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Original article

Anatomical Study of Garden Nasturtium (*Tropaeolum Majus* L.) Growing under the Climatic Conditions of Annaba (Eastern Algeria) [1]

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Abstract

Tropaeolum majus L. (garden nasturtium) is a fast growing climbing annual plant characterized by its leaf venation. It is known for its medicinal, ornamental and culinary utility. The aim of this work was to study the anatomy of the garden nasturtium growing under the climatic conditions of Annaba (eastern Algeria). Garden nasturtium stem, petiole, leaf and root were harvested during the month of November (2016). Microscopic observation of the different organs revealed that the anatomy of this plant contains much more hydrophilic cellulosic tissues (parenchyma and collenchymas) than hydrophobic lignified tissues. We can deduce that garden nasturtium requires a high humidity which explains the great growth of this species under the climatic conditions of the region of Annaba, characterized by Mediterranean climate (high rainfall, high atmospheric humidity and mild temperature)..

Keywords: *Tropaeolum majus* L., Anatomy, Region of Annaba.

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INTRODUCTION

Tropaeolum majus L. (garden nasturtium) is a succulent fast growing climbing annual herb which is indigenous to the Andes Mountains in South America, mainly in Peru, Ecuador and Colombia (Small & Deutsch, 2001). It was introduced into Europe in the sixteenth century and elsewhere subsequently (Wilson, 2007).

This species that belongs to the Tropaeolaceae family is known for its ornamental, culinary and medicinal utility. It is characterized by a fleshy trailing stem, veined green orbicular leaves with slightly wavy edges peltated on a long petiole (Beloued, 2014) as well as yellow, red or orange beautiful flowers in the form of an open funnels that carries a spur (Al-Shehbaz & al.,2009). However, all the parts of this herb are edible (Wilson, 2007), the leaves and the flowers remain the most used parts because of their pungent peppery flavor and can be consumed alone, added in salads, in sandwiches or any other raw vegetables (Gray AM, 2009; Al-Shehbaz & al.,2009; Baba Aissa F, 2000).

Due to its important therapeutic properties, *T. majus* has always been used in folk medicine to treat several diseases. It is used externally as disinfectant (Garzón & Wrolstad, 2009) or in dermatology and cosmetology for the treatment of appendages diseases (Bazylko & al., 2014), superficial and limited burns and diaper rash (Bruneton, 1999). As for internaly, This herb has proven its efficiency as a good remedy for the treatement of cancer, upper respiratory tract such as bronchitis, tuberculosis and asthma (Duke & al., 2009), genitourinary tract infections (Lourenço & al., 2012), urinary tract diseases (Junior & al., 2009) and many other conditions. Furthermore, various studies in experimental pharmacology have been carried out on T. majus L or compounds isolated from this herb. These studies have revealed the presence of many biologically active compounds such as benzyl isothiocyanate which possesses antimicrobial, anticancer as well as anti-inflammatory activities (Binet, 1964; Pintão & al. 1995; Aires et al. 2009; Dufour et al. 2012; Lee et al. 2009). Antineoplastic and antifeeding activities have been attributed to the tetracyclic triterpene cucurbitacins (Picciarelli & al. 1984; Picciarelli and Alpi 1987).

The aim of this work is to study the anatomy of the garden nasturtium growing under the climatic conditions of Annaba (eastern Algeria) because a little 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

Annaba is a town located in the East of Algeria between latitudes 36'30N and 37'03N and the longitudes 07'20E and 08'40E.The climate is of Mediterranean type, characterized by a rainy season going from September to May and a dry and sunny summer. The duration of the dry period is 03 months (June, July, and August). The wettest month is January (77.7%); while the least humid month coincides

with the month of July (70.58%). *T. majus* develops on a substrate on a very steep slope, so that retains very little moisture.

Plant Materials

Garden nasturtium stem, petiole, leaves and root, were harvested in November (2016). Some of fresh samples of the plant were used to determine the moister content; a second part was fixed in 70% alcohol for anatomical study.

Moisture content of T.majus

It was determined by desiccation of the plant material at temperature of 105 ± 2 ° C under vacuum until a constant mass. The amount of water contained in the plant or organ is obtained by making the difference in mass between the fresh material and the dry matter after desiccation. This difference is expressed as a percentage of the fresh matter according to the formula determined by the relation:

MC in% = (FW -DW) x100 / PF.

MC: water content (in %)

FW: fresh weight (in g)

DW: dry weight after drying in an oven (in g).

Anatomy

Thin histological sections of garden nasturtium organs were prepared according to the double staining method (Congo red and methyl green) then observed under microscope "Optika" (x10 and x40).

