STUDIES REGARDING THE BEHAVIOR OF SOME SPECIES OF *SEDUM* UNDER THE STRESS CONDITIONS INDUCED BY ROOF CULTURE

STUDII PRIVIND COMPORTAREA UNOR SPECII DE *SEDUM* LA CONDIȚIILE DE STRES INDUSE DE CULTURA PE ACOPERIŞ

NEGREA Roxana[1]
e-mail: roxana.acfrance@gmail.com

Abstract. *The principles of green roof landscaping, essential in developing cultivating projects, can be successfully applied knowing the full characteristics of the species that are used. Taking this into consideration, the main objective of this research is to enrich the assortment of ornamental used in the landscaping of the green roofs with new species, resilient to the stress caused by the existing cultures present on roofs. The biological material used was composed of 108 mature specimens of Sedum spurium 'Fuldaglut' and Sedum reflexum 'Angelina' cultivated in 3 types of substrate in containers, placed on the roof. Analyses carried out in the experiment have shown the ability to adapt to the stress conditions of the two species of Sedum by determining peroxidase and catalase activity. As a result of the study performed we were able to determine which of the two species is more adaptable to the roof culture, and also the adequate substrate for elaborating the cultivating schemes.*
Key words: *Sedum, roof culture, substrate, stress.*

Rezumat. *Principiile amenajării acoperişurilor verzi, esențiale în elaborarea schemelor de plantare, pot fi aplicate cu succes doar cu condiția cunoașterii în amănunt a caracteristicilor speciilor care intră în compoziția lor. Luând în calcul aceste considerente, obiectivul central care face subiectul acestei lucrări este acela de a îmbogăți sortimentul de plante ornamentale utilizate în amenajarea acoperişurilor înverzite cu specii rezistente la stresul datorat condițiilor de cultură existente la nivelul acoperişurilor. Materialul biologic utilizat a fost format din câte 108 exemplare mature de Sedum spurium 'Fuldaglut' şi Sedum reflexum 'Angelina' cultivate în containere amplasate pe acoperiş, în trei tipuri de substrat. Analizele efectuate în cadrul experimentului au evidențiat capacitatea de adaptare la condițiile de stres a celor două specii de Sedum prin determinarea activității peroxidazei și a catalazei. În urma studiului efectuat s-a putut determina care din cele două specii este mai pretabilă culturii pe acoperiş, cât și substratul cel mai adecvat pentru elaborarea schemelor de plantare.*
Cuvinte cheie: *Sedum, cultură pe acoperiş, substrat, stres.*

INTRODUCTION

Growing flower species on rooftops has encouraging advantages in terms of environment, education system and community life, boosting the populations solidarity in order to achieve a framework for proper long-term management of

[1] University of Agricultural Sciences and Veterinary Medicine of Iaşi, Romania

premises. As a result, traditionally, gardens and green areas in Romania, have long been planted with numerous species of rustic plants, some of them from the spontaneous flora, but with high decorative value (Zaharia *et. al.,* 2013), which determined them to be later on "adopted" and frequently cultivated on roofs, or in certain areas (corresponding to the specific habitat of the plants), or wide spread, in the case of those with greater adaptability or which are commonly found in the spontaneous flora.

These qualities of flower species, especially of those belonging to the Sedum genus, decorative due to the beauty of the flowers and leaves, contribute to increasing the ornamental quantity of towns, as they can be used both for outfitting ground level spaces and in compositions successful carried out for roof gardens. This combination of business with pleasure is encouraged and highly developed in several US cities, Canada and Australia. A major importance in the sustainable maintenance of this algorithm is to maintain these plantations in the best possible condition at roof level by identifying and reducing the stress they face as much as possible (Haggas, 2006).

One of the reasons why not every plant may be used for growth on rooftops is hydric stress (Emilsson, 2008), which has a pronounced influence on the metabolism of phosphorus compounds in leaf tissue, inducing reduction of their content, especially of etheric carbohydrates during vegetative phenophases (Iordănescu, 1988). Despite this reason, there are many examples of plants cherished and cultivated in Romanian gardens, who because of ability to adapt can be used successfully in the creation of green roof: *Sempervivum tectorum* L., *Arabis caucasica* L. *Vinca major* L. (Negrea *et al.*, 2014). These species are among those with high ecological plasticity, which can be grown in the most various climatic conditions (Haggas, 2006). This feature is due to the large adaptability to environmental conditions in which they formed - from open places with strong insolation and severe humidity (Stefan *et al.,* 2013), to shady forests with moist soils.

In order to have an answer as accurately as possible about the emergence of the phenomenon of stress, manifested due to the culture medium from the roof (Nagase and Dunnett, 2011), we have to correlate the biochemical processes with the structural aspects, the lack of a fair enzyme activity is both the result of an imbalance and an adverse biochemical reactions (Weisany *et al.,* 2012). The whole complex of biochemical factors, substances responsible for upsets due to both environment and culture due to various substrates, is an important means of assessing the incompatibility between species from the experiment and different types of substrate.

