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SOME ASPECTS REGARDING THE PROPAGATION BY CUTTINGS OF ORNAMENTAL SPECIES ON DIFFERENT ROOTING SUBSTRATES

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Abstract

Plants, as intelligent organisms, have developed mechanisms for survival, which humans have studied and used to expand the methods of multiplication of various categories of plants. In the field of ornamental plants one of the most common method of propagation is the vegetative method by cuttings. In the present work, the testing of the most commonly used rooting substrates (sand, perlite, peat, peat mixed with perlite 1:1) for the top cuttings of shoots of some indoor ornamental species, decorative by flowers and leaves (Nerium oleander, Pelargonium odoratissimum, Croton variegatus, Hypoestes sanguinolenta, Coleus hybridus) continued. The parameters analysed to evaluate the efficiency of the rooting substrate were some biometric characteristics the average length of the main root and the average length of shoots together with the rooting percentage. For the statistical interpretation of these parameters, the IRP (index of Root and Peak) indicator was developed. The consistency of the IRP indicator was analysed using the Alpha Cronbach coefficient.

***Key words**: cuttings, rooting substrates, Alpha Cronbach.*

INTRODUCTION

Propagation of plants by cuttings is based on the ability of these fragments - from the various organs of plants (stems, shoots, leaves, roots) to form at the basal pole, when they are placed in optimal conditions, roots and on apical pole the aerial organs, resulting in new plants, very similar to the mother plants.

According to the literature, the cuttings obtained from the tops of the branches take root faster than the cuttings of the section (or obtained from the lateral branches), due to the higher auxin content (Burzo et al., 2005).

Billions of new plants are produced each year, starting from cuttings harvested from carefully selected mother plants. The quality of young plants is the result of the interaction between the genetic and physiological limits of the plant, the rooting substrate and the ensured environmental conditions (Druege, 2020).

Last but not least, pruning is one of the methods used to ensure the survival of endangered plant species. Thus, in the species *Jasminum parkeri* Dunn (Kashyap et al., 2021), a woody ornamental shrub, not only was it possible to protect the species from population decline but there was even an increase in the adaptive potential of the species, which may be a sign of superior uses as a decorative plant in India, simultaneously with the reintroduction of ex situ cultivated plants into natural populations.

Wild populations of *Hoya imperialis* and *Hoya coronaria* (family Apocynaceae), particularly decorative by flowers, are under special pressure in their areas of origin (Brunei), due to the continuous decline of habitat and unsustainable harvests. Two methods of propagation have been studied for ex situ preservation: by cuttings and by micropropagation. The cuttings were treated with rooting stimulants and placed on a substrate of peat and perlite. The results showed a good multiplication rate, even in the case of unstimulated cuttings. Micropropagation did not work (Mohd Don et al., 2021).

What is very important to note is that continuous innovation in vegetative propagation is one of the drivers of plant breeding programs facilitating the production of high-quality plants with the same genetic characteristics as the mother plant and without diseases or pests (Rufo and Colombo, 2020).

Peat is a type of natural substrate of organic origin, often used in flower production, being found alone or in various combinations, both in the composition of rooting substrates and those for containerized culture. It should be noted that concerns have now begun to be identified about the possibility of replacing peat due to its non-renewable resource characteristics (Aboksari et al., 2021).Substrates for rooting ornamental cuttings can be classified as "light" substrates, usually simple or mixed, consisting of natural components (peat, sand) and artificial components (perlite) (Davidescu et al., 2001), combined in various proportions depending on the specific requirements of the plants (Manda et al., 2019).

It is good to know that water, simple, can also be used as a rooting "substrate", for certain species in genera such as *Nerium, Pelargonium, Saintpaulia, Hibiscus, Cyperus, Tradescantia, Ficus, Hedera, Scindapsus* (Șelaru, 2006).

A quality substrate is, in most cases, beyond the quality of the biological material available, one of the essential conditions for the success of plant propagation through cuttings. Such a substrate must have good air porosity, be able to retain water and be sterile - free of pathogens.

