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Original article

Anatomical Study of *Atriplex halimus* L. (Guettaf) Growing under the Climatic Conditions of Biskra - Algeria

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Abstract

Atriplex halimus L. known as "Guettaf" (Amaranthaceae) is used in Algerian traditional medicine to treat several diseases such as rheumatism and fever. The aim of this work is to study the anatomy of the Atriplex halimus L., growing under the climatic conditions of the State of Biskra (north-east of Algeria). *Atriplex halimus* L., stem, leaf and root were harvested during the month of January, 2019. Microscopic observation of the different organs revealed that the anatomy of this plant contains many more characters of xerophytism as the presence of thick cuticle, trichomes, perivascular sheath and much more hydrophilic cellulosic tissues (parenchyma and collenchymas) than hydrophobic lignified tissues. We can deduce that Atriplex halimus L., requires a high humidity, which explains the adequate growth of this species under the climatic conditions of the region of Biskra.

Keywords: *Atriplex halimus* L., Anatomy, Region of Biskra.

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INTRODUCTION

The desertification of large areas of the globe, is an ever-increasing phenomenon against, which an active control strategy is needed to safeguard not only the natural fertility of ″at-risk environments″, but also its recovery where technically possible.(Mulas and Mulas, 2004).

Algeria is not immune to this phenomenon and the introduction of arid shrubs resistant to aridity is one of the means used for the recovery of degraded soils. Among the halophytic species that are of real practical interest is *Atriplex halimus* (Le Houérou and Pontanier, 1988).

Atriplex species are an important forage reserve and are able to accumulate large amounts of salt in their tissues and more specifically in trichomes, located on the surface of leaves (Mozafar and Goodin, 1970).

Atriplex halimus L. (Guettaf) is a shrub native to North Africa where it is very abundant; it also spreads to Mediterranean coastal areas. It is present in regions where the ecological imbalance is accentuated and where the phenomenon of desertification takes alarming dimensions.

The aim of this work is to study the anatomy of the *Atriplex halimus* growing under the climatic conditions of the region of Biskra (north-east of Algeria), since limited data is available on its anatomical structure in relation to the climatic characteristics of the biotopes in which it develops.

Materials and Methods

Site characteristics description

The state of Biskra is located in the north-east of Algeria, and it has an altitude of 87 m in the northern part of the Sahara Desert, which gives it the hot desert climate properties. In 2007, the population was 307,987. The city lies about 248 miles (400 km) from Algiers, 71 miles (115 km) southwest of Batna and 137 miles (222 km) north of Touggourt. It is nicknamed "The Queen of the Zibans", "The door of the desert" and "The Saharan Nice" because of its location which is the in beginning of the desert.

Plant Materials

Atriplex halimus L. stem, leaf and root, were harvested in January, 2019. A fresh sample of the plant was fixed at 70% alcohol for anatomical study.

Anatomy

Thin histological sections of *Atriplex halimus* L., organs were prepared accordingly with the double staining method (Congo red and methyl green) then observed under microscope ″Optika″ (x10 and x40).

