RESEARCH ARTICLE

ASSESSMENT OF AIR POLLUTION TOLERANCE INDEX OF PLANT SPECIES GROWING NEAR METAL CASTING FOUNDRIES AROUNDPEELAMEDU, COIMBATORE.

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Abstract

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The study examined Air pollution tolerance index (APTI) of 35 plants growing near metal casting foundries located in and around Peelamedu, Coimbatore. Four physiological and biochemical parameters of plant leaves namely total chlorophyll content, relative water content, pH, and ascorbic acid content which can be used as predictor of air quality. It is observed that *Lantana indica, Nerium indicum*, *Duranta repens,Amaranthus viridis, Ricinus communis*, *Bauhinia racemosa* and *Samanea saman*, showed higher APTI values. The study indicates that plantation of tolerant species are useful for bio monitoring and to develop green belt in and around industrial areas.

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Introduction:-

Air pollution was earlier considered as a local problem around large point sources. But due to the use of tall stacks and long range transport of pollutants, it has become a regional problem. Many developing countries including India have experience a progressive degradation in air quality as a result of rapid pace of development over the last three decades. During this period newly industrialized countries underwent unparalleled economic growth, swelling urban populations and generated excessive emissions from automobiles, factories and refuse burning (Agbaire and Esiefarienrhe 2009). Much of the 20th century witnessed an increasing trend in urbanization in developing countries. While urbanization is a stimulus of development, in the process many cities in Asia, Africa, the Near East and Latin America are facing two challenges of pollution and congestion (Ashmore, 2005).

Air pollution is more complex than most other environmental challenges. No physical or chemical methods are known to ameliorate air pollution. A suitable alternative is to develop a biological by growing green plants in and around industrial and urban areas (Shannigrahi *et al.,* 2004, Ghose and Majee 2001 and Aarti *et al*., 2012).

Plants plays a vital role in monitoring and maintaining the ecological balance by actively participating in the cycling of nutrient and gases like CO_2, O   and also provide enormous leaf area for impingement absorption and accumulation of air pollutants to reduce the pollution level in the air environment (Escobedo *et al*., 2008). Several contributors agree that air pollution affects the plant growth adversely (Rao 2006, Chandawat*et al*., 2011 and Bhattacharya *et al*., 2012).

Coimbatore, one of India's leading industrial centers with excellent potential for industrial growth isspread about 105.6 sq.km and has a population of 1.1 million people. The city is one of the important foundry cluster area in

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southern India. The majority of the foundry units fall under the category of small scale industry. There are about 250 small scale foundries located every 2 km in the industrial sector of Coimbatore. Air pollution due to these industries has become a serious environmental stress to plants. The emission of gases and dust particles from the industry causes serious setback to the overall physiology of plants. Among all the plant parts, leaf is the most sensitive part to air pollutants and several other such external factors. Response of plants toward air is being assessed by air pollution tolerance index. This index has been used to rank plant species in their order of tolerance to air pollution. Some plant species and varieties are so sensitive that they can be conveniently employed as biological indicator or monitors of specific pollutants. The present investigation was undertaken to study the air pollution tolerance index of plant growing near mental casting foundries located in and around Peelamedu, Coimbatore.

Materials and Methods:-
Study Area:-
Peelamedu is a residential and commercial neighborhood in the city of Coimbatore, Tamil Nadu, India, located at 11.031.N and 76.999 E. It is situated just 5 km away from the heart of the city Gandhipuram. There are many large, medium and small scale metal casting foundries are operating from here.

Sampling:-
For the present study, fresh leaves from each plant were collected from the experimental sites of urban and industrial areas of Peelamedu from July to March, 2012-2013. Three replicates of fully matured leaves of each species were taken in the morning (9:30 am to 11:30 am). The experiments were replicated three times for each biological factor. Leaves from same plant species (control) were collected from Indian Forest Genetics and Tree Breeding (IFGTB) Campus which is used as control area located for away from the industrial area which is a pollution free atmosphere. The weight of fresh leaves was taken immediately upon getting to the laboratory. Samples were preserved in refrigerator for further analysis.

Ascorbic acid content:-
Ascorbic acid content (expressed in mg/g) was measured using spectrophotometric method (Bajaj and Kaur, 1981). 1 gram of the sample was measured in to a test tube, 4 ml oxalic acid – EDTA extracting solution was added. Then 1 ml of orthophosphoric acid followed by 1 ml of 5% teraoxosulphate (vi) acid. To this 2ml ammonium molybdate was added and then 3ml of water. The solution was then allowed to stand for 15 minute, after which the absorbance at 760 nm was measured with a spectrophotometer. The concentrations of ascorbic acid in the sample were then extrapolated from a standard ascorbic acid curve.