MATERIALS AND METHODS

This preliminary research was carried out in the greenhouses of the Hortinvest Center of the USAMV Bucharest during 2019-2021.

The studied biological material consisted of cuttings from a number of five ornamental species, decorative by habitus, foliage, flowers, grown in pots in the conditions of our country.

Croton variegatus L. (sin. *Codiaeum variegatum* (L.) Rumph. Ex A. Juss), family Euphorbiaceae, ord. Malpighiales, native to Malaysia, Australia, plant with permanent vegetation, reaches heights of 60-80 cm, decorative by its rich foliage, elliptical leaves elongated, entire or cut symmetrically or asymmetrically, with straight or wavy edge, are leathery and variously colored with spots, dots, streaks of red, yellow, orange, pink, purple that give surprisingly beautiful combinations. The yellow flowers placed in clusters are not of decorative interest (Șelaru, 2006).

Hypoestes sanguinolenta (Van Houtte) Hook. f., family Acanthaceae, ord. Lamiales, species native to Madagascar, herbaceous, with a height of up to 30-40 cm, has continuous vegetation and rapid growth. The leaves, placed opposite, have an oval-elliptical shape with a sharp tip and numerous small pink spots on the green background of the upper face. The reverse of theleaf is purple. The small, purple flowers have no decorative value (Șelaru, 2006).

Nerium oleander L., family Apocynaceae, ord. Gentianales, is native to India, Singapore, Nepal, China, Mediterranean regions. It can bloom from spring to late autumn. As a potted plant, the oleander can reach heights of 1-2 m and has the appearance of a bush shrub. The flexible shoots are trimmed with leathery leaves, very similar to willow or olive leaves. The flowers can be simple or wrapped, grouped in rich bouquets and have a wide range of colors, from white, pink, yellow to red or purple (Șelaru, 2006).

It is a very important species, especially in the Mediterranean area, where there is a high demand, which justifies the efforts of growers to obtain and perpetuate plants with valuable characteristics, vegetative propagation by cuttings is one of the most important methods in this regard, along with of more sophisticated methods such as *in vitro* multiplication (Ochoa et al., 2003; Simion and Anton, 2009; Vila et al., 2010; Aryan and Rani, 2016). But this species is important not only from a decorative point of view, but also as a factor that contributes to the decrease of pollution in the urban environment due to its resistance (Doganlar et al., 2012; Vasquez et al., 2016; Elloumi et al., 2017).

Pelargonium odoratissimum (L.) L'Hér. family Geraniaceae, ord. Geraniales - the apple geranium, or the scented geranium (Thirumalachar, 1944; Toma, 2009), or in Romanian “drușaim” Șelaru, 2006).The species comes from South Africa (Cape of Good Hope), has deeply lobed leaves (7-11 lobes) with serrated edges. The bluish- green tongue has a fine pubescence. The flowers are purple, small, less decorative. The whole plant is strongly fragrant, being used in food as an aromatic plant and in medicine.

There are also opinions about this species, according to which the propagation by stem cuttings does not give the expected results, due to the difficult rooting (Ebrahimzadeh et al., 2021), while studies carried out on other species of the genus confirm the ability of reproduces faithfully from cuttings, with or without the use of rooting stimulants (Georgescu et al., 2012; Toma et al., 2012).

Coleus blumei Benth. (sin. *Plectranthus scutellarioides* (L.) R.Br.), family Lamiaceae ord. Lamiales, although is mainly known as a garden plant (Șelaru, 2007), it is beginning to establish itself in the assortment of indoor plants, due to the diverse coloration of its particularly decorative leaves. Although it can be propagated by seeds, due to genetic instability, pruning is practiced using stem cuttings with apical leaves, treated with rhizogenic substances (Belniaki et al., 2018) when it is necessary to quickly obtain large quantities of uniform plant material for the establishment various forms of decoration (vegetable carpets, mosaics etc.). At the same time, some studies show that the exposure of cuttings to the light of different types (Cho et al., 2022) favors the further development of new plants.

