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EFFECTS OF AIR POLLUTION ON MORPHOLOGICAL AND PHYSIOLOGICAL FEATURES OF *Malva parviflora*

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ABSTRACT

Increasing industrial activity intensifies the release of different types of harmful pollutants into the atmosphere. Air pollution with dust, smoke and chemical vapor is hazardous to humans as well as to plants. This study describes the effect of air pollution resulted from brick factories and road side pollution on some morphological and physiological characteristics of *Malva parviflora* growing naturally around these pollution sources. The morphological traits as stem length, branch number, root length, leaf length, leaf width and leaf area as well as some physiological characteristics as levels of chlorophyll a, chlorophyll b, carotenoids and total soluble sugars were investigated. The results showed that the morphological and physiological features of *Malva parviflora* were reduced in the polluted areas in comparison with regions away from these areas.

Keywords: Air pollution, morphological traits, physiological characteristics, *Malva parviflora.*

INTRODUCTION

Pollutants released from different industries adversely affect man's food supply. The presences of such toxic pollutants in the environment are responsible for altering the ecosystem. The air pollution due to traffics and brick factories plays a significant role in the environment imbalances and in production of air pollution hazardous effects (Stern, 1976; Thambavani and kumar 2011; Thambavani and kumar 2012).

Air pollution causes diverse effects on the physiological processes in plants that lead to reduction in plant growth (Schutzki and Cregg, 2007). Air pollution affects many metabolic processes in plants such as photosynthesis, mitochondrial respiration and stomatal clogging (Miller *et al.*, 1973).

Taylor and Davies (1990) reported that the ambient level of air pollution affects stomatal conductance, photosynthesis and root morphology of young beech. Out of the most recent studies indicated that dust accumulation causes severe damage in the photosynthetic apparatus is study by Santosh and Tripathi (2008).

Besides causing suppression of plant growth, pollution dust induces the changes in the physico-chemical properties of the soil rending it (Parthasarthy et al., 1975; Singh and Rao, 1978; Addo et al., 2013). In comparison to gaseous air pollutants, only limited studies have been carried out on the effect of particulate air pollutants on plant including fluoride dust (McCune *et al.,* 1965), soot (Miller and Rich, 1967), lead particles, brick factories pollutants, roadside pollutants, cement dust (Darley, 1966; Pandey and Simba, 1988, 1990) and coal dust (Rao, 1971).

The aim of the study was to investigate the impacts of roadside and brick factories pollutants on morphological characteristics and physiological features of *Malva parviflora*.

MATERIALS AND METHODS

The *Malva parviflora* samples growing naturally around road sides and brick factories were collected at zero meter (polluted sites) and 120 meters (non-polluted sites) from the studied pollution sources.

Chlorophyll a, chlorophyll b and carotenoids were analyzed following the method of Lichthenthaler (1987). Total soluble sugar was determined by the method adopted by Thayumanavan and Sadasivam (1984). Leaf area was estimated as Length X Breadth X 0.794 (Carvalho *et al*., 2011). The samples were investigated in triplicate.

RESULTS AND DISCUSSION

The morphological characteristics:

The obtained results showed significant reduction in the morphological characteristics in the polluted sites at roadside (Table 1) than the sites at 120 meters away from these sites (considered as control). Where the stem length was 28.13 ± 4.99 cm at the polluted sites and 41.25 ± 8.26cm at 120 meters away from polluted sites; root length was 10.28 ± 1.37 cm at the polluted sites and 12.94 ± 1.70 cm at 120 meters. Also, number of branches, leaf length, leaf width and leaf area were recorded in polluted sites and at 120 meters as follow: 9.5 ± 3.16 and 16.88 ± 5.28; 4.68 ± 0.31cm and 6.36 ± 0.63 cm respectively leaf width from 5.2 ± 0.46 and 7.33 ± 0.77 as well as 18.24 ± 2.11 cm^2 and 34.98 ± 5.04 cm^2 respectively.

