Research Article

Study of effect of industrial pollutants on morphological and biochemical parameters of some common fruit yielding plants around Vedanta Aluminium Limited, Jharsuguda

Sandhyarani Choudhury, Binod Parida and Dr. Lichita Patro*
PG Department of Botany, Government Autonomous College, Rourkela - 700694

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ABSTRACT

Industrial pollutants contribute a major source of air pollution throughout the world. It not only has a negative impact on animals but also on plants. Several morphological and vital physiological processes are affected negatively by these pollutants. Present investigation explains the studies on comparative account on the impact of industrial pollutants from Vedanta Aluminium Limited, Jharsuguda. The leaf samples of *Carica papaya, Psidium guajava, Mangifera indica and Atrocarpus heterophyllus* were collected from areas with potentially higher and lower levels of industrial pollution. Average leaf area, dust load on leaf, pH, photosynthetic pigments such as chlorophyll-a, chlorophyll-b, carotenoid and pheophytin were quantified. There is a significant reduction in leaf area, pH, chlorophyll and carotenoid content of plants with increase in dust content at polluted site as compared to non-polluted site. But there is dramatic rise in pheophytin content showed the resistant of plants towards industrial pollutants. As it was observed that the plants under experimentation show sensitive to industrial pollutants, thus may cause decrease the economic and nutritional value of the fruit yielding plants.

***Corresponding author:**

Dr. Lichita Patro*

PG Department of Botany, Government Autonomous College, Rourkela - 700694
E-mail: lichita_k9@yahoo.com

INTRODUCTION

In nature, plants frequently experience a wide range of stresses, both abiotic and biotic (1).Plants response to abiotic stress factors are extensively studied in recent years and are shown to result in several responses. Abiotic stress factors may be physical (Heat, chilling, flooding, drought, salinity, radiation) or Chemical (air pollution, heavy metals, pesticides) (2).The plants being immobile, experience more stress than animals, due to industrial pollution. Many plants are very sensitive to these pollutants which can damage their leaves, growth and primary productivity (3).The leaves of the plants that get damaged most than the other parts of the plants due their external exposure to environment. The major damages caused by the pollutants to plants include chlorosis, necrosis and epinasty (4).The Pollutants are the major abiotic stress that cause damage in morphological as well as many physiological processes like photosynthesis, protein synthesis, stomatal behaviour, senescence etc. (5).Since plants are stationary and continuously exposed to industrial pollutants from the surrounding atmosphere, the rate of damage to plants is proportional to the intensity of the pollution (6).

A number of literatures are available regarding various parameters like chlorophyll content, relative water content, ascorbic acid content, amount of dust load etc, to assess the air pollutants effect (6-9). But a single parameter is not sufficient for quantifying the present pollution induced changes. Therefore, in the present study morphological as well as biochemical parameters have been studied for identifying stress tolerance level of plants. Some common fruiting plants were collected from the area located within 5 K.M radius of Vedanta Aluminium Limited, Jharsuguda which is a Aluminium smelter industry releasing pollutants like SO_2,CO_2,NO_2,CO etc. The fruiting plants grown in polluted site is compared with the non-polluted site (Sunapanga near Maneswar, a small town in Sambalpur) where there is no effect of industrial pollution.

METHODOLOGY

Plant materials

The present investigation deals with comparative study of fruiting plants growing under heavily industrial polluted site with that of less or unpolluted site. For the experimental purpose leaf samples of four common fruiting plants grown on the road side were selected. The plants were *Carica papaya, Psidium guajava, Magnifera indica, and Atrocarpus heterophyllus*

Study area

Leaf samples were collected from Vedanta Aluminium Limited (VAL), Jharsaguda, One of the full-fledged industries producing metals. Recent reports of ministry of environmental and forest, Govt. of India declared VAL area as one of the worst polluted sites in the country. The extent of dust pollution in the area has been visible with reduction in visibility. The present study was undertaken to identify the tree species facing the pollution which are nearest to industry present within 5 K.M of radius of Vedanta Aluminium Limited.

For the comparative study, the control samples were collected from Sunapanga, near Maneswar, a small town in Sambalpur district. It is a rural area without effect of pollution.

Determination of leaf area and amount of dust content

The leaf area and amount of dust content of the leaves collected from both polluted and non-polluted sites were determine by the procedure given as per Thakar and Mishra (5).

Determination of pH

The pH of the solution obtained from washing of leaves were determined by the ELICO table top pH meter as per Shukla et al., (11).

Quantification of leaf pigments

The leaves from the fourth whorl of the plants selected for the experimental purpose were taken for quantification leaf pigments. Pigments were extracted from the leaves with chilled 80% acetone. Estimation of chlorophyll (chl) was performed spectrophotometrically as per Arnon (12) and that of carotenoids (car) as per Liaaen-Jensen and Jensen (13).The pheophytin (pheo) was estimated as per the method described by Vernon (14).

RESULTS

The table-1, 2, 3 and 4 depicts different physiological and biochemical parameters of leaves of *Carica papaya, Psidium guajava, Mangifera indica and Atrocarpus heterophyllus* respectively. The content of dust load showed the trend *Carica* (66.6%) > *Mangifera* (55%) > *Psidium* (50.2%) > *Atrocarpus* (39%). In all the cases pH of plants from polluted site showed acidic nature whereas at non-polluted site the pH of leaves were neutral. Similar trend of decrease in leaf area, Chl a/b, total chlorophyll (chl) and carotenoids (car) were observed in the above mentioned tables. The decrease in leaf area in *Psidium* (43%) is more as compared to *Carica* (37%), *Mangifera* (26%) and Artocarpus (12.5%). There was also more loss in chlorophyll (51%) and carotenoids (34%) content of *Psidium* leaves in contrast to others. On the other hand there was significant increase in pheophytin content in all the cases.