Long shoots were harvested from the existing mother plants in the didactic collection, from which top shoots were made with 3-5 knots each. Cuttings with relatively different lengths resulted since the distance between the nodes on the stem is different, being larger at the base and smaller towards the top.

After sampling, the cuttings were shaped differently, the leaves from the lower node were removed, and the others from the upper nodes were shortened, almost in half, to the species that allow this intervention, to have a smaller leaf area, so a process of less intense perspiration.

In this context, a bifactorial experiment (type 5 x 4) was organized, as follows:

A factor- cuttings of the 5 ornamental species mentioned above, of 30 repetitions each.

B factor- 4 rooting substrates: river sand (V_1), perlite (V_2), peat (V_3), and a mixture of peat and perlite (1:1) (V_4).

Once made, the cuttings were distributed in the properly prepared rooting substrates, in alveolar plates (51 x 33 x 4.4 cm; 70 cells, usable volume about 4 cm^3/root cell). Throughout the rooting, the appropriate environmental factors were ensured: temperature 20-22°C, atmospheric humidity 95-97%, the maintenance of the permanent substrate revived by frequent watering. The rooting time was 4-5 weeks.

Indicators were defined that define the process of rhizogenesis: percentage of rooting, length of main root and length of rooted cuttings.

An indicator has been defined to reflect the three types of measurements: percentage of rooting (**PR**), the average of the root length of the cuttings main (**RL**) and the average length of the rooted shoots (**LS**), for each type of substrate.

The data were normalized using the unity-based normalization method (Myatt and Johnson, 2014) using the formula:

$$X_{new} = \frac{X_{old} - X_{min}}{X_{max} - X_{min}}$$

The comparison of the data sets was made using the IRP indicator (index of Root and Peak):

IRP = 45% x PR + 10% x LR + 45% x LS,

The Alpha-Cronbach coefficient (Cronbach, 1951), used to study the consistency of the IRP indicator (reliability of IRP index) was calculated using GNU pspp 1.4.0. This software was used for ONEWAY ANOVA to compare the averages of the IRP indices for each species (DF=4, $p<0.05$)

RESULTS AND DISCUSSIONS

The process of rhizogenesis was influenced differently depending on the substrates in which the cuttings were rooted.

1. Percentage of rooting recorded very different values, between 50% and 100%, influenced by both the substrate used and the species (Figure 1).

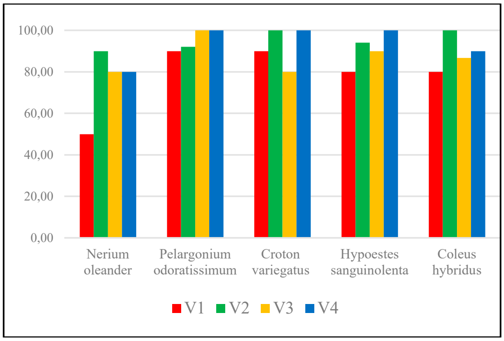

Figure 1. Percentage of rooting on different substrates

In *C. variegatus* cuttings, the rooting percentage was 100% for experimental variants of V_2 and $V_4$are in accordance with the data from literature (Şelaru, 2006), 90% for V_1 cuttings and 80% for V_3 cuttings. The best results were obtained in substrates with perlite due to its granular structure, being easy to cross for roots.
H. sanguinolenta recorded, as can be seen, the highest percentage of rooting on the substrate composed only of peat and perlite (V_4), the percentage value being 100%. In the V_2 cuttings have rooted in the percentage of 94%, take in V_3 90%. The lowest yield was obtained in cuttings rooted in V_1, the percentage of rooting on this substrate being 80%.
In *C. hybridus*, the rooting percentage was different depending on the substrate, so the highest value was obtained in cuttings that had V_2 as their rooting substrate (100%) (confirming the literature data, Nicu and Manda, 2021), then, in descending order, those rooted in the substrate composed of V_4(90 %), 87 % V_3 and V_1 (80 %).
N. oleander: the highest rooting percentage was obtained in the case of the substrate composed only of perlite - V_2 (90%). The lowest yield was obtained in cuttings rooted in the substrate formed only from V_1 (50%). On the other sub-strates (V_3 and V_4) the rooting percent were 80%.
Concerning *P. odoratissimum* cuttings, from the analysis of the results obtained for peak cuttings, in each substrate, it can be concluded that on the rooting substrate represented by V_4, the best 100% results were recorded. The worst results were obtained in the 90% V_1 substrate.