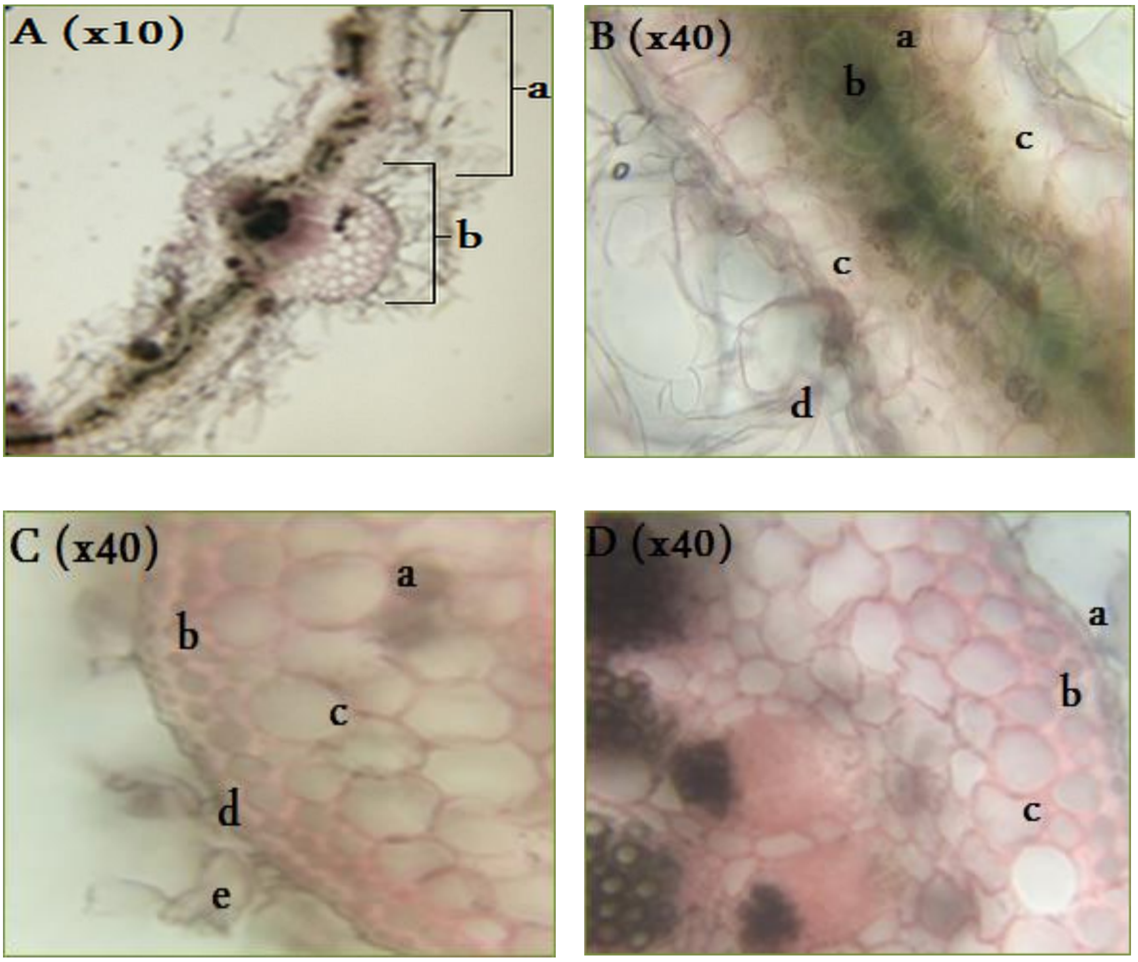
Results

Anatomical structure

The histological sections made on the stem, leaf and root of the *Atriplex halimus* L., allowed the observation of the structures represented in the figures below:

Leaf

It is bifacial, typical of Dicotyledons. Upper and lower epidermis of the blade formed by rectangular cells covered by a thick cuticle with homogeneous mesophyll constituted by the palisadic parenchyma as the sheet is in position. Collenchymatic cells are located under the upper and lower epidermis; in the median region of the leaf there is a vascular bundle (Fig. 1). Girdle perivascular surrounds the cribro-vascular beam is characteristic of the cross section of the leaf. Trichome and druse crystals of calcium oxalate are also found.



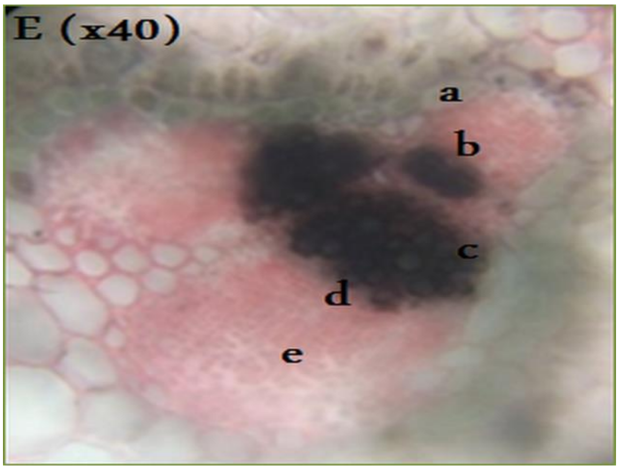


Figure 1. Representative images of *Atriplex halimus* L. leaf cross-section. ***(A)*** *Atriplex halimus* L. leaf cross-section: (a) leaf blade, (b) leaf main vein; ***(B)*** *Atriplex halimus* L. leaf blade: (a) girdle perivasculair, (b) beam cribro vascular, (c) palisade parenchyma, (d) Trichome; ***(C)*** Detail of the lower face of *Atriplex halimus* L. leaf main vein: (a) druse crystals of calcium oxalate, (b) angular collenchyma, (c) parenchyma in lacunae, (d) Lower cutinisé epidermal, (e) trichome; ***(D)*** Detail of the upper face of *Atriplex halimus* L. leaf main vein: (a) upper cutinisé epidermal, (b) angular collenchyma, (c) parenchyma in lacunae; ***(E)*** *Atriplex halimus* L. leaf main vein: (a) girdle perivasculair, (b) supernumerary cambium, (c) secondary xylem, (d) cambium, (e) secondary phloem.

