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Foliar Micro-Structural Deformation of Four Plants in Selected Agricultural Farmlands at 9th Mile Industrial Area Enugu, Nigeria: Indication of Industrial Pollution

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Abstract

Background: Air, water and soil pollution of the 9th mile environment have been reported by several researchers. In this study we assessed foliar micro-structural deformation as indication of industrial pollution.

Materials and Methods: Fresh leaf samples of four plants *(Chromolaena odorata (L) King & Robinson*, *Ficus thonningii Blume*, *Urena lobata L*, *Crotalaria retusa L)* were randomly collected from the Test Site (TS) and Control Site (CS). The samples were taken in quadruplet (An, Bn, Cn, Dn) 100 m along a transect, using a sharp kitchen knife to destalk mature leaves from the branches in morning hours. The fresh leaf samples were immediately taken to the Department of Plant Science and Biotechnology University of Nigeria, Nsukka for taxonomical identification. Foliar photomicrography was done by impression techniques following standard methods.

Result: The foliar photomicrographs analysis revealed distorted micro structural arrangement, stomata and guard cell destruction in leaf samples from test site as compared to control samples. The study showed that foliar photomicrography could be used as an analytical tool in the environmental impact assessment, auditing, and evaluation of industrial pollution.

Keywords: Foliar microstructure; Industrial pollution; Agricultural farmland; Environment

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Introduction

The metamorphosis of the 9th mile corner from a transit camp for travelers between the eastern and the northern regions of Nigeria in the early 1930 into an industrial settlement in the recent past has attracted major important industries like the Nigerian Brewery Plc Plant, AMA Brewery Plant, Seven-Up Bottling Company Production Plant, Nigeria Bottling (NB) Company Plant, Mega filling stations, to mention but these few. Industrialization has a pulling effects on rural-urban migration is a recognized driving factor in population growth [1]. Thus, the emergency of 9th mile as an industrial site in Enugu state has attracted a significant increase in human population and associated anthropogenic activities.

Industrial pollution has been recognized as a major global problem with serious consequences for the sustainability of the ecosystems as well as the quality of life and economic performance of human communities. The 9th mile environment has witnessed a continuous input of industrial pollutants in the past two decades, especially from breweries and bottling companies. Several studies have implicated Brewery industries at the 9th mile area in environmental pollution of terrestrial and aquatic ecosystem of the host communities [2-5]. Most of the studies were carried out on the Brewery industrial effluent discharges into the soil and water bodies of the 9th mile environment. The deviations of the effluent analytical results from the acceptable international and national standards were used as indicators of pollution. Few such studies have considered vegetation analysis as a tool in assessing industrial pollution in the study area, except for Nwadinigwe [6], who attributed differences in air pollution tolerance indices of plants growing around the 9th mile industrial site and the control site to effluent pollution.

Owing to their static disposition plants are the major recipient of environmental pollutants [7]. While animals may move away from the site of polluted environment in response to pollution-induced stress, plants respond by alterations of some biochemical, anatomical and physiological features as adaptive measures to ameliorate the pollution induced stress [8]. This study used the changes in foliar photomicrograph in plants as indication of industrial pollution of the 9th mile agricultural farmland.

Materials and Methods

Study area

9th mile area originally called 9th mile corner is a sprawling industrial site situated in Udi, Enugu, Nigeria with geographical coordinates of 6°25' 0" North, 7°25' 0" East. It is one of the fastest growing settlements in Enugu State with a population of 25,000 people as at 2006 (National Population Census, NPC 2006). From its beginning as a transit camp for travelers between the eastern and the northern regions of Nigeria in the early 1930, it has developed into a mega industrial settlement hosting such important industries like the Nigerian Brewery Plc Plant, AMA Brewery Plant, Seven-Up Bottling Company Production Plant, Nigeria Bottling (NB) company plant and other associated concerns. It is today the industrial hob of Enugu State with bustling environmental and social activities and a revenue spinner for Udi Local Government Council, Enugu State and Federal Governments of Nigeria [5].

