters that are analyzed for APTI play significant role to determine susceptibility/ tolerance. According to APTI value the plants are grouped as sensitive or tolerant[24]. The APTI values of *Amaranthus viridis* was 17.26 which lies under intermediate response and that of *Euphorbia hirta* is 12.5 categorized as sensitive species.

Total chlorophyll was found to be higher in *E. hirta* compared to *A. viridis*. Chlorophyll content signifies the plant's photosynthetic activity and development of biomass. Depletion in chlorophyll is an indication of poor vigour. The chlorophyll level decreased under stress[25].

Bell and Mudd[26] suggested that tolerance of plant's to SO_2 might be linked to synthesis or degradation of chlorophyll. An increase in the atmospheric CO_2 alter the activity of Ribulose 1,5, bis phosphate caboxylase and oxygenase (RUBISCO) in favour of carboxylation[27,28]. Very high concentration of CO_2 in the atmosphere can result in the closure of stomata as it is a natural anti transpirant and which results in decreased internal CO_2 concentration in the leaves, thus causing a decrease in net photosynthesis[29,30]. This can also result in reduced transpiration pull which will shut down the supply of water for the photosynthetic mechanism[31].

Ascorbic acid content showed higher levels in *A. viridis* than in *E. hirta* for which low values were recorded showing a susceptible nature. Ascorbic acid is a natural antioxidant which prevents the damaging effect of air pollution in plant tissues[12]. It plays a significant role in photosynthetic carbon fixation, so is a very important multiplicative factor used in determining APTI. Higher ascorbic acid concentration is a sign of tolerance against SO_2 pollution[32,33]. Lower ascorbic acid content in the leaves suggest sensitive nature towards automobile exhaust[34]. Tripathi and Gautam[35] reported higher concentration of ascorbic acid in the leaves of *Mangifera indica.* L. near roadside due to enhanced pollution by vehicles.

Relative water content is a crucial prerequisite for plant life. The shortage of water may cause severe stress in plants[36]. High water content within the plant maintains its physiological balance under stress. Air pollution increases cell permeability[37] which causes loss of water and dissolved nutrients resulting in the early senescence of leaves[38].

The leaf extract pH in the presence of acidic pollutants decreased and the decline was greater than that of tolerant plants. Higher levels of leaf extract pH in plants under polluted conditions may increase their tolerance level to air pollution[36].

Air pollution tolerance index is an index which denotes capability of a plant to combat against air pollution. Plants having higher index value are tolerant to air pollution and can be used as sink to mitigate pollution while plant with low index value are less tolerant and can be used as indicators of air pollution.

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