Stem

It has a very simple structure. The epidermis is single layered followed by a collenchyma of four cell layers and a much reduced cortical parenchyma. The Vascular bundles are arranged on a single concentric circle, on the periphery of a highly developed marrow. The epidermal cells are rectangular, collenchyma, of the angular type. Cortical parenchyma is formed by four layers of cells (Fig. 2B), the medullar parenchyma occupies most of the stem (Fig. 2A).

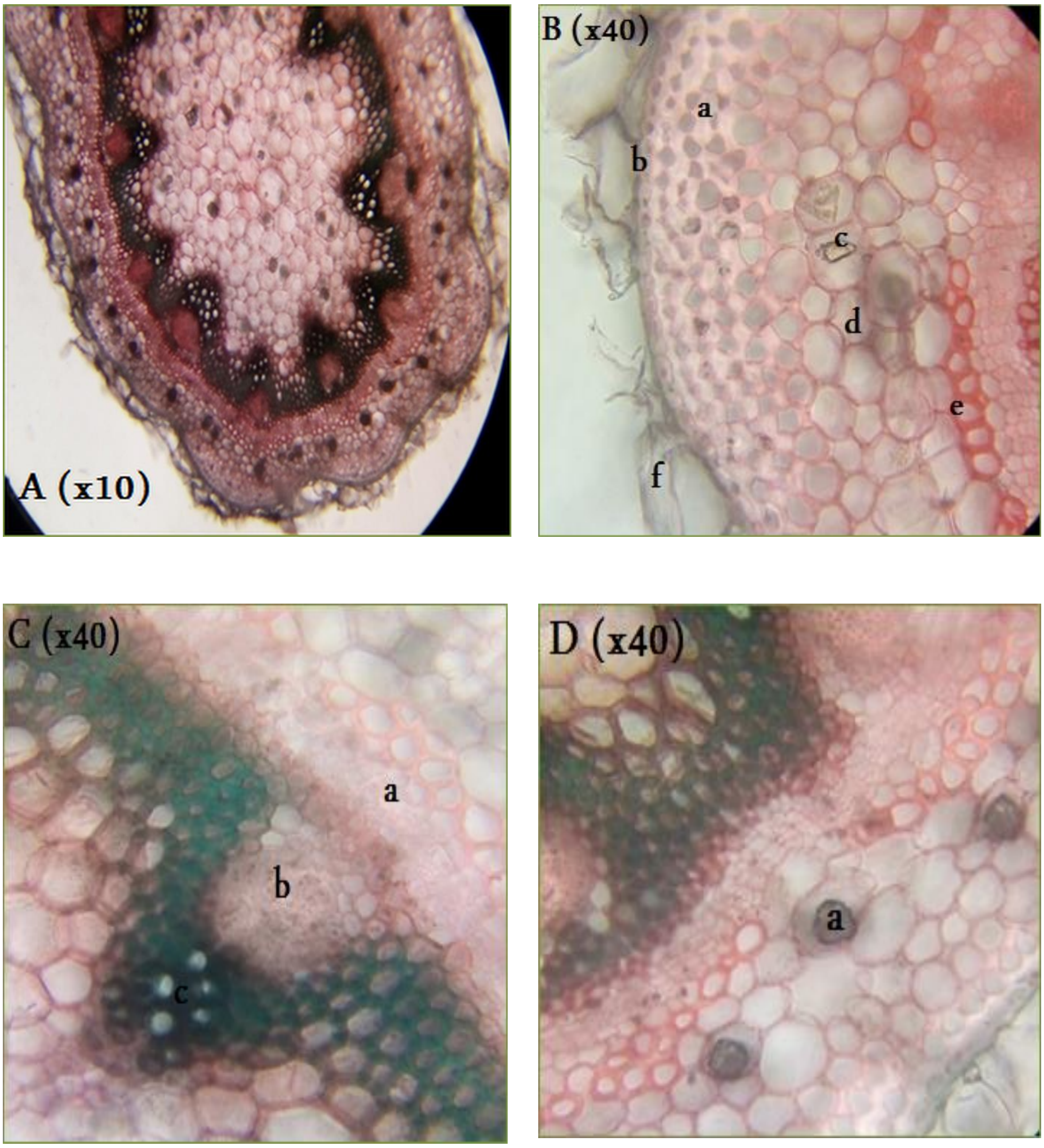


Figure 2. Representative images of *Atriplex halimus* L. stem cross-section. ***(A)*** *Atriplex halimus* L. stem cross-section; ***(B)*** Detail of the cortex of *Atriplex halimus* L. stem: (a) angular collenchyma, (b) epidermis, (c) prism of calcium oxalate, (d) cortical parenchyma, (e) cellulosic fiber, (f) trichome; ***(C)*** Detail of the beam cribrovascular of *Atriplex halimus* L. stem: (a) secondary phloem, (b) interligneous phloem, (c) secondary xylem; ***(D)*** Detail of the druse crystals of calcium oxalate of *Atriplex halimus* L. stem: (a) druse crystals of calcium oxalate.

Root

The root presents a suber of seven layers of suberous cells, and a cortical small parenchyma. The marrow that was occupied by a cellulosic parenchyma disappears and is occupied by the secondary xylem that is surrounded by the cambium, and by the phloem, both arranged in the shape continue pachyte grouped in several concentric rings (Fig. 3).

