PHYSIOLOGICAL PARTICULARITIES OF PLANTS FROM THE *CRASSULACEAE* FAMILY

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ABSTRACT

The interest in research regarding plants from the Crassulaceae family has arisen with the discovery of the fact that they have the ability to absorb and fix carbon dioxide during the night because during daytime they keep their stomata closed in order to save water.

The data presented in the paper reveals that these plants have high drought resistance, both by providing high osmotic pressure at the cellular level, and by regulating the gas exchange (water, carbon dioxide, oxygen) due to the prompt reaction of closure and opening of the stomata. Absorption and saving water in this way is very important in the environmental conditions in which these plants live.

INTRODUCTION

Species in the *Crassulaceae f*amily are fleshy, succulent herbs with simple, entire or toothed leaves. Some species form a basal rosette of leaves from which the flowering stem grows. The flowers, usually arranged in branched inflorescences, are actinomorphic usually have both pollen-bearing and ovule-bearing parts, and are 4- or 5-merous. Sepals, petals, and carpels are present in the same number, and stamens are present in either once (rarely) or twice (usually) the number of petals. The sepals are sometimes fused together at the base. The petals are usually distinct from one another, but may also be fused together basally. The sepals and petals attach below the ovary (i.e., the ovary is superior). The ovary matures into a fruit called a follicle(https://gobotany.newenglandwild.org/family/crassulaceae/).

Crassulacean acid metabolism (CAM) is a major physiological syndrome that has evolved independently in numerous land plant lineages. CAM plants are of great ecological significance, and there is increasing interest for their water-use efficiency and drought resistance. Integral to the improvement in water-use efficiency that CAM affords is a unique pattern of stomatal conductance, distinguished by primarily nocturnal opening and often extensive diurnal flexibility in response to environmental factors(Lutge U., 2004).

While quantitative census data for CAM diversity and biomass are largely missing, intuition suggests that the larger CAM domains are those systems which are governed by a network of interacting stress factors requiring versatile responses and not systems where a single stress factor strongly prevails. CAM is noted to be a strategy for variable, flexible and plastic niche occupation rather than lush productivity. Physiological syn□ecology' reveals that phenotypic plasticity constitutes the eco-physiological advantage of CAM(Lutge U., 2004)

The simplest definition of CAM, first described for species of the family *Crassulaceae,* is that there is nocturnal uptake of CO_2 via open stomata, fixation by phosphoenolpyruvate carboxylase and vacuolar storage of CO_2 in the form of organic acids, mainly malic acid (Osmond, 1978).

For terrestrial plants, the greatest benefit of CAM is considered to be increased water use efficiency because stomatal opening during the dark period causes much less transpirational loss of water than opening during the light period(Lutge U., 2004)

Sedum telephium has the potential to exhibit pure C_3 characteristics when well-watered and a transition to CAM in drought, including a continuum of different stages of CAM expression which are repeatedly reversible under changing drought and watering regimes (Lee and Griffiths, 1987).

Generally, water is considered to be the most important factor and CAM to be an adaptation to water-shortage stress because transpirational water loss is minimized by CO_2 acquisition via open stomata during the dark period and CO_2 assimilation behind closed stomata during the light period.

Light has two important functions in CAM. First, it acts as the energy source of photosynthesis and second, it affects expression and performance of CAM via signalling systems. (Lutge U., 2004)

In C_3/CAM intermediate species, light responses of stomata also change dramatically when CAM is induced. In *Portulacaria afra*, blue-light and red-light responses of stomata in the C_3-state are lost in the CAM-state. Signals such as p^i_{CO2}, high water pressure differences between leaves and the atmosphere, high temperature and low water potential are excluded as being inhibitory signals for stomatal opening in response to blue and red light during CAM. The inhibition is also observed in isolated epidermal peels and different signalling must be involved (Lee and Assmann, 1992).

One promising route for future research will be to make use of known C_3-CAM intermediates and facultative CAM species as tools for exploring the molecular changes associated with the commencement of CAM stomatal rhythms (Winter and Holtum, 2014; Brilhaus et al., 2016). The identification of gradients in the relative contributions of C_3 and CAM along the linear leaves of C_3-CAM intermediate monocot species is another naturally occurring system ripe for further investigation (Popp et al., 2003; Freschi et al., 2010).

MATERIAL AND METHOD

Four species of the genus *Sedum* were used in the experiments: *S. album, S. sexangulare, S. hispanicum* and *S. maximum.*

Physiological researches consisted in the analysis of physiological processes (photosynthetic intensity, transpiration intensity) as well as physiological indexes (active photosynthetic radiation, leaf temperature, stomatal conductance) using the Lci portable analyser.

In order to observe how plants behave, they were grown on limestone substrates, in vegetation vessels, under stress conditions.

Determinations were made in direct sunlight and in the dark, by covering the assimilation chamber with tinplate paper and wallpapering it with filter paper to provide moisture.