2. The length of the main roots

The main root length (Figure 2) in *C. variegatus* had values in the range of 7.10 cm in V_4, and 5.1 cm in V_1. Intermediate values were recorded onV_3 (6.90 cm) and V_2 (5.50 cm).

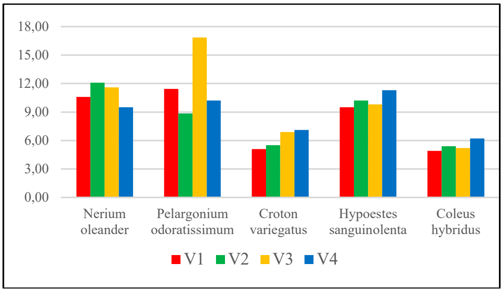

Figure 2.The length of the main root to rooted cuttings on different substrates (cm)

Taking into account the obtained results it can be easily seen that the longest main roots in the rooted cuttings of the species *H. sanguinolenta* were in the case of V_4 (11.30 cm), and the shortest roots were observed in the cuttings rooted in the V_1, 9.50 cm. The length of the roots of the cuttings rooted in V_2 (10.20 cm) and V_3 (9.80 cm) had very close values.
Regarding the biometric parameters studied in the case of the *Coleus hybridus* species, both in the case of the aerial vegetative part (shoots) and in the case of the root system, it was found that their values are close, higher values can be observed in the evolution of the cuttings rooted in V_4, on the second position were placed the cuttings rooted in V_2, and the lowest values were recorded in the cuttings rooted in V_1. The length of the main root recorded values ranging from 6.20 cm (V_4) to 4.90 cm (V_1).
In the case of *N. oleander* species it can be easily seen that the longest roots have grown in plants rooted in V_2 (12.10 cm). The V_4 gave the lowest values, 9.5 cm.
The main root length for the species *P. odoratissimum* was between 21.82 cm (V_3) and 14.84 cm in the case of V_2.

3. The length of the shoots

In the case of the shoot length parameter (Figure 3), in the *C. hybridus* species, the values were close, noting the roots formed in V_4 substrate (19.10 cm), the V_2 ones 18.40 cm, 18.21 cm those from V_3 and the lowest values (17.90 cm) in the case of V_1.

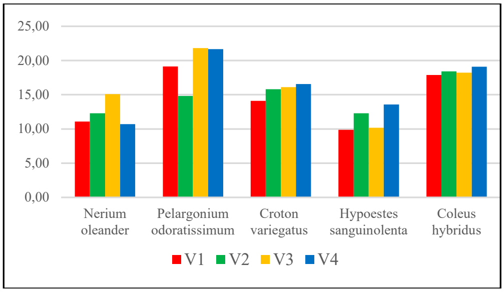

Figure 3. The length of shoots at rooted cuttings on different substrates (cm)

The length of the shoot at *C. variegatus* recorded close values, the highest - 16.56 cm in V_4, the smallest - 14.10 cm in the V_1. Root and shoot have the same decreasing tendency from V_4, V_3, V_2 to V_1.