Reported to the particular ecopedological conditions on which flowering species are grown, not always the most favorable, the culture site is the main way to fight the limiting factors of the soil (Levitt, 1980).

MATERIAL AND METHOD

The biological material used was composed of *Sedum spurium* 'Fuldaglut' and *Sedum reflexum* 'Angelina', both purchased in pots of 12 cm from a specialized nursery. *S. spurium* 'Fuldaglut' is a vigorous perennial species, 10-15 cm tall with semi persistent

leaves, with whole or slightly serrated edges and pink or fuchsia star-shaped flowers (Zaharia, 2010). *S. reflexum* 'Angelina' is also perennial, 5 to 10 cm in height, with succulent and 1-2 cm long leaves, light-green mixed with yellow flowers, hermaphrodite, with 5 sepals and 5 petals, simple, succulent, grouped in inflorescences. The literature shows that fruits are polifollicles (Smydo, 2006), but none of the studied specimens, did not produce fruits the first year of planting.

The 216 mature uniform vegetal material (108 specimens for each species) has been transplanted in the spring of 2014 on the roof of a building belonging to the University of Agricultural Sciences and Veterinary Medicine of Iasi (fig.1.), by mounting them in 18 containers of 80/480 cm. In order to also make a comparative analysis between their development, the experimental scheme for each species includes three variants (type of culture substrates), with four repetitions each and 9 plants per repetition: V_1 (control) - forest soil, V_2– mixture of Novobalt peat (43%), coconut fiber (30%), composted bark (23%), alginate (4%), V_3– blonde peat (40%), brown peat (30%), sand (10%) and forest soil (20%).

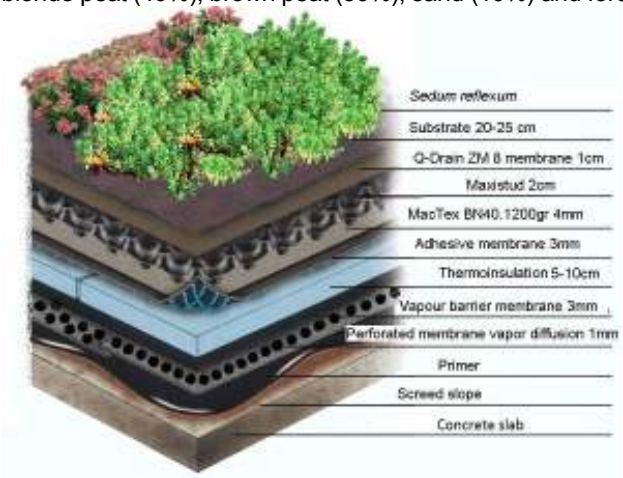

Fig. 1 - Section through roof-mounted alveoli

The overall objective of the research pursued in this paper was to conduct biochemical research on the plant - growth substrate association, to highlight the expression of adaptability phenomenon to various substrate. The research is focused on catalase and peroxidase activity, as indicators of adaptability to stress induced by specific roof conditions (drought, sunstroke etc.).

Peroxidase activity (POD) was then determined according to the method described by Brad et al. (Iordanescu and Dumitru, 1988) in which the reaction medium contains 0.1 mL ascorbic acid, 1 mL of distilled water, 2 mL and 1 mL prepared benzidine reactive protein. The method is based on measuring the color intensity of the product of oxidation with hydrogen peroxide under the action of peroxidase. To determine the activity of catalase (CAT) iodometric titration method was used. The hydrogen peroxide left decomposed after a certain time of incubation, oxidizes the potassium iodide.

RESULTS AND DISCUSSIONS

The opportunity of the study is achieved by increasing green areas in urban landscape in terms of continuous demographic growth. Landscape architecture, being directly related to ensuring the ecological balance of the environment, has as main

objective the preservation and development of landscapes and their associated values for the benefit of current and future generations. The scientific research addressed in this paper focused on some plants with ornamental characteristics, recording the way they adapt and develop in the agro-meteorological Iasi area, with the purpose of including them on green rooftop culture (fig. 2.).

a) **b)**

Fig. 2 - *Sedum spurium* 'Fuldaglut' (a) and *Sedum reflexum* 'Angelina' (b) at the moment of planting

The determination of the enzymatic activity is a practical way to assess the level of stress, being used as a method of evaluating the ability of the plant to respond to this stress factor induced by the type of substrate. By studying the manner of their adaptability some modifications have been observed in enzyme activity.

Peroxidase activity average values determined two weeks after establishing the experimental crop was 8.09 U/mg protein for *Sedum spurium* and 7.75 U/mg protein for *Sedum reflexum* (fig. 3).