Results

Moisture content of T.majus (Fig 1)

All *T.majus* organs are rich in water, especially the stem (74%), the root (64%) and the flower (61%). The leaf with 44% is the least succulent organ because of the thinness of the limb.

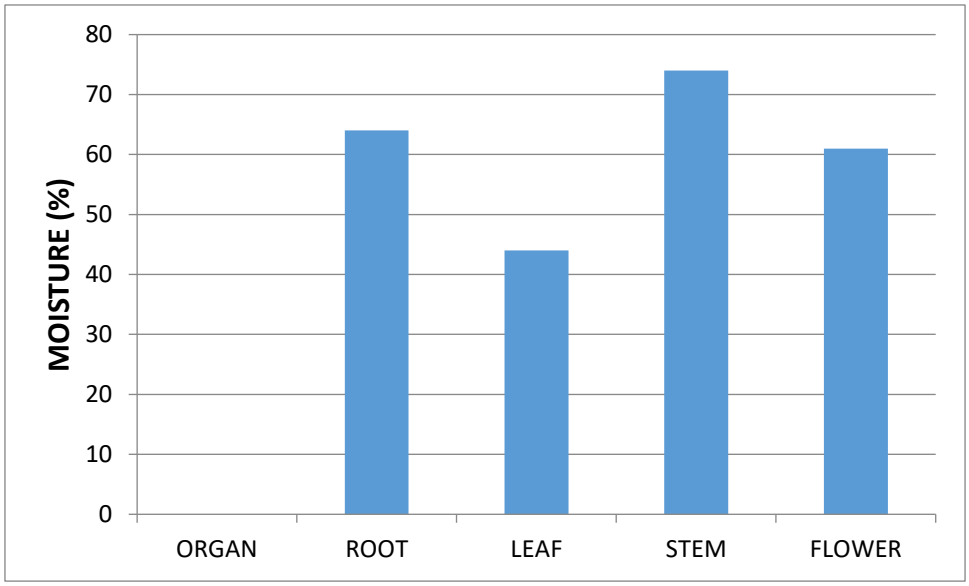


Figure 1. Moisture content of the different organs of the nasturtium

Anatomical structure

The histological sections made on the stem, petiole, leaf and root of the nasturtium allowed the observation of the structures represented in the figures below:

Leaf

It is bifacial., typical of Dicotyledons with several ribs arranged in a webbed manner (since the leaf is of peltate venation). Collenchymatic cells are located under the upper and lower epidermis; in the median region of the leaf there is a vascular bundle (Fig 2). Epidermis is single layered provided with glandular and eglandular hairs. Eglandular hairs are more common than glandular ones (Fig 3). Indeed, the epidermis is endowed with long pluricellular uniseriate hairs, difficult to detect even under a microscope because they are transparent. Small secretory hairs are also found.

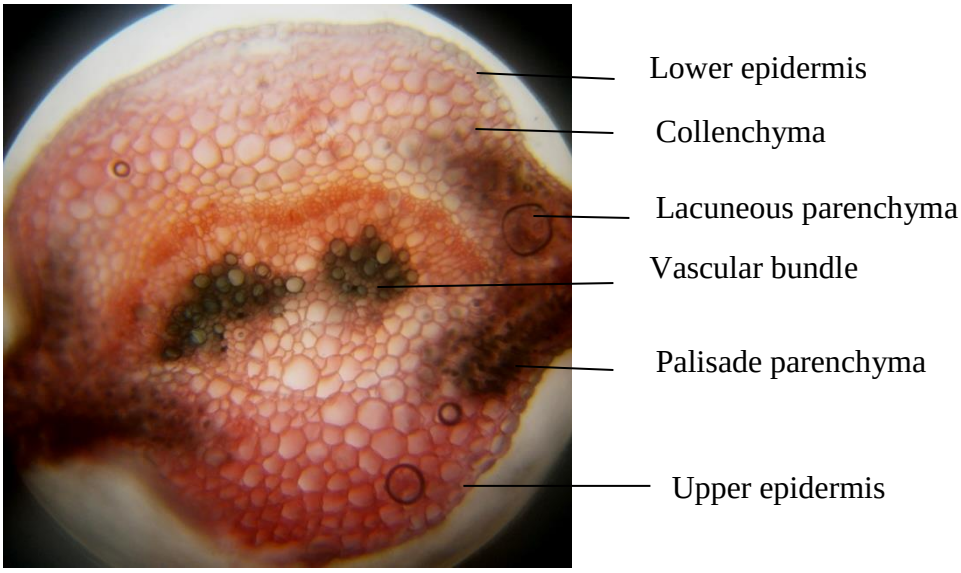
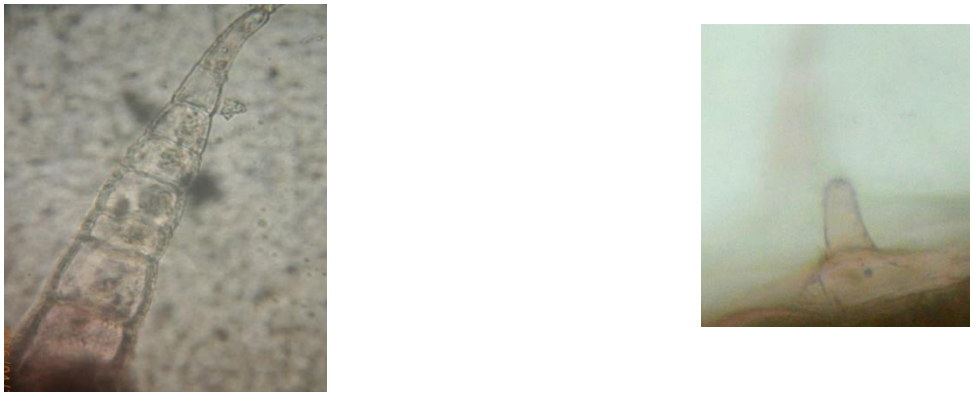