Sample collection and treatment

Sample collection and treatment were as previously reported elsewhere [8]. Briefly, the foliar parts of the following plant samples: *C. odorata (L) King & Robinson*, *F. thonningii Blume, U. lobata L, C. retusa L*, were randomly collected from agricultural farmland in the study site 100 meters from each other in a transect formation. The plants' ages were indeterminate as they have been growing wildly in the site through generations. The plants were thoroughly examined in their habitat and records of their physical features, noted in the field note book. Healthy leaf samples were carefully cut off from their stalk, stored separately in perforated brown envelopes, and taken to the department of Plant Science and Biotechnology, University of Nigeria, Nsukka, for taxonomical identification. The leaf samples were washed in running tap water to remove dust particles, and dried at room temperature in the Anatomy laboratory of the department.

Foliar photo-micrograph

Using a camel hair brush, nail varnish was applied on 22 cm × 22 cm portion of both the adaxial and abaxial surfaces of the leaf and left to dry for 10 min. Subsequent coatings were applied for the second and third times and left to dry for 10 min and 20 min respectively. The samples were then passed through air current for 1 h to ensure maximum dryness. Epidermal strips of the leaf samples were scrapped gently with the aid of forceps and placed on a clean slide, stained with Safranin, washed with alcohol three times and covered with a cover slip before mounting for microscopic examination. The slide was viewed under the light microscope at x40 magnifications and photomicrographs were taken with Zeiss light microscope with MC'35 Camera for 53 mm film at x400 magnification.