Table-1: Effect of pollutant stress on content of dust load (in gm), leaf area (in cm 2), chlorophyll (mg/gm FW), carotenoids (mg/g FW), pheophytin (mg/g FW) of *Carica papaya.* Mean of 7 independent measurements ± SD

Parameters	NPS	PS
Dust load	3±0.10	5±0.6
pH	7.1	6.1
Leaf area	656.73±6.5	406.7±5.1
Chl a/b	3.21	3.08
Total chlorophyll	4.66±0.43	3.23±0.22
Carotenoid	0.21±0.01	0.18±0.01
Pheophytin	8.27±0.8	12.74±0.9

NPS-Non polluted site, PS- Polluted site

Table-2: Effect of pollutant stress on content of dust load (in gm), leaf area (in cm 2), chlorophyll (mg/gm FW), carotenoids (mg/gm FW), pheophytin (mg/gm FW) of *Psidium guavaja.* Mean of 7 independent measurements ± SD

Parameters	NPS	PS
Dust load	2.3±0.10	3.5±0.6
pH	7.2	5.9
Leaf area	43.5±0.5	23.7±0.1
Chl a/b	2.23	3.02
Total chlorophyll	8.22±0.43	3.97±0.22
Carotenoid	0.26±0.02	0.17±0.01
Pheophytin	3.27±0.8	4.84±0.9

NPS-Non polluted site, PS- Polluted site

Table-3: Effect of pollutant stress on content of dust load (in gm), leaf area (in cm 2), chlorophyll (mg/gm FW), carotenoids (mg/gm FW), pheophytin (mg/gm FW) of *Mangifera indica.* Mean of 7 independent measurements ± SD

Parameters	NPS	PS
Dust load	4±0.3	6.2±0.6
pH	7.3	5.6
Leaf area	49.3±0.5	36.7±0.3
Chl a/b	2.97	2.21
Total chlorophyll	7.66±0.45	4.23±0.22
Carotenoid	0.29±0.01	0.18±0.01
Pheophytin	11.27±1.2	17.74±0.92

NPS-Non polluted site, PS- Polluted site

Table-4: Effect of pollutant stress on content of dust load (in gm), leaf area (in cm 2), chlorophyll (mg/gm FW), carotenoids (mg/gm FW), pheophytin (mg/gm FW) of *Artocarpus heterophylla.* Mean of 7 independent measurements ± SD

Parameters	NPS	PS
Dust load	2.3±0.10	3.1±0.6
pH	7.1	6.6
Leaf area	56.73±2.5	49.7±5.1
Chl a/b	2.5	2.0
Total chlorophyll	6.66±0.5	5.23±0.3
Carotenoid	0.26±0.01	0.20±0.01
Pheophytin	12.27±0.7	16.74±1.1

NPS-Non polluted site, PS- Polluted site

DISCUSSION

The intensity of pollutant stress is defined by the calculated values of dust load on the surface of the leaves. Dust deposition capacity on leaves varies from species to species which depends on the surface geometry, phyllotaxy and leaf external characteristics such as presence or absence of hairs, cuticles, length of petiole, height and canopy(5, 15-17).Highest dust accumulation in *Carica papaya ,Psidium guavaja and Magnifera indica* than *Artocarpus* due to waxy coating, rough surface with slightly folded margin. Lower dust accumulation in *Artocarpus* may be due to its smooth flat surface and entire margin. Our result shows similarity that evidenced from Rai and Panda (18, 19). Due to accumulation of dust there is damage of cuticular wax by which pollutants enter the leaves through stomata (20).As the pollutants content more amount of oxides of nitrogen, sulphur, carbon they cause acidity in cell sap which is confirmed by our result on the measurement of pH.

When we determine the leaf area, the size of the leaves of all the plants under study became decreases in polluted site as compared to non-polluted one. This is because of necrosis, curling and folding of leaves in polluted areas. Similar result was observed by Shukla et al., and Singh and Kant (11, 21).

The loss of Chl were more pronounced in all the plants under experimentation due to pollutant stress as compared to non-pollutant ones. The decline in pigment content could be attributed to the increase in pH and decrease in leaf area due to dust load. The higher the level of pollutants, the lower the Chl content, as certain pollutants totally reduce the Chl content (22). The Chl a/b value which was taken as the index for the relative stability of reaction centres of the photo systems and the light harvesting complex of chloroplast (LHC). The decline in Chl a/b in all the cases showed the relatively stable LHC which could be an adaptive strategy to overcome the stress.

On the other hand, there was a dramatic increase in pheophytin content as supported by Rao and Leblanc and Agarwal (23, 24). There is formation of Pheo by acidification of Chl in the presence of acidic pollutants like sulphur dioxide and nitrogen dioxide in the present study area. As for photosynthetic pigments, the study shown that there is an adverse effect of heavy metals like Aluminium, Cadmium, and Chromium etc. on ordinary photosynthetic activities of plants. Chl revealed declined in activities as contrast to Pheo activity which shows a sharp rise especially to pollutant stress. (25). It is demonstrated that under pollutant stress chlorophyll undergoes several photochemical reactions oxidation, reduction and pheophytinisation (26, 27). Conversation of Chl to Pheo during pollutant stress depends on temperature, length of heat treatment and pH. As the air pollutants cause high temperature and acidic pH in atmosphere directly affect the cell sap.

Thus from the above discussion it can be concluded that the plants under pollutant stress show sensitivity towards pollution. This may cause reduction in nutritional value and yield of fruits in these plants.

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