Figure 2. Cross-section of the main vein of garden nasturtium leaf seen under an optical microscope (x10).



A **B**

Figure 3. Structure of the eglandular hair (A) and the glandular hair (B) of garden nasturtium seen under an optical microscope (x40).

Stem

It has a very simple structure. The epidermis is single layered followed by a collenchyma of three 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, is formed by two layers of cells, underlying the epidermis. Cortical parenchyma is formed by five layers of cells (Fig 4). The medullar parenchyma occupies most of the stem (Fig 5). For the stem, the angular collenchyme and the large area occupied by the parenchymal marrow, is consistent with the work of Dickson (2000)

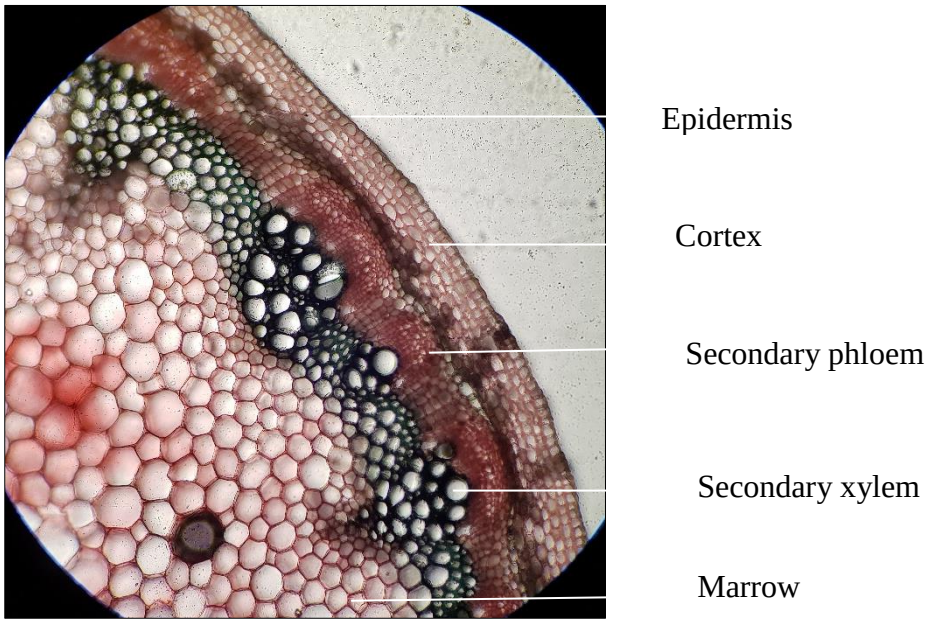


Figure 4. Cross-section of the stem, seen under an optical microscope (x10).