Total chlorophyll content:-
Chlorophyll content was estimated using the method of Arnon (1949). 0.1 gram of fresh leaf material crushed with mortar and pestle. The crushed samples were collected and washed with 2 ml of 80 per cent acetone in three tubes. The contents are transformed into centrifuge tubes and the samples are centrifuged at 2,500 rpm for 10 min. The supernatant was collected in each test tube and the final volume of supernatant is made up to 10 ml by adding 80 per cent acetone using measuring cylinder and the absorbance is read at 645 nm and 663 nm for chlorophyll a and b using a spectrophotometer. The amount of total chlorophyll present in the extract (mg chlorophyll per gram tissue) was calculated by using the formula given below:

$$\text{Chlorophyll a / g tissue} = 12.7 (A_{663}) - 2.69 (A_{645}) \text{ x } \frac{V}{1000} \times W$$

$$\text{Chlorophyll b / g tissue} = 22.9 (A_{645}) - 4.68 (A_{663}) \text{ x } \frac{V}{1000} \times W$$

$$\text{Total chlorophyll / g tissue} = 20.2 (A_{645}) - 78.02 (A_{663}) \text{ x } \frac{V}{1000} \times W$$

where: A = Absorbance at specific wave length, V = Final volume of chlorophyll extract in 80 per cent acetone, W = Fresh weight of tissue extracted.

Leaf extract pH:-
For determining pHof leaf extract, 5 gram of fresh leaf material was homogenized with 50 ml of distilled water and samples of the homogenate were centrifuged at 3000 rpm for 10 min and pH value of leaf extract was determined using a calibrated digital pH meter with buffer solution of pH 4 and pH 7.

Relative water content:-
Leaf RWC is determined by using the method described by Singh (1997) and calculated with the formula   RWC
(%) = [(FW – DW) /)(TW – DW)] x 100
                    where,   **FW** – Fresh Weight,
                DW – Dry Weight,
                TW – Turgid Weight.

Fresh weight is recorded by weighting the fresh leaves. To get the dry weight, the leaves were dried in an oven at
70°C for overnight and then taken the dry weight. For getting the turgid weight, the leaves were immersed in water
overnight, blotted dry and then weighed.

Air pollution tolerance index determination:-
APTI was calculated by the following formula proposed by Singh and Rao (1983).The formula of APTI is given as:
            APTI= [A (T+P) +R]/10
Where A= ascorbic acid content (mg/g)
        T= total chlorophyll (mg/g)
        P= pH of leaf extract
        R= relative water content of leaf (%)

Results and Discussion:-
The plant being constantly exposed to the environment absorbs, accumulate and integrate pollutants impinging on
their foliar surface. Consequently they show visible or subtle changes depending on their sensitivity level.

Table 1:- Ascorbic acid content, Total chlorophyll, pH, and Relative water content of the selected plant species

S.No	Name of the plant	Ascorbic acid content (mg/g)	Total chlorophyll content (mg/g)	pH value	Relative water content (%)
1.	*Achras sapota*	36.6± 1.22	0.49± 0.17	6.1± 0.03	73.4± 3.05
2.	*Achyranthus aspera*	37.9± 2.02	0.70± 0.07	7.2± 0.02	82.0± 2.22
3.	*Aegle marmelos*	45.7± 0.70	1.50± 0.02	6.3± 0.01	69.0± 2.01
4.	*Amaranthus viridis*	60.6± 1.44	1.85± 0.22	6.7± 0.02	62.5± 3.18
5.	*Azadirachta indica*	20.1± 1.00	1.06± 0.05	6.1± 0.02	77.9± 3.22
6.	*Bauhinia racemosa*	76.8± 1.41	0.32± 0.67	6.2± 0.02	44.8± 2.88
7.	*Boerhaavia diffusa*	21.9± 1.33	1.07± 0.34	6.3± 0.01	45.0± 2.04
8.	*Caesalpinia pulcherrima*	62.1± 1.01	0.60± 0.67	6.1± 0.02	53.8± 3.55
9.	*Calotropis gigantea*	17.8 ± 0.32	0.33± 0.04	6.4± 0.01	77.5± 1.88
10.	*Cassia fistula*	59.4± 0.06	1.46± 0.12	4.6± 0.02	78.0± 2.22
11.	*Catharanthus roseus*	47.0± 1.12	0.57± 0.09	6.1± 0.02	79.8± 3.05
12.	*Citrus lemon*	36.6± 2.23	1.06± 0.34	7.3± 0.03	66.6± 3.05
13.	*Clitoria ternatea*	56.0± 1.20	0.13± 0.07	6.8± 0.02	59.3± 1.42
14.	*Datura stramonium*	45.0± 1.22	0.83± 0.21	5.4± 0.01	78.7± 2.01
15.	*Duranta repens*	81.0± 2.45	0.29± 0.06	6.2± 0.01	72.2± 3.22
16.	*Lantana indica*	79.2± 1.22	0.48± 0.22	7.8± 0.01	50.8± 3.06
17.	*Lowsonia inermis*	32.1± 1.02	1.40± 0.01	5.4± 0.02	81.0± 2.22
18.	*Lycopersicum esculentum*	31.0± 0.82	0.17± 0.02	5.1± 0.01	74.02± 2.44
19.	*Mangifera indica*	46.1± 1.04	0.30± 0.02	5.9± 0.02	74.47± 3.05
20.	*Mirabilis jalapa*	51.5± 1.00	0.12± 0.04	5.3± 0.02	71.01± 2.22
21.	*Nerium indicum*	78.0± 1.22	1.40± 0.08	6.1± 0.01	86.03± 3.88
22.	*Parthenium hysterophorus*	27.6± 0.88	0.20± 0.04	6.1± 0.02	61.09± 4.01
23.	*Pisonia alba*	44.6± 1.05	0.32± 0.09	6.1± 0.02	83.7± 2.86
24.	*Polyalthia longifolia*	15.0± 1.22	0.17± 0.02	6.0± 0.01	84.23± 3.88
25.	*Pongamia pinnata*	37.6± 0.44	0.06± 0.12	6.3± 0.02	73.8± 2.84
26.	*Prosopis juliflora*	68.6± 1.02	0.25± 0.05	6.1± 0.02	80.0± 3.18
27.	*Psidium guajava*	17.0± 1.22	0.12± 0.34	6.1± 0.03	70.0± 2.09