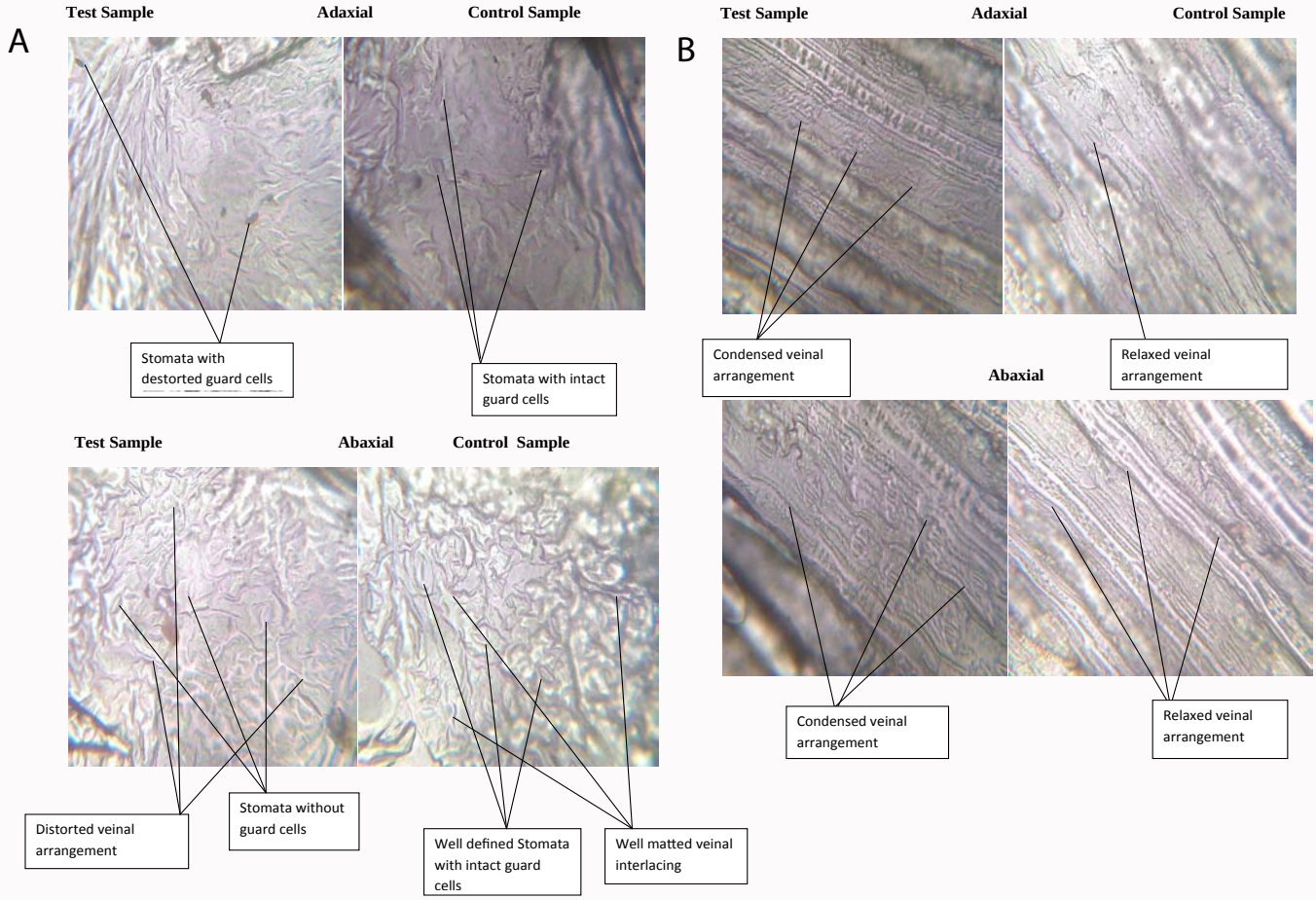

Figure 1: Figure 1A and 1B represents the foliar photomicrograph of adaxial and abaxial surfaces of *C. odorata (L) King & Robinson*.