Meanwhile, at the brick factories there were significant reduction in the morphological characteristics at the polluted sites as stemlength from 42.50 ± 4.50 cm at the factory sites to 24.25 ± 4.03 cm at 120 meters away from factory sites, root length from 8.23 ± 1.67 cm at the factory sites to 6.30 ± 1.46 cm at 120 meters away from factory sites, number of branches from 19.00 ± 3.46 at the factory sites to 11.00 ± 3.16 at 120 meters away from factory sites, leaf length from 5.85 ± 0.57 cm at the factory sites to 4.08 ± 0.61cm at 120 meters away from factory sites, leaf width from 4.40 ± 0.89 cm at the factory sites to 2.75 ± 0.37 cm at 120 meters away from factory sites and leaf area from 19.57 ± 5.39 cm^2 at the factory sites to 8.48 ± 2.22 cm^2 at 120 meters away from factory sites (Table 1). The Reduction increased with increasing the distance from the factories where the dust and pollutants released from their chimneys are at high elevation and so carried by air to affect plants away the factory itself.

Generally, the leaf area, leaf length, leaf width, number of branches, stemand root length were significantly reduced in polluted area than in areas away from pollution. Air pollutants can cause leaf injury, stomatal damage, reduced photosynthetic activity, disruption in membrane permeability and reduction in the growth and yield of the plants. Previous research reported significant reduction in many leaf growth parameters in the polluted areas in comparison with the control ones (Jahan and Iqbal, 1992; Seyyednejad *et al*., 2011). The obvious reduction in the leaf surface area causes less contact with air pollutants and improves plant resistance to pollution. Reduction in leaf area of many plant species growing in the vicinity of heavy pollutants was observed. Some hidden injury or physiological disturbance might be occurred in addition to the reduction in morphological and anatomical attributes (Seyyednejad *et al*., 2009). Long-lasting impact of different pollutants including sulphur and nitrogen oxides and heavy metals causes a reduction in the leaf size and growth of aerial parts (Kozlov *et al*., 1999; Tiwari *et al*, 2006). These leaf characteristics can demonstrate the air pollution (Jahan and Zafar, 1992).

Table 1. The comparison of morphological characteristics of *Malva parviflora* in the study sites.

Pollution source	Roadside		Brick factories	
Distance	Polluted sites	120m away	Polluted sites	120m away
Stem length (cm)	28.13 ± 4.99	41.25 ± 8.26	42.5 ± 8.54	24.25 ± 4.03
Branches number	9.5 ± 3.16	16.88 ± 5.28	19.00 ± 3.46	11.00 ± 3.16
Root length (cm)	10.28 ± 1.37	12.94 ± 1.70	8.23 ± 1.67	6.3 ± 1.46
Leaf length (cm)	4.68 ± 0.31	6.36 ± 0.63	5.85 ± 0.57	4.08 ± 0.62
Leaf width (cm)	5.2 ± 0.46	7.33 ± 0.77	4.4 ± 0.89	2.75 ± 0.37
Leaf area (cm^2)	18.24 ± 2.11	34.98 ± 5.04	19.58 ± 5.39	8.48 ± 2.22

Polluted sites = at zero meter; 120m away= 120 meters away from the pollution source. Values are the means of replicates ± standard deviation.

The biochemical characteristics:

It is clear from the results that the leaves collected from roadside polluted areas and at 120 meters from polluted areas showed significant decrease in chlorophyll a from 2.70 ± 0.85 mg/g fresh weight at 120 meters away from polluted sites to 1.16 ± 0.15 mg/g fresh weight at the polluted sites, chlorophyll b from 1.54 ± 0.58 mg/g fresh weight to 0.57 ± 0.11 mg/g fresh weight, carotenoids from 0.82 ± 0.48 mg/g fresh weight to 0.28 ± 0.13mg/g fresh weight and soluble sugar from 146.9 to 70.9 mg/g fresh weight. While the leaves collected from brick factories polluted area showed significant decrease in chlorophyll-a from 1.60 ± 1.10 mg/g fresh weigh at the factory sites to 1.17 ± 0.16 mg/g fresh weight at 120 meters from the factory sites, chlorophyll b from 0.86 ± 0.58 mg/g fresh weight at the factory sites to 0.65 ± 0.12 mg/g fresh weight at 120 meters away from the factory sites, carotenoids from 0.65±0.11 mg/g fresh weight at the factory sites to 0.29 ± 0.13 mg/g fresh weight at 120 meters from factory sites and soluble sugar from 128.88 at factory sites to 75.18 mg/g fresh weight at 120 meters away from factory sites (Table 2). The Reduction increased with increasing the distance from the factories where the dust and pollutants released from their chimneys are at high elevation and so carried by air to affect plants away the factory itself.