28.	*Ricinus communis*	59.2± 1.33	1.60± 0.02	6.7± 0.02	75.6± 3.02
29.	*Samanea saman*	49.1± 0.88	0.34± 0.02	6.1± 0.01	46.6± 2.66
30.	*Sida acuta*	26.4± 1.08	0.46± 0.08	6.4± 0.02	49.86± 3.60
31.	*Tabernaemontana divaricata*	31.6± 1.20	0.43± 0.05	6.1± 0.02	83.07± 4.02
32.	*Tecoma stans*	25.3± 1.22	1.08± 0.08	5.6± 0.01	64.6± 3.18
33.	*Terminalai catappa*	75.4± 1.55	0.48± 0.02	4.5± 0.02	75.49± 2.02
34.	*Thespesia populnea*	63.0± 1.44	0.93± 0.02	6.0± 0.02	72.04± 1.88
35.	*Tridax procumbens*	23.6 ± 1.05	0.71± 0.02	5.9± 0.01	64.71± 3.33

 The increased level of ascorbic acid in leaves will increase air pollution tolerance in plants (Chaudhury and Rao, 1977). In the present study, the plant species namely *Duranta repens,Lantana indica,Nerium indicum, Bauhinia racemosa, Terminalai catappa, andProsopis juliflora* showed increased concentration of ascorbic acid (Table 1). The variation in chlorophyll content in plants is because of various environmental factors such as air, water and soil (Katiyar and Dubey 2000). Chlorophyll is the principal photoreceptor in photosynthesis. Hence its measurement is an important tool to evaluate the effects of air pollutants on plants. It plays an important role in plant metabolism and any reduction in chlorophyll content corresponds directly to plant growth (Joshi and Swami, 2009). A higher concentration of chlorophyll was recorded in *Amaranthus viridis* followed by *Ricinus communis, Aegle marmelos,Cassia fistula, Lowsonia inermis* and *Nerium indicum* (Table 1).

The leaf extract pH was found to be alkaline in species like *Lantana indica* (7.8), *Citrus lemon* (7.3) and *Achyranthus aspera* (7.2) whereas, it was acidic in other species. A significantly lowest pH value was shown in *Terminalia catappa* (4.5) (Table 1). Schltz and Reck (1977) reported that in the presence of an acidic pollutant, the leaf pH is lowered and decline is greater in sensitive species. A shift in cell sap pH toward the acid side in the presence of an acidic pollutant might decrease the efficiency of conversion of hexose sugar to ascorbic acid. However, the reducing activity of ascorbic acid is pH controlled, being more at higher and less at lower pH. Hence, the leaf extract pH on the higher side gives tolerance to plants against pollution (Agarwal and Tiwari, 1997). Relative water content is associated with protoplasmic permeability in cells caused loss of water and dissolved nutrient resulting in early senescence of leaves (Masuch *et al*. 1988). It is likely that the plants species with high relative water content may be tolerant to pollutants. The relative water content was found to be higher in *Nerium indicum* (86.03), and *Polyalthia longifolia* (84.23), *Pisonia alba* (83.7), *Achyranthus aspera* (82.0), *Lowsonia inermis* (81.0)and *Prosopis juliflora* (80.0)(Table 1).