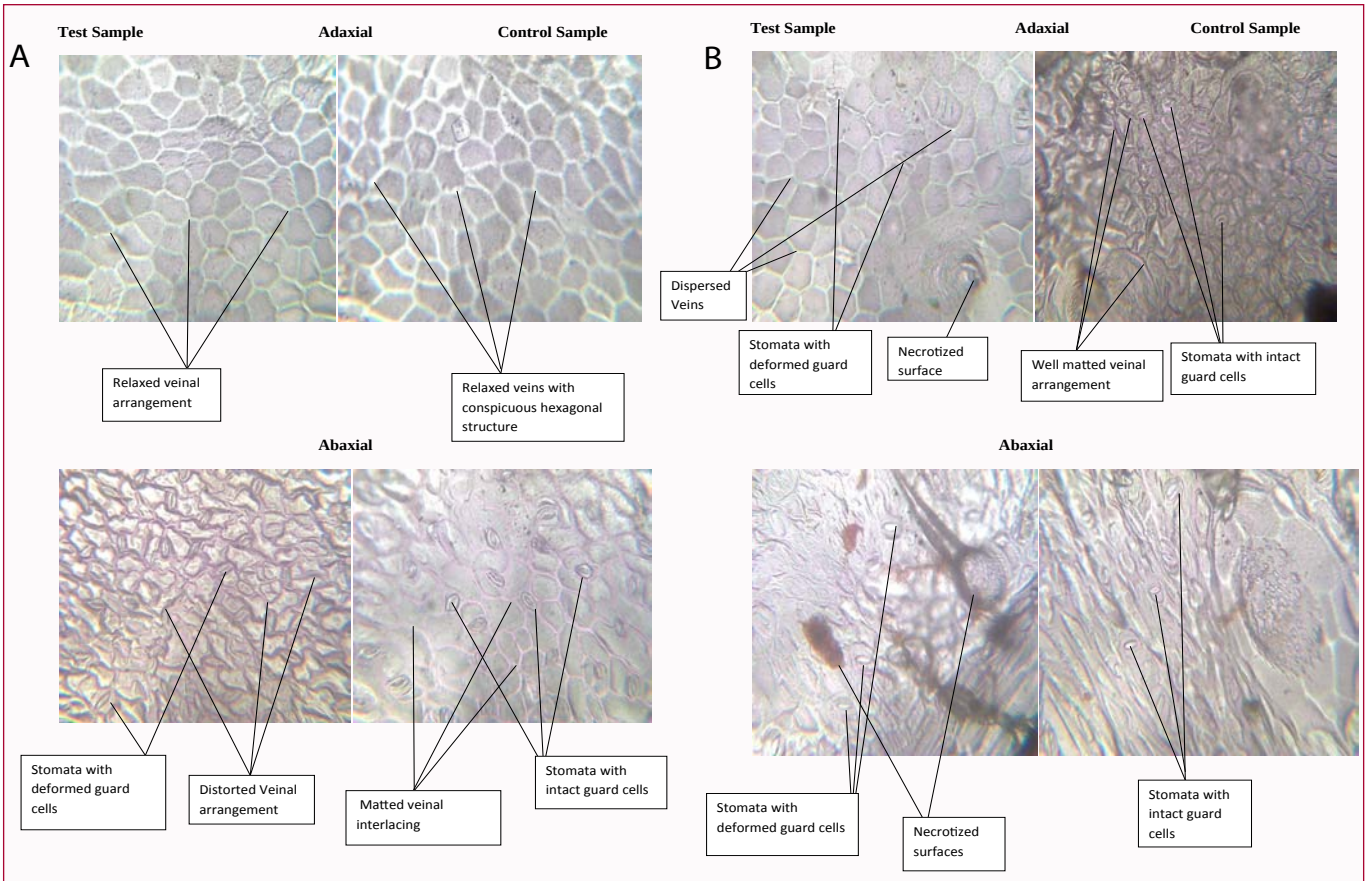

Figure 2: Figure 2A and 2B represents the foliar photomicrograph of the adaxial and abaxial surfaces of *F. thonningii Blume.*