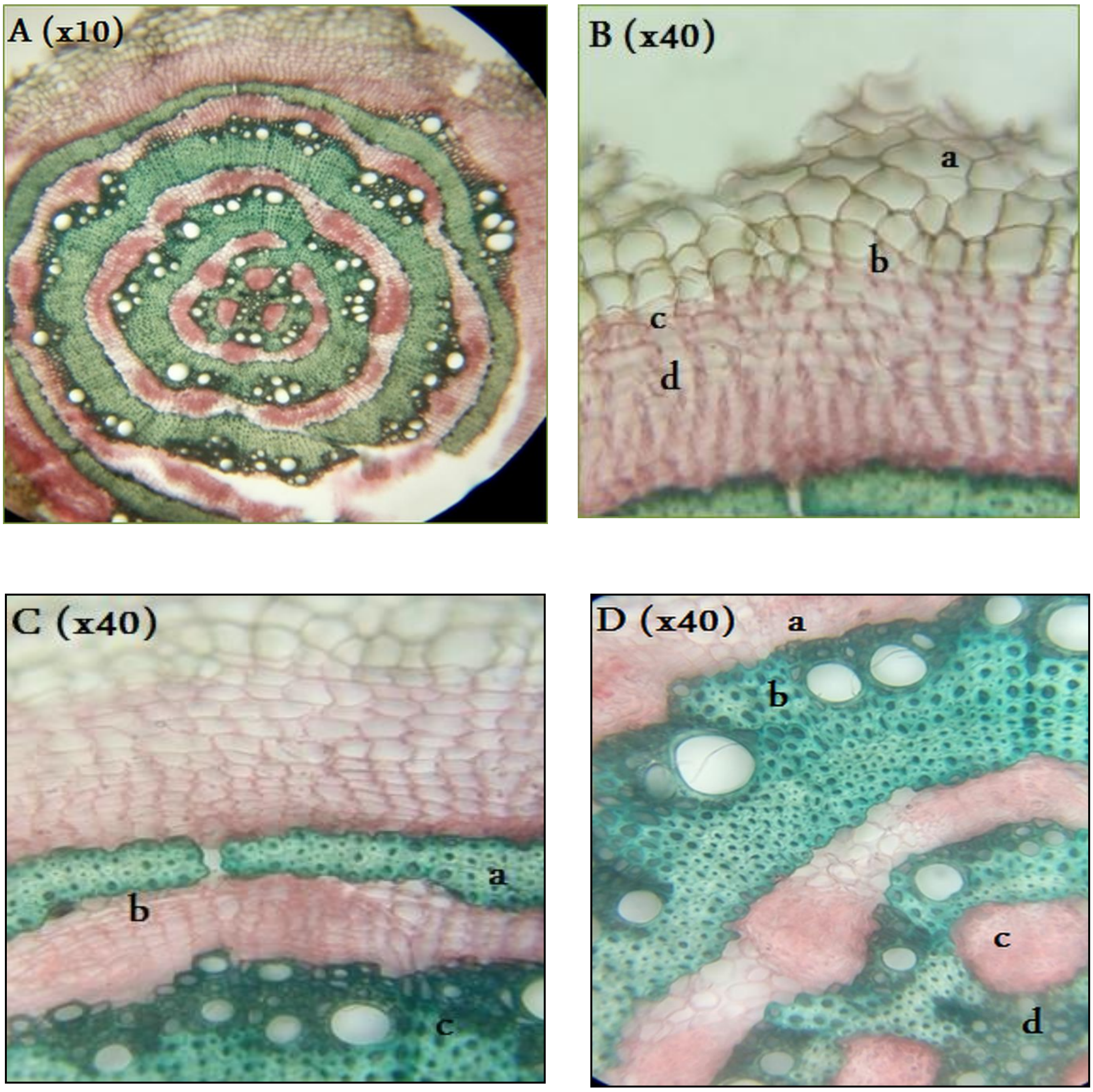


Figure 3. Representative images of *Atriplex halimus* L. root cross-section. ***(A)*** *Atriplex halimus* L. root cross-section; ***(B)*** Detail of the cortex of *Atriplex halimus* L. root: (a) suber, (b) phellogen, (c) phelloderm, (d) cortical parenchyma; ***(C)*** Detail of the beam cribrovascular of *Atriplex halimus* L. root: (a) lignified fibers, (b) secondary phloem, (c) secondary xylem; ***(D)*** Detail of the central cylinder of *Atriplex halimus* L. stem: (a) secondary phloem, (b) secondary xylem, (c) phloem, (d) xylem.

Discussion

According to the anatomical characteristics, Atriplex halimus L., is of the xerophytic type. Xerophytic plants are adapted to drought because, on the one hand, they optimize their ability to absorb water as developing water-saving mechanisms by accumulating water reserves in organs called succulent (David et al., 2014). On the other hand, they limit as much as possible the loss due to transpiration. We can note the two strategies at *Atriplex halimus* L.

Atriplex halimus L., has succulent organs. The presence of cuticle over the leaves increases the cuticular resistance, thus reducing water loss. In addition to that, *Atriplex halimus* L., presents xerophytic stomata which are sunk in the epidermis. Trichomes considered to have a significant contribution to blocking the free circulation of water vapor from stomata (sweating), as well as to reduce the overheating of leaves (Kintzios, 2002). The presence of these hairs could also help the plant to reduce its evapotranspiration and provides protection against intense illumination (Ehleringer and Mooney, 1978; Kelley et al., 1982).

Salt crystals form in trichomes, bursting the cell, allowing salt to be rejected on the surface of the leaf (Soloév, 1968; Mozafar, 1969).

