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Research Article

Environmental Impact On Morphological and Anatomical Structure of *Ricinus communis* L. Leaves Growing in Kathmandu, Nepal

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Abstract

The current study was done to examine the impact of environmental pollution on morphology and anatomy of leaf of *Ricinus communis* L. of Kathmandu. The comparative study was done between the plants of high polluted sites i.e Ringroad sides and less polluted sites i.e Raniban forest of Kathmandu. The plants from both sites showed visible morphological and anatomical changes in leaves. These both study sites were found with similar soil factors and climatic factors. Reductions in some morphological and anatomical features were observed in leaves growing in highly polluted site. Reduction in leaf area, petiole length, thickness of palisade layer and thickness of spongy parenchyma was noticed in the leaves from highly polluted sites of Kathmandu. Other morphological and anatomical features such as leaf dry mass content, stomata frequency, thickness of cuticle and size of epidermal cells were noticed to be increased in leaves from highly polluted sites.

Keywords: Leaf area; Leaf dry mass; petiole; Stomata frequency; Cuticle.

Introduction

Leaf is the most sensitive and exposed part to be affected by air pollutants instead of all other plant parts such as stems and roots (Leghari and Zaidi, 2013). Urban air pollution is an environmental problem in developing countries (Mage *et al*., 1996). The increasing number of industries and automobiles vehicles is continuously adding toxic gases and other substances to the environment (Jahan and Iqbal, 1992). Such pollutants include sulphur and nitrogen oxides, carbon monoxides and soot particles as well as smaller quantities of toxic materials (Agbaire and Esiefarienrhe, 2009). In urban environment, trees play animportant role in improving air quality by absorbing gases and particles (Woo and Je, 2006). Plants leaf acts as the scavengers for many air borne particulates in the atmosphere (Joshi and Swami, 2009). Specific morpho-anatomical and physiological-biochemical characteristics are the results of plant adaptations on environmental conditions (Kovacic and Nikolic, 2005). Stress conditions can disturb the formation of sclerenchymatic fibres in leaves of poaceae (Gielwanowska*et al*., 2005).

Kathmandu is Nepal’s largest urban center with an annual population growth rate five percent. Air quality in Kathmandu is regularly surpassed very unhealthy levels and even reached hazardous in March and April 2016 (http//www.iied.org/clearing- air- Kathmandu). Biodiversity of urban roadside plants acts as an eco-sustainable filter for air pollution. Foliar surface of urban roadside plants acts as a sink for PM (particulate matters) depositions and through their depositions they show

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specific morphological, physiological and biochemical parameters of plants of an urban area now being investigated as an integral part of air pollution science (Rai, 2016).

All available literatures reveal that there is little information on the effects of air pollutants on plant tissues. Hence the present study is carried out on some morphological as well as anatomical characteristics of *Ricinus communis* L. of Kathmandu valley.

Materials and Methods

Kathmandu city resides in bowl-shaped valley, and it greatly enhances the likelihood of air pollution problems. The valley's unique shape prevents the escape of industrial and vehicular emissions. In the last one decade, the number of vehicles in the capital city has tripled. Two thirds of deadly pollutants are caused by vehicular emissions and dust according to Ministry of Health, Nepal Government. The present study has been carried out at ringroad side of Kathmandu, Nepal as highly polluted site (hps) (Fig. 1) and Raniban forest of Kathmandu as less polluted sites (lps) (Fig. 2). Ring-road is central part of Kathmandu with high vehicular emissions and heavy dust particles than the Raniban forest which is preserved area under the Shivapuri Nagarjun National park. The soil characteristics of these both study sites were found similar. The soil type was found silty loam. The soil pH of Raniban forest area and Kathmandu urban area was noted as 4.95 and 5 and the organic matter content (%) was noted as 1.728 and 2.4 respectively (Thapa, 2007 and Bajracharya*et al*., 2007)

Ricinus communis is common shrub plant of about 15-20 feet height was selected for study. Leaf samples were collected in November and December, 2017 (winter season) from the plants having similar DBH (diameter at breast height), uniform height and similar growth form. Leaves were brought to laboratory in polythene bags. Some leaves were preserved in formalin for the anatomical study. Leaves area was determined by using graph paper. The length, breadth and petiole length of leaves were measured by using scale.

Fig. 1: *Ricinus communis* plant from highly polluted site (hps)

Study of stomata of leaves was performed under calibrated microscope. For the calculation of the specific leaf dry mass content, leaves were kept in hot air oven for four hours in 100◦c temperature.