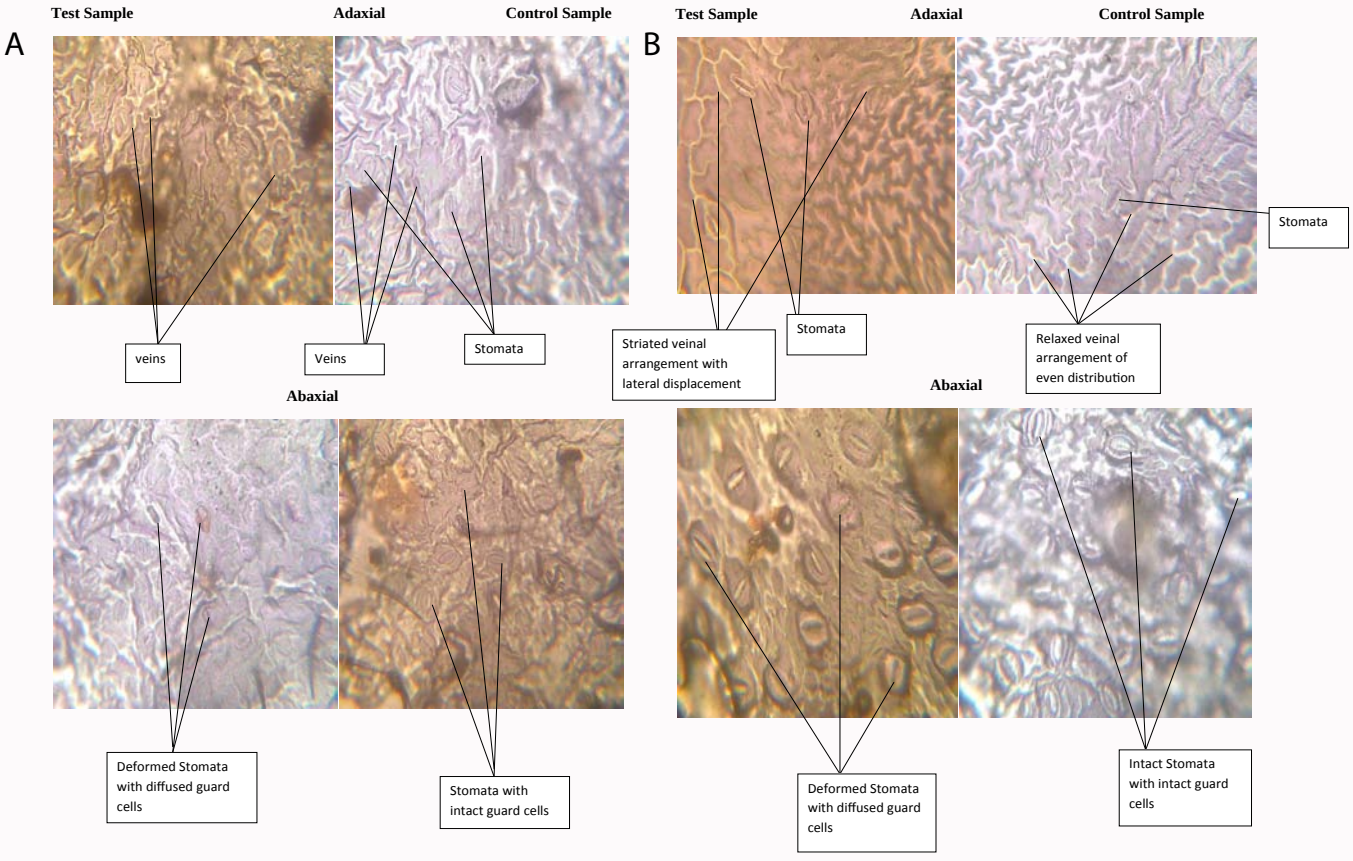

Figure 3: Figure 3A and 3B represents the foliar photomicrograph of the adaxial and abaxial surfaces of *U. lobata L.*