In the case of the species *H. sanguinolenta* the length of the shoot from V_4 had the highest value - 13.58 cm, then 12.30 cm in V_2, 10.19 cm in V_3 and 9.88 cm in the V_1. All the indicators followed had the lowest values in the cuttings rooted in the V_1, average values in the case of cuttings rooted in V_2 and V_3, and the V_4cuttings gave the best results.
In the species *C. hybridus*, shoots of an average length of 19.10 cm were observed in the case of $V_4$and 17.90 cm in the case of cuttings rooted in V_1.
The species *N. oleander* recorded the following values of the length of the shoot, as can be seen from the graph: maximum 15.10 cm in V_3; minim 10.70 cm in V_4, intermediate values of 12.30 cm in V_2 and 11.10 cm in V_1. *P. odoratissimum* had the longest shoots among the species studied, the size of the shoots being between 21.82 cm in V_3 and 14.84 cm in V_2. However, the experimental results show that cutting is a good method for the multiplication of *P. odoratissimum* plants, inciting some contrary opinions in the literature (Ebrahimzadeh et al., 2021).
By applying the IRP coefficient, it was aimed at identifying the response of each studied species to the substrates used for rooting (Figure 4), resulting in the following:

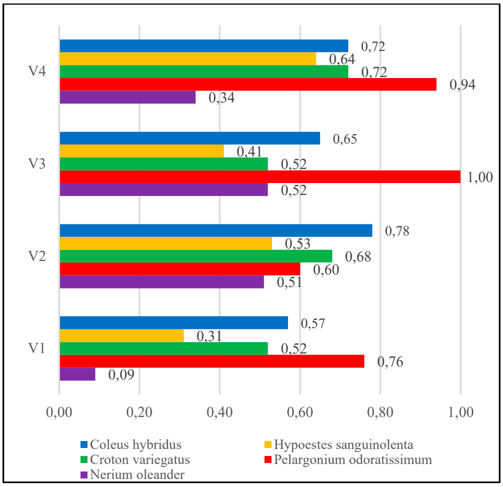

Figure 4. The IRP coefficient on the substrate

River sand (V_1) - the best results were obtained at the rooted cuttings of the species *P. odoratissimum*, at the opposite pole being the rooted cuttings of *N. Oleander* (which confirm the results obtained by Ochoa et al., 2003).
Perlite(V_2) - the best behaviour was recorded in the case of *C. hybridus* rooted cuttings and the worst result was obtained in *H. sanguinolenta*.
Peat (V_3): the greatest influence it had in the cuttings of *P. odoratissimum*, and the lowest on the cuttings of the species *H. sanguinolenta*.
The mixture of peat + perlite (V_4) was the most favourable for the cuttings of *P. odoratissimum* and the least favourable for the cuttings of *N. oleander*.
Subsequently, the averages of the IRP indicators for each species were calculated and the averages were compared with the help of ONEWAY ANOVA, obtaining significant differences (Figure 5).
Following the data processing with the help of ONEWAY ANOVA, it can be seen that, in the case of the substrates studied, the best results were obtained when rooting the *P. odoratissimum* cuttings, and the worst results were recorded in the case of *N. oleander* cuttings, which may lead to the idea that for this species other types of rooting substrates should be tested.

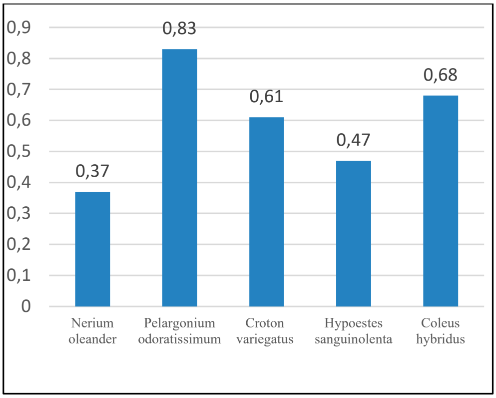

Figure 5. The mean of the IRP coefficient

CONCLUSIONS

The use of the IRP coefficient allowed the customized identification of the efficiency of the rooting substrates for each species. Thus, at *N. oleander* - the best results were obtained on V_3 (but almost the same in V_2) and the weakest on the V_1; at *P. odoratissimum* - the best behaviour was in V_3 and the weakest in V_2; at

C. variegatus - it was best for V_4 and the weakest for V_1 and V_3; at *H. sanguinolenta* - the best result was in V_4 and the weakest in V_1; at *C. hybridus* - the maximum was recorded at the V_2 and the minimum at the V_1.