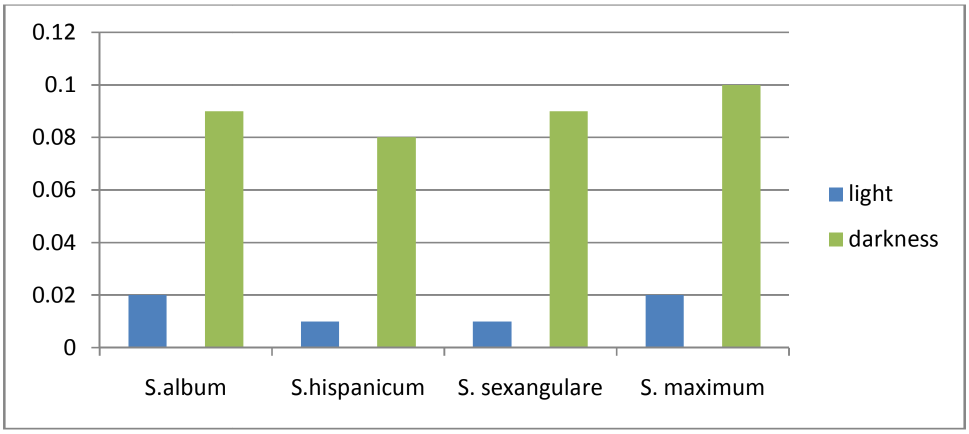
RESULTS AND DISCUSSIONS

In direct sunlight, the intensity of photosynthesis had undetectable values with the Lci.

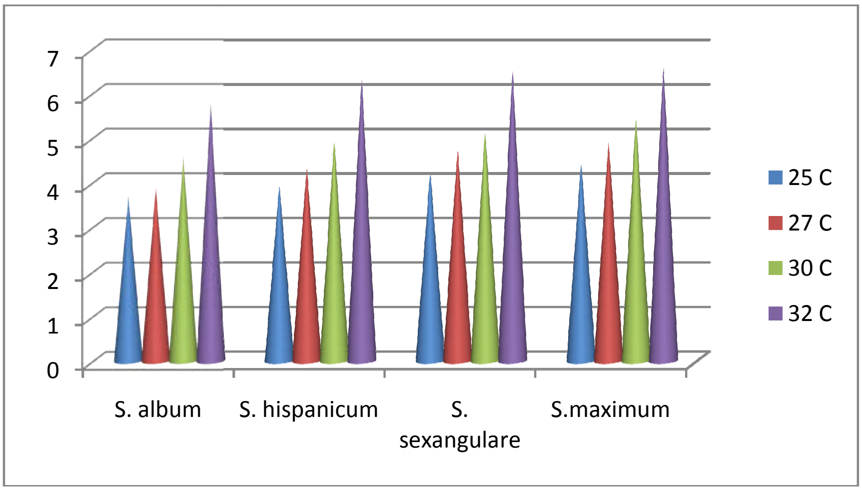
Stomatal conductance also had very low values, not influenced by the intensity of light and temperature in the assimilation chamber.

At *Sedum album* and *Sedum maximum*, stomatal conductance was 0.02 mol / m2 / s. At *Sedum hispanicum* and *Sedum sexangulare*, the stomatal conductance was of 0.01 mol / m2 / s (gr. 1).

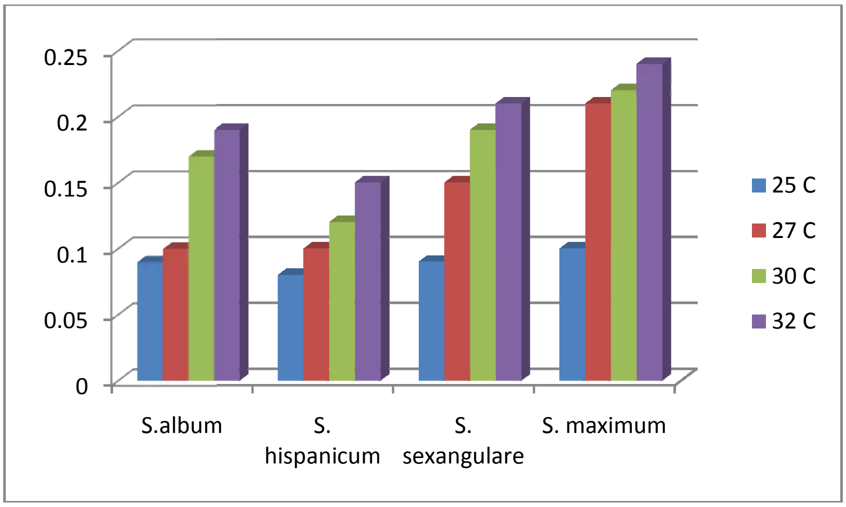
In the dark, under adequate humidity, the intensity of photosynthesis recorded an increase proportional with the temperature in the assimilation chamber. Thus, at 25 ° C, the intensity of photosynthesis showed the values: 3.7 μmol / m2 / s in *Sedum album*, 3.9 μmol / m2 / s in *Sedum hispanicum*, 5.8 μmol / m2 / s at *Sedum maximum* and 4.6 μmol / m2 / s at *Sedum sexangulare*.