Fig. 2: *Ricinus communis* plant from less polluted sites (lps)

Anatomical study was done with the help of fine anatomical section of preserved leaves under calibrated microscope. Quantitative measurement of thickness of upper cuticle, and size of upper epidermis was done under calibrated microscope. Permanent slides were prepared after completion of alcohol dehydration series. Leaves samples for all necessary data were taken in five replicates. All the data were collected and analyzed with the help of Microsoft excel 2013.

Result

Morphological Characteristics

The average dry mass content of leaves increased from 30.54% in less polluted sites to 60.7% in highly polluted sites (Fig. 3). An increase of 98.75 % dry weight was exhibited at highly polluted sites. The study revealed that the leaves of *R. communis* collected from highly polluted sites showed decrease of 45.42% in their leaf surface. The average leaf area of the leaves in highly polluted site was found 94.2 cm^2 and in less polluted site was found 172.6 cm^2 (Fig. 4). The average of petiole length from leaves in highly polluted sites (19.6 cm) was less than the less polluted site (24.2 cm). This decrease was 19.00 % (Fig. 5). The stomata frequency in the leaves of highly polluted site was found 6.02 per mm^2 whereas in less polluted site it was 5.77 per mm^2. This increase was 4.33 % (Fig. 6).

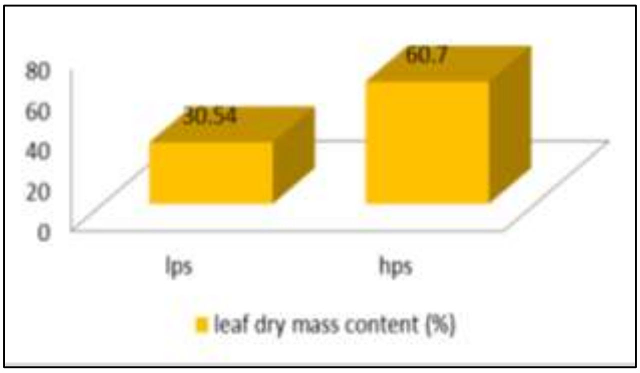


Fig. 3: Leaf dry mass contents

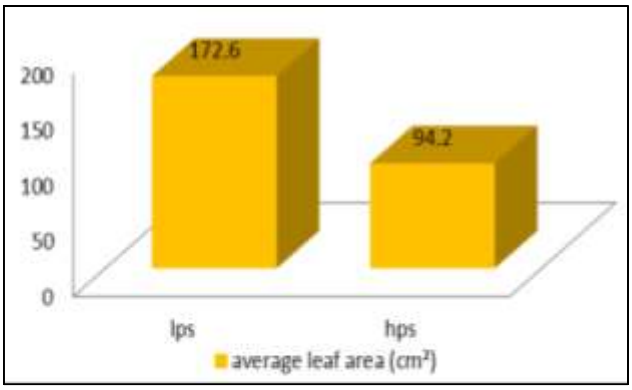


Fig. 4: Average leaf area

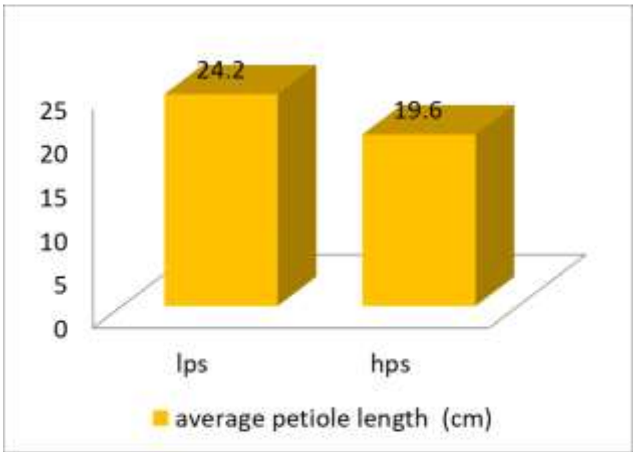


Fig. 5: Average length of petiole

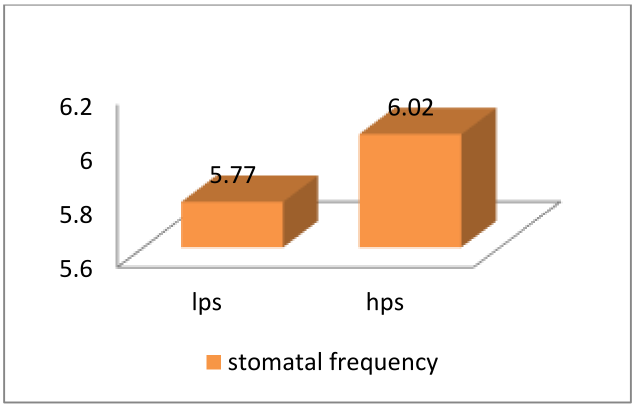


Fig. 6: Average stomatal frequency

Anatomical Characteristics

At highly polluted site, *R. communis* leaves exhibited 100%, 76.19 % and 73.07.22 % increase in the thickness of upper cuticle, length of upper epidermal cell and breadth of upper epidermal cell respectively in highly polluted sites (Figure 7, 8). A decrease of 27.23% thickness of palisade parenchyma and 13.92 % Spongy parenchyma were observed in leaves collected from highly polluted site (Figure 9, 10).

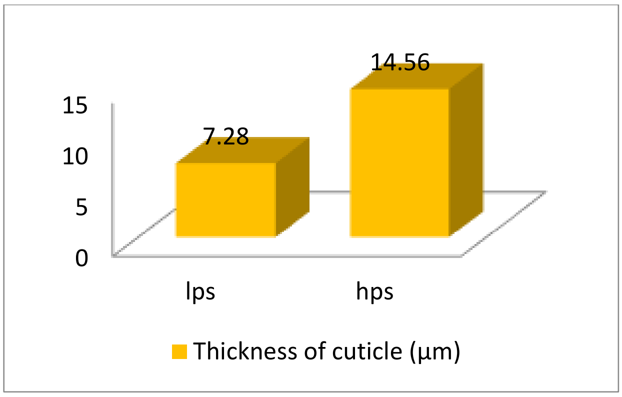


Fig. 7: Average thickness of cuticle

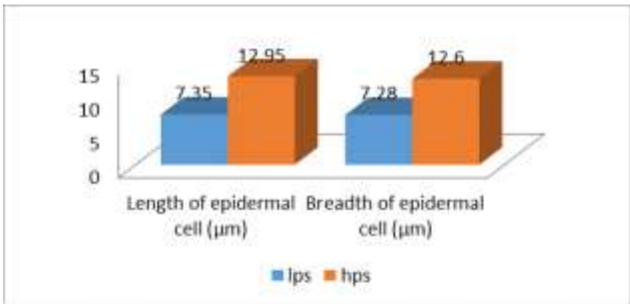


Fig. 8: Average size of epidermal cells

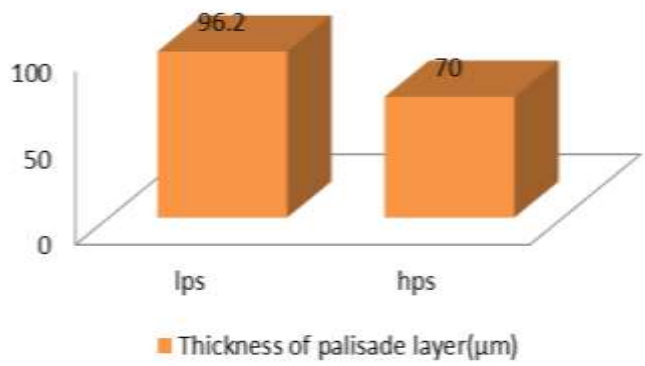


Fig. 9: Average size of palisade parenchyma

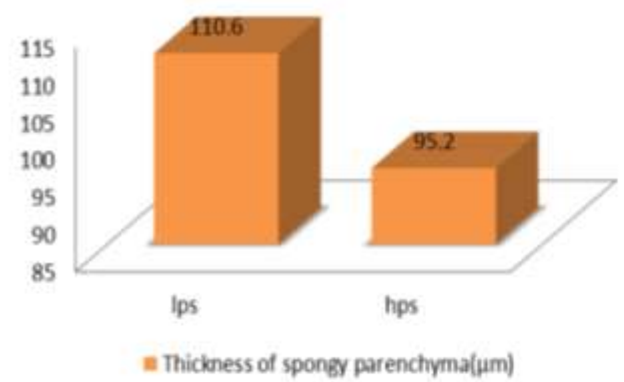
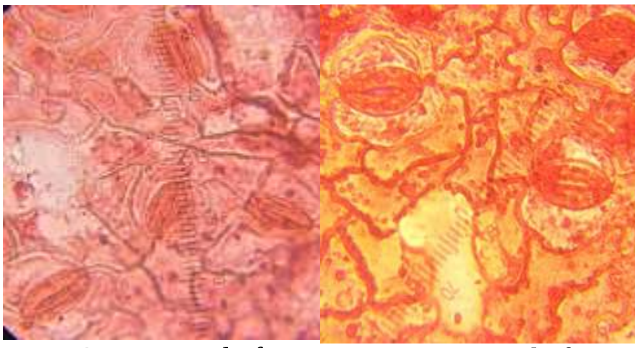