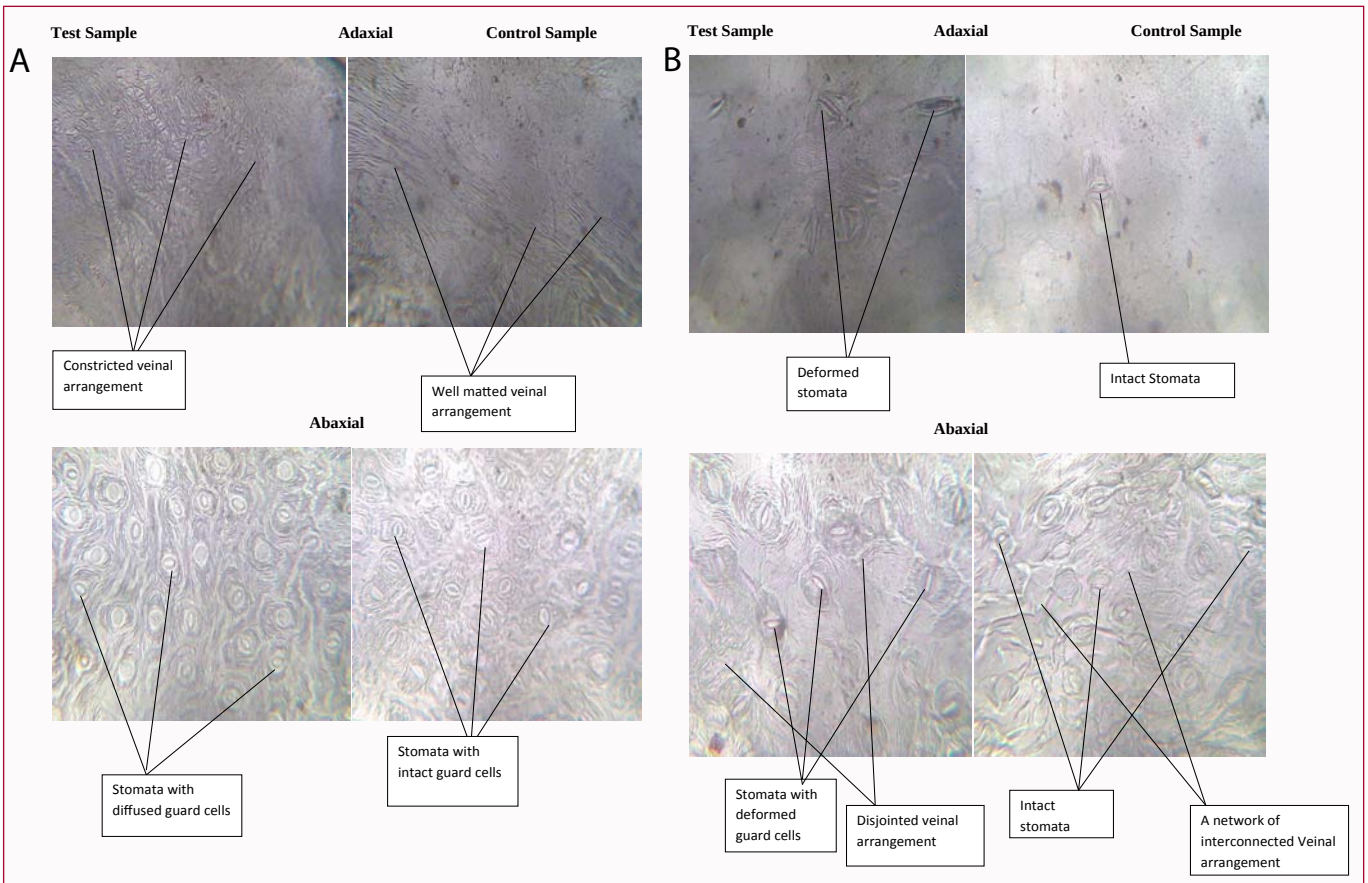

Figure 4: Figure 4A and 4B represents the foliar photomicrograph of the adaxial and abaxial surfaces of *C. retusa L.*

Result and Discussion

The result of the study is presented in Figures 1 to 4.

Figure 1A, 1B represents the foliar photomicrograph of adaxial and abaxial surfaces of *C. odorata (L) King & Robinson*. The adaxial surface of the leaf from the test site showed shrunken guard cells while the controlled site sample showed intact guard cells. The abaxial surface of the test sample also showed deformations in vein arrangement and in the guard cells. There were no distinctive stomata. While the control sample showed well matted vein arrangement, intact stomata and guard cells.

Figure 2A, 2B represents the foliar photomicrograph of the adaxial and abaxial surfaces of *F. thonningii Blume*. There were remarkable differences in the vein arrangement of the test and control samples. Though the test and control samples showed relaxed vein arrangement on the adaxial surfaces that of the control was conspicuously hexagonal. The abaxial of the test showed distorted vein arrangement with deformed guard cells while the control had matted vein interlacing and distinctive stomata with intact guard cells.

Figure 3A, 3B represents the foliar photomicrograph of the adaxial and abaxial surfaces of *U. lobata* L. The adaxial surface of the test sample showed striated vein arrangement with lateral displacement and the control showed relaxed vein arrangement of even distribution. The abaxial of the test had deformed stomata with diffused guard cells and that of the control had intact stomata with intact guard cells.

Figure 4A, 4B represents the foliar photomicrograph of the adaxial and abaxial surfaces of *C. retusa* L. The adaxial surface of the test had constricted vein arrangement and that of the control had well matted vein arrangement. In the abaxial surfaces the test showed stomata with diffused guard cells and the control showed Stomata with intact guard cells.

The observed foliar distortion in the test samples compared with those of the control agreed favorably with the report of Gostin [9], that pollution stress altered the structure of the leaves in the industrial areas. The modification of the frequency and sizes of stomata as a response to the environmental stress is an important manner of controlling the absorption of pollutants by plants [9]. These foliar deformities were indications of polluted environment.

Conclusion

The study shows that 9th mile industrial effluents had marked negative impacts on physiological and anatomical configuration of selected plants studied and that foliar photomicrography can be used as pollution assessment tool in environmental impacts assessment of industrial sites.

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