Gr.1. The stomatal conductance in light and darkness (μmol / m^2 / s)



Gr.2. The intensity of photosynthesis (μmol / m2 / s) in the dark, at different temperatures of the assimilation chamber

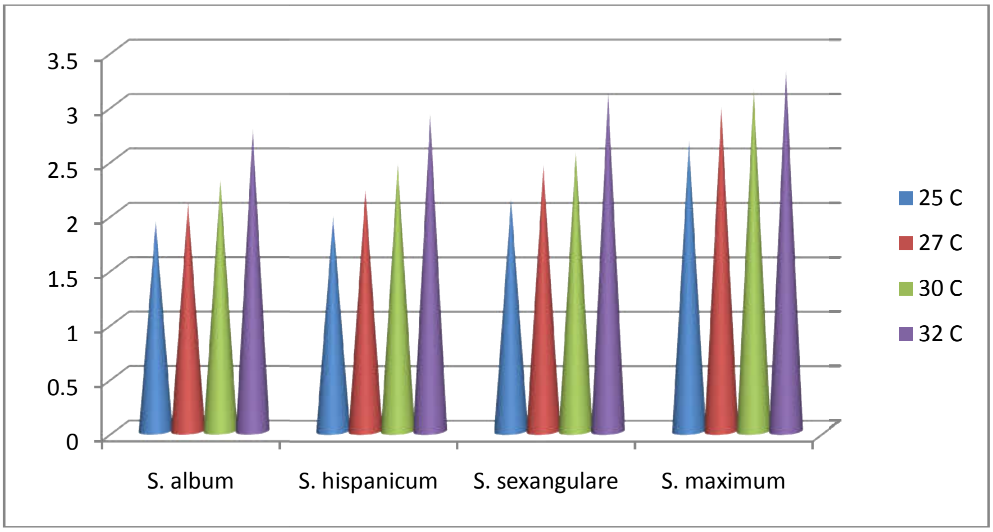


Gr. 3. The stomatal conductance (µmol / m2 / s) in the dark, at different temperatures of the assimilation chamber

At an assimilation chamber temperature of 32 ° C, photosynthesis increased in intensity, showing the values: 4.4 µmol / m2 / s at *Sedum album*, 4.9 µmol / m2 / s at *Sedum hispanicum*, 6.6 µmol / m2 / s at *Sedum maximum* and 5.4 µmol / m 2 / s at *Sedum sexangulare* (gr.2).

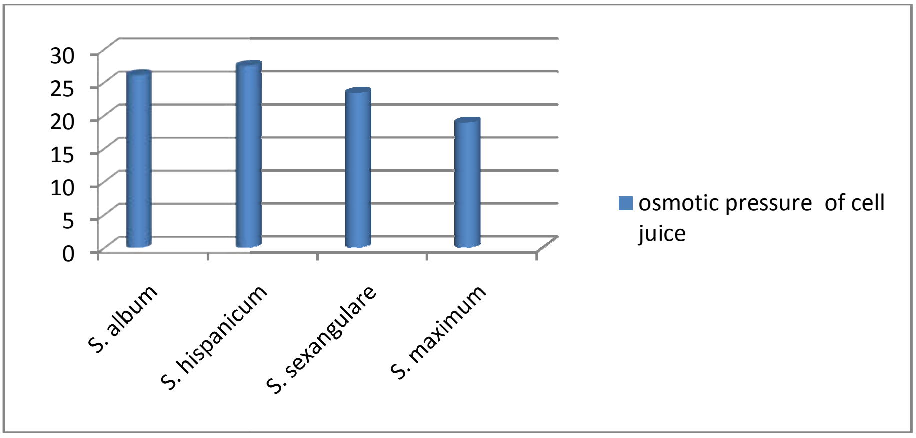
The stomatal conductance values also increased proportionally with the temperature (gr.3).

The transpiration intensity was also zero in the light, but in the dark it increased proportionally with the temperature. The highest values of transpiration in the dark were recorded at *Sedum maximum* (3,22 mmol/m^2 /s), and the lowest at *Sedum album* (gr.4).



Gr.4. The intensity of transpiration (µmol / m2 / s)
in the dark, at different temperatures of the assimilation chamber

The osmotic pressure of the cell juice in the plants of the *Crassulaceae* family shows high values, these values assuring the rise of the raw sap under conditions of poor water supply and during the day because of the lack of action regarding the leaf suction force. The highest osmotic pressure is recorded at *Sedum hispanicum* (27.5 atm), the lowest value being that of *S. maximum* (18.9 atm).



Gr.5. The osmotic pressure of cell juice (atm)

CONCLUSIONS

The plants of the *Crassulaceae* family are adapted to survive under water stress conditions.

They show the ability to fix carbon dioxide in the dark due to their acid metabolism (CAM)

The stomatal conductance in conditions of drought reaches a minimum value during the day time and a maximum value during the night, when the transpiration process takes place.

The osmotic pressure of the cell juice has high values, allowing the ascension of raw sap in the plant body.

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