Fig. 10: Average thickness of spongy parenchyma



A. S Stomata peel of *R. communis*(hps) B. Stomata peel of *R. communis*(lps)

Fig. 11: Stomata peel of R. communis; A. (hps), B. lps

Discussion

Leaf is the most sensitive and exposed parts to be affected by air pollutants instead of all other plant parts such as stem and roots (Leghari and Zaidi, 2013). Plants leaf acts as the scavangers for many air borne particulates in atmosphere (Joshi and Swami, 2009). Air pollution is one of the severe problems facing the world today. It deteriorates the ecological condition (Tripathi and Gautam, 2007). According to bio monitoring observations the So_2 and No_2 concentrations are higher at urban sites (Tiwari *et al*., 2006). Most of the plants experienced physiological changes before showing visible morphological damage to leaves (Liu and Ding, 2008). Air pollutants cause leaf injury, stomata damage, premature senescence, decrease photosynthetic activity, disturb membrane permeability, reduce growth and yield in sensitive plant species (Tiwari *et al*., 2006). In the present study, plants of pollution stress area showed reduction in leaf area and petiole length. Similar results were observed by Dineva, 2004; Tiwari *et al*., 2006; Jahan and Iqbal, 1992; Sayyednejad *et al*., 2009; Leghari and Zaidi, 2013 and Assadi *et al*., 2011. Mahajan *et al*., 2015 have found the leaf area in polluted site was reduced than in non-polluted site. Sharma *et al*., 2017 have also found decrease in leaf area in roadside plants. Munzuroglu *et al*, 2003 have found that the reduction in leaf size, width and area might be due to cause of hidden injury or physiological disturbance occurring in morphological and anatomical characters of plants. The leaf dry mass content of was found higher in the leaves from highly polluted sites in spite of smaller leaf area, it may be due to the dust particles suspended in the leaves. Bhatti and Iqbal, 1988 have found that the automobile emissions significantly reduced the leaf dry weight of *Guaiacum officinale* L., *Ficus benghalensis* and *Eucaluptus* sp. at polluted sites of Karachi. Hussain *et al*., 1997 have also found decrease in leaf fresh and dry weight of roadside plant *Bougainvillea spectabilis* Wild. *R. communis* leaves of highly polluted have found the increase in frequency of stomata in this study. Raina and Bala, 2007 have reported decrease in frequency of stomata in polluted areas.

This study have observed thick cuticle in the leaves of highly polluted site. Thickness of cuticle may be the adaptation character in the pollution stress condition. Thick cuticle may help to prevent the entry of air pollutants in the leaf cells. Pourkhabbaz *et al*., 2010 have observed thin cuticle in the plants of urban area.

This study have found that the size of upper epidermal cells in the leaves of *R. communis* increase in the highly polluted site. Yunus and Ahmed (1980) have found smaller size of epidermal cells in Guava leaves growing in polluted site. Gostin , 2009 studied in some Fabaceae species and found the epidermic cell generally had a decreased size in the leaves exposed to the pollutants. The research work also shows that there is reduction in the thickness of spongy parenchyma of leaves in the polluted areas. Similar results were observed by Jahan & Iqbal, 1992 and Raina & Chand, 2011.

Conclusion

This study was focused on the impact of air pollution on the morphology and anatomy of leaves of *R. communis*. The two studied sites have possessed with similar soil type and climatic condition. These two sites were dominantly different in the contamination degree due to motor vehicles exhaust. The leaves of *R. communis* growing in highly polluted site possess increased dry mass content, reduction in leaf area and petiole length. These leaves growing in highly polluted areas contain thick cuticle, high stomata frequency, increase size of epidermal cells and reduced thickness of palisade and spongy parenchyma.

This study has found that the leaves of *R. communis* tolerated pollution stress by decreasing the morphological parameters such as leaf area and petiole length and increasing the anatomical characters such as cuticle thickness, epidermic cell size and stomata frequency. Due to this resistant capacity to the pollution stress, *R. communis* plant is found dominantly growing in the roadside areas.The present study provides a good basis for further research on impact of the air pollution in the morphological and anatomical parameters of the plant's leaf.

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