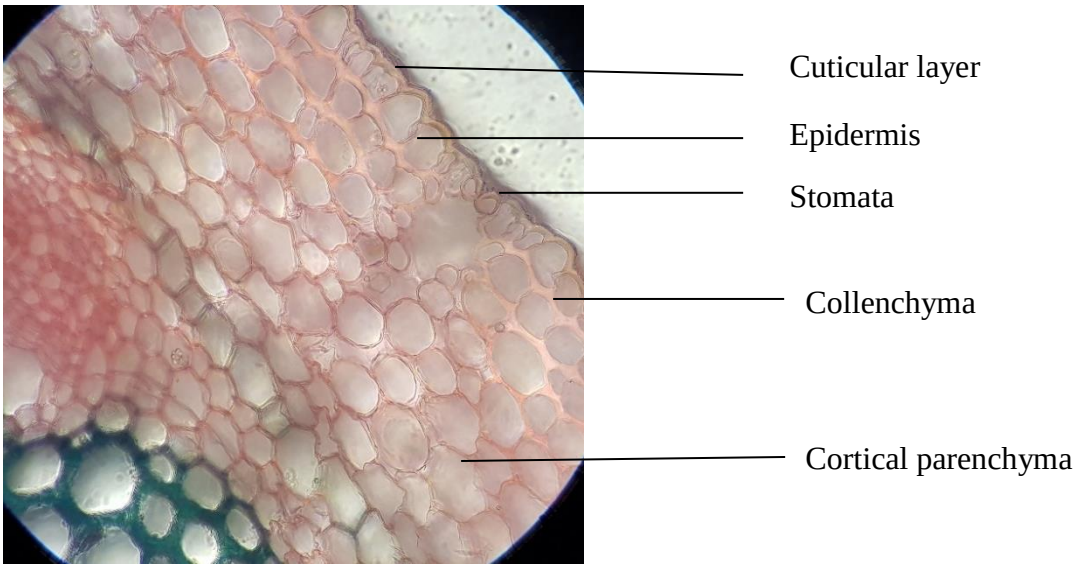


Figure 5. Detail of the cortex of the cross section of *T. majus* stem, seen under an optical microscope (x40).

Petiole

Its structure is very similar to that of the stem. It's very rich in parenchyma (Fig 6). Each vascular bundle (Fig 7) irrigates a rib in the mesophyll, the vascular bundle are are arranged on a circle, because the leaf has a pelted venation.

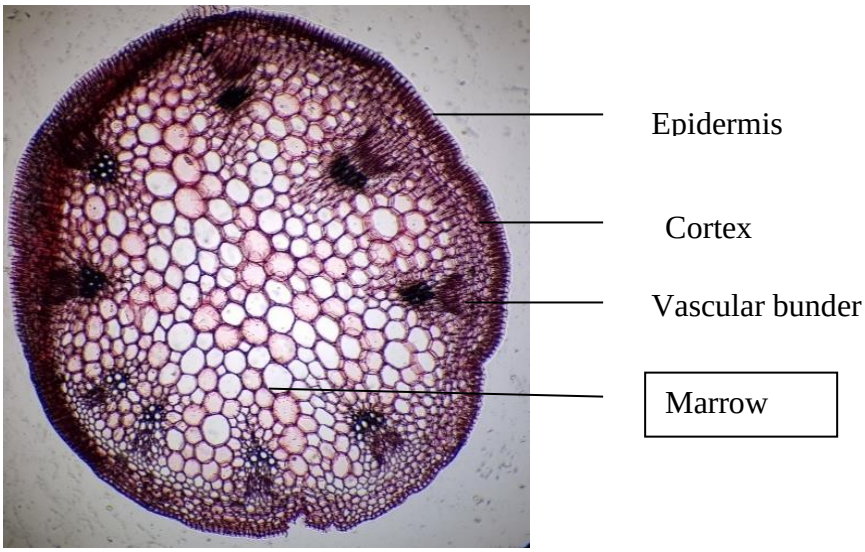


Figure 6. Cross section of the petiole, seen under an optical microscope (x10).

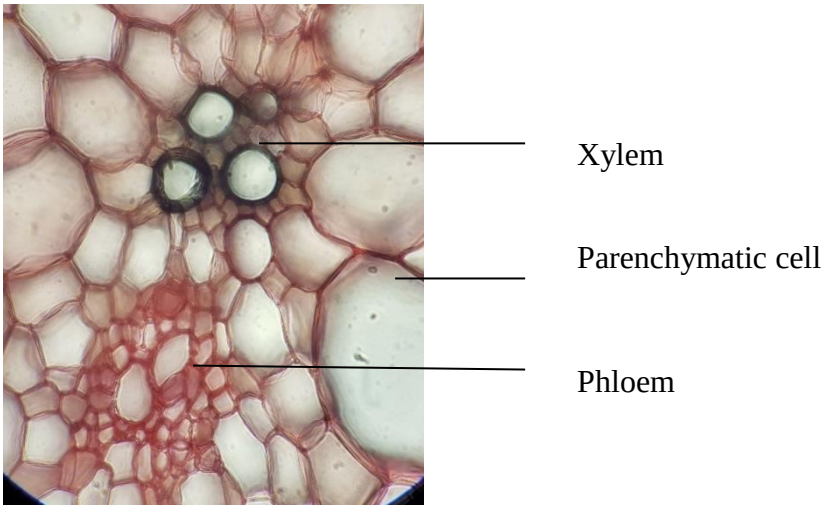


Figure 7. Detail of the Vascular bundle of the petiole, seen under an optical microscope (x40).