Chlorophyll and carotenoids are the main core of energy production in green plants, and their amounts are significantly changed by environmental effects on plant metabolism (Shweta and Agrawal, 2006). The photosynthetic pigments are most likely to be damaged by air pollution. Chlorophyll pigments under stress might undergo several photochemical reactions such as oxidation, reduction, phaeophytinisation and reversible bleaching (Giri *et al*, 2015). The chloroplast damaged by incorporation of cement dust on leaf caused reduction in chlorophyll concentration in the plants which are near the industry (Lerman, 1975; Singh and Rao, 1978). Similar results were observed in maize (Pandey and Simba, 1989; Pandey *et al*., 1999). Sulphur oxides and nitrogen oxides have detrimental effects that degrade chlorophyll to a photosynthetically inactive phaeophytin and Mg^{++}. Any alteration in chlorophyll concentration may change the morphological, physiological and biochemical behaviour of the plant. Air pollution-induced degradation in photosynthetic pigments was also observed (Bansal, 1988; Singh, 1990; Sandelius, 1995, Giri *et al*, 2013). Many researchers reported reduced carotenoids content under the effect of air pollution (Joshi *et al*, 2009; Tiwari et al, 2006; Giri *et al*, 2013).

In plant tissue, soluble sugars have osmoprotectant and cryoprotectant roles and their presence is important for plasma membrane integrity. Soluble sugars are important components in plant tissues; represent the source of energy in all organisms (Shvaleva *et al*, 2005; Moraga *et al*, 2006; Naya *et al*, 2007). Soluble sugars significantly reduced under air pollution due to the increase in respiration and decrease of CO_2 fixation because of chlorophyll deterioration. Pollutants like sulphur oxides and nitrogen oxides might cause more depletion of total soluble sugars in leaves of plants grown in polluted areas (Tripathi and Gutam, 2007; Giri *et al*, 2013).

Table 2. The comparison of biochemical characteristics of *Malva parviflora* in the study sites.

Pollution source	**Roadside**		**Brick factories**	
distance	**Polluted sites**	**120m away**	**Polluted sites**	**120m away**
Chlorophyll a mg/g FW	1.16 ± 0.15	3.70 ± 0.85	1.60 ± 1.10	1.17 ± 0.16
Chlorophyll b mg/g FW	0.57 ± 0.11	1.21 ± 0.58	0.86 ± 0.58	0.68 ± 0.13
Carotenoid mg/g FW	0.28 ± 0.13	0.82 ± 0.48	0.65±0.11	0.29 ± 0.13
Total soluble sugars mg/g DW	70.9	146.9	128.88	75.18

Polluted sites = at zero meter; 120m away= 120 meters away from the pollution source.
FW= Fresh weight, DW= dry weight.

CONCLUSION

The concentrations of chlorophyll a, chlorophyll b, carotenoids and total soluble sugar in *Malva parviflora* reduced in polluted regions. In addition, the growth traits of *Malva parviflora* were reduced in polluted regions compared with regions away from pollution.

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تأثير تلوث الهواء على الصفات المورفولوجية والفسيولوجية فى نبات الخبيزة

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زيادة الأنشطة الصناعية أدى إلى ظهور العديد من ملوثات الهواء في الغلاف الجوي هذه الملوثات لها تأثير خطير على الإنسان والنبات. هذه الدراسة تصف تأثير ملوثات الهواء الناتجة من مصانع الطوب و طرق المواصلات على الخصائص المورفولوجية و الفسيولوجية لنبات الخبيزة التي تنمو طبيعيا حول هذه المصادر . تم قياس الخصائص المورفولوجية مثل طول الساق & عدد الافرع وطول الجذر وطول وعرض الورقة ومساحة الورقة بالاضافة لبعض الخصائص الفسيولوجية مثل مستوى كلوروفيل (أ & ب) والكاروتينات والسكريات الكلية في النبات حيث اظهرت النتائج انخفاض ملحوظ في هذه الخصائص في النباتات القريبة من مصادر التلوث .