Following the measurements performed for the species *Sedum spurium*, the highest values of POD, were obtained from the control variant V_1 situated on the substrate made from the forest soil, both in November and in May (9.10 respectively 8.98 U/mg protein), showing the stress faced by them. Although the differences are small compared to the control (by 3.4-5.3%), the lowest value of POD was recorded in plants located on the substrates V_2 and V_3, which is a clear indication of the fact that this types of substrate reduces stress (fig. 3).

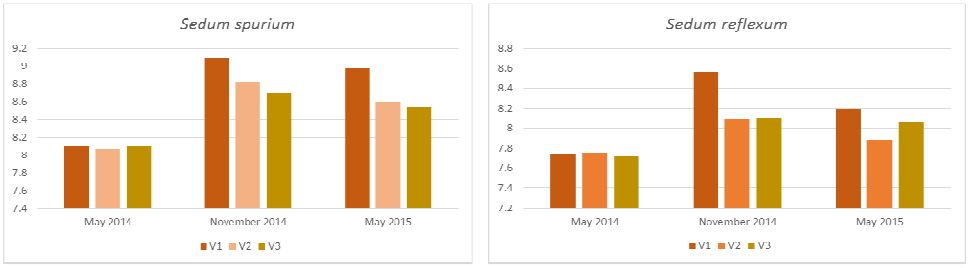

Fig. 3 - Peroxidase activity (POD) during a year of vegetation (U/mg protein)

In the case of the *Sedum reflexum* species, by analyzing the data concerning POD activity it could be observed that the plants located in the substrate consisting of forest soil from variant V_1 manifested the highest stress in November reaching the value of 8.57 U/mg protein, while the substrates of the embodiments V_2 and V_3 peroxidase activity decreased by 5.7-5.9% compared to the control (fig. 3). In May, peroxidase activity decreases for all variants, but maintained higher values for V_1.

Two weeks after planting, catalase activity (CAT) determined for the two species recorded close relative values, ranging from 4.38 U/mg protein for *Sedum spurium* and 4.82 U/mg protein for *Sedum reflexum*, in the three variants of substrate (fig. 4).

Tests carried in November 2014 and May 2015 indicate different values for catalase activity, depending on the variant and species (fig. 4). Both the *Sedum spurium* and the *Sedum reflexum*, the lowest catalase activity was recorded in the variants V_2 and V_3. In May 2015 the values of CAT were similar for the three variants (between 4.69-4.77 U/mg protein for *Sedum spurium* and 5.11-5.25 U/mg protein for *Sedum reflexum*). In all measurements, variant V_1 recorded the highest values of catalase activity (fig. 4).

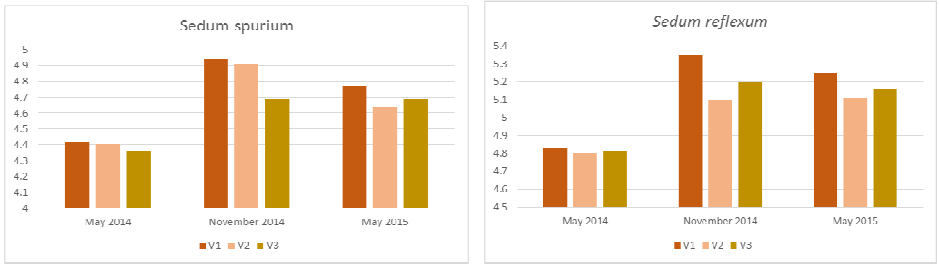

Fig. 4 - Catalase activity (CAT) during a year of vegetation (U/mg protein)

The analyzes and the tests carried out on the two investigated species showed a more intense enzyme activity in the case of plants located on the substrate consisting of forest soil (V_1).

Knowing that the intensification of catalase activity is conditioned by increasing the quantity of hydrogen peroxide accumulated in tissues, a specific phenomenon under stress conditions, the results show the continued existence of adaptation processes in plants, given the fact that this enzyme is involved in the mechanism of adaptation of the plants to drought.

CONCLUSIONS

In terms of rooftop culture the plants are subject to additional factors stress, since values of peroxidase and catalase activity registered immediately after planting material on the rooftop, in the first decade of May 2014, are lower than those recorded after 6 respectively 12 months after planting (November 2014 and May 2015).

The relatively small differences registered between the variants indicate little influence of substrate type on adaptation to growing conditions on the roof of *Sedum spurium* 'Fuldaglut' and *Sedum reflexum* 'Angelina'. However, lower levels of peroxidase and catalase activity of the variants V_2 and V_3, we recommend the substrates consisting of Novobalt peat (43%), coconut fiber (30%), composted bark (23%), alginate (4%) and those composed of blonde peat (40%), brown peat (30%), sand (10%) and forest soil (20%).

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