Root

The root presents a suber of three layers of suberous cells, a cortical small parenchyma. The marrow that was occupied by a cellulosic parenchyma disappears and is occupied by the secondary xylem surrounded by the cambium then by the phloem. Unlike the usual anatomical structure, the root of Nasturtium presents a very developed central cylinder (Fig 8).

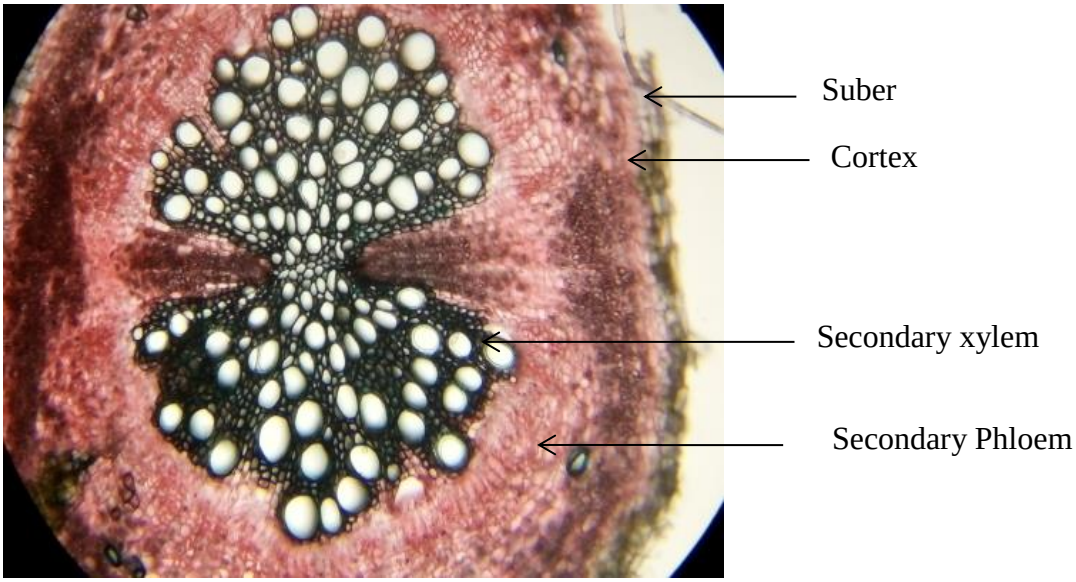


Figure 8. Cross section of the root of the nasturtium seen under an optical microscope (x10).

Discussion

According to the anatomical characteristics, T. majus 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 & al., 2014). On the other hand, they limit as much as possible the loss due to transpiration. We can note the two strategies at *T.majus*

T. majus has succulent organs. The presence of cuticle over the leaves increases the cuticular resistance, thus reducing water loss. In addition to that *T. majus* presents xerophytic stomata of anisocytic type which are sunk in the epidermis marking the xerophytic type for *T. majus* (Zanetti & al., 2004). Long, transparent, eglandular hairs are also a sign of xerophytism. The eglandular hairs have long been considered to have a significant contribution to blocking the free circulation of water vapor from stomata (sweating), as well as to reduce overheating of leaves (Kintzios, 2002).

Conclusion

In Algeria, Nasturtium (*Tropaeolum majus* L) is mainly considered as a decorative plant, but in reality this plant has several therapeutic properties. Indeed it is antimicrobial, antioxidant and especially rich in ascorbic acid.

The aim of this work is to study the anatomy of the garden nasturtium growing under the climatic conditions of Annaba (Eastern Algeria).

Microscopic observation of the leaf, petiole, stem and root of the nasturtium harvested in November 2016, revealed that the anatomy of this plant contains many more hydrophilic cellulosic

tissues (parenchyma, collenchyma and liber) than hydrophobic lignified tissues. This deduced that the nasturtium requires a high humidity. This explains the great growth of this species under the climatic conditions of the region of Annaba. Despite that, *T. majus* present several characters of xerophytism as the presence of cuticle, long and transparent eglandular hairs and the succulence of all its organs.

These characters allow this species to withstand the long dry season that characterizes the Mediterranean climate in the city of Annaba.

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