In many species of the genus *Atriplex*, resistance to salt stress is associated with the presence of specialized organs such as vesicular hairs (trichomes) and excretory glands on the surface of the leaves that gives them a whitish, more or less shiny appearance. These anatomical structures are specialized in the storage of the Na^+ ion in the leaves; Na^+ is then eliminated by degeneration of trichomes, preventing excessive and toxic accumulation of this cation in leaf tissues (Metkalfe, 1957; Crete, 1959; Emberger, 1960; Malcolm et al., 2003).

Atriplex halimus is a halophytic shrub with photosynthesis in C4 (Martinez et al., 2003).

C4 plants have anatomical characteristics that allow them a high efficiency photosynthetic metabolism (increase in CO_2 levels). The foliar anatomy of C4 plants is of the "Kranz" type, showing a sheath of large cells that surround vascular tissues. C4 plants have a better water use efficiency than C3 plants under drought conditions and high temperature (Martinez et al., 2003).

We also noted the presence of supernumerary formations (Emberger, 1960; Botineau, 2010; Guinard, 2012).

Conclusion

In Algeria, The salinity of soils in arid and semi-arid areas leads to the loss of fertile soils as well as the vegetation cover, and the rehabilitation of these soils by species of the genus *Atriplex*, such as *Atriplex halimus*, seems to show a very promising route.

The aim of this work is to study the anatomy of the *Atriplex halimus* L., growing under the climatic conditions of the State of Biskra (eastern Algeria).

Microscopic observation of the leaf, stem and root of the *Atriplex halimus* L. harvested in January (2019), revealed that the anatomy of this plant contains many more characters of xerophytism as the presence of cuticle, trichomes and the succulence of all its organs. These characters allow this species to withstand the long dry season that characterizes the hot desert climate in the city of Biskra.

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