Air pollution tolerance index is an index denotes the capability of a plant to combat against air pollution. Plant which have higher index value are tolerant to air pollution and can be caused as sink to mitigate pollution, while plants with low index value show less tolerance and can be used to indicate levels of air pollution (Singh and Rao, 1983). Among the plant species studied the highest tolerance was shown *Lantana indica* (68.12), *Nerium indicum* (67.10), *Duranta repens* (59.79), *Ricinus communis* (56.70), *Amaranthus viridis* (57.60), *Bauhinia racemosa* (54.50), *Samanea saman* (52.06), *Prosopis juliflora* (51.60) and *Thespesia populnea*(50.86) (Figur.1). Plantation of these tolerant species is useful for bio monitoring and to develop the green belt among the nature and to reduce industrial air pollution. This is very essential for saving the environment for our future generation to protect the present generation.

Figure: 1 Air Pollution Tolorance Index of Selected Plants
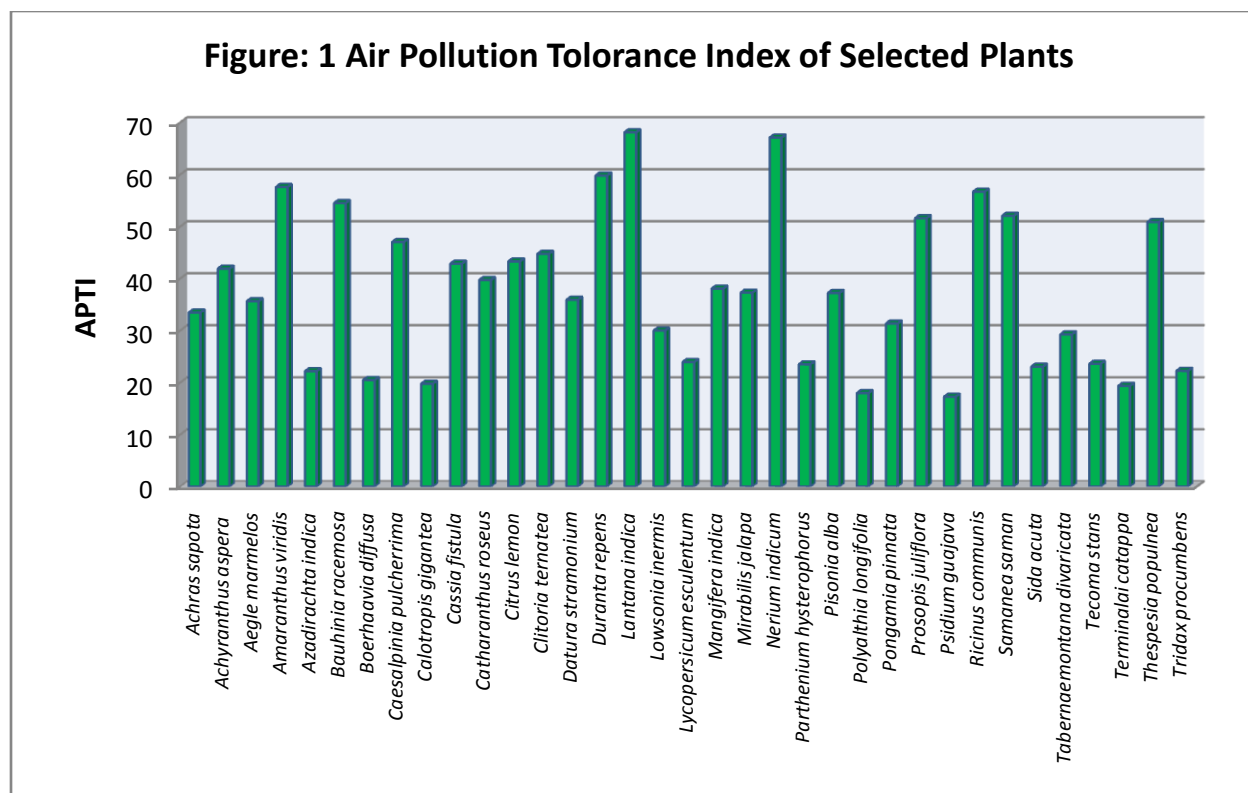
Conclusion:-

Day by day with increasing urbanization and industrialization, the air quality is degrading. Plants plays significant role in mitigation the air pollution and maintains ecological balance. APTI determination is of utmost importance because with increase in small scale industries the pollution load is on rise. From the results of the present study, this tolerant plant species can be used as indicators of pollution there by acting as a sink to all air pollutants.

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