Such coefficients, of the type used in this paper (IRP), which quantify, from a mathematical point of view, the evolution of some biometric parameters, in this case, those that characterize the process of rooting of cuttings, can be useful tools, within the reach of researchers, to highlight the interaction between the elements that intervene in this type of processes.

REFERENCES

Aboksari, H. A., Hashemabadi, D., &Kaviani, B. (2021). Effects of an Organic Substrate on *Pelargonium peltatum* and Improvement of its Morphological, Biochemical, and Flowering Parameters by Root-inoculated Phosphate Solubilizing Microorganisms. *Communications in Soil Science and Plant Analysis*, 52(15), 1772-1789.

Aryan A., Rani P. (2016). Augmentation of ornamental plants using micropropagation. *Int. J. Res. Biosciences*, 5 (1), 25-31.

Belniaki, A.C., Rabel, L.A., Gomes, E.N., &Zuffellato-Ribas, K.C. (2018). Does the presence of leaves on coleus stem cuttings influence their rooting? *Ornamental Horticulture*.

Burzo, I., Amăriuței, A., Vâșcă-Zamfir, D. (2005). *Fiziologia plantelor de cultură, vol.VI, Fiziologia plantelor floricole*, București RO, Ed. Elisavaros.

Cho, K.H., Laux, V.Y., Wallace-Springer, N., Clark, D.G., Folta, K.M., & Colquhoun, T.A. (2019). Effects of Light Quality on Vegetative Cutting and *In Vitro* Propagation of Coleus (*Plectranthus scutellarioides*). *HortScience*.

Cronbach, L.J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, 16, 297-334.

Davidescu, V., Madjar, R., Costea, G., Stanica, F., Carețu, G. (2001). *Substraturi de cultură*, București RO, Ed. Ceres.

Doganlar, Z.B., Doganlar, O., Erdogan, S., Onal, Y. (2012). Heavy metal pollution and physiological changes in the leaves of some shrub, palm and tree species in urban areas of Adana, Turkey. *Chemical Speciation and Bioavailability*, 24 (2), 65-78.

Druege, U. (2020) Overcoming Physiological Bottlenecks of Leaf Vitality and Root Development in Cuttings: A Systemic Perspective. *Front. Plant Sci.* 11:907. doi: 10.3389/fpls.2020.00907

Ebrahimzadeh, A., Fathollahzadeh, M., Hassanpouraghdam, M. B., &Mavaloo, M. A. (2021). Micropropagation of *Pelargonium odoratissimum* (L.) L'Her. through petioles and leaves. *REVISTA DE LA FACULTAD DE AGRONOMIA DE LA UNIVERSIDAD DEL ZULIA,* 38(2), 261-278.

Elloumi, N., Belhaj, D., Mseddi, S., Zouari, M., Ben Abdallah, F., Woodward, S., &Kallel, M. (2017). Response of *Nerium oleander* to phosphogypsum amendment and its potential use for phytoremediation. *Ecological Engineering*, 99, 164-171. https://doi.org/10.1016/j.ecoleng.2016.11.053.

Georgescu, M. I., Vişcă-Zamfir D., Săvulescu E. (2012) The effects of the crop's substrate and of the rooting stimulators on the internal structure of the vegetative organs of the geranium plant (*Pelargonium peltatum*). *Scientific Papers. Series B. Horticulture*, Vol. LVI, ISSN-L 2285-5653, 347-350.

Kashyap, U., Chandel, A., Sharma, D., Bhardwaj, S., & Bhargava, B. (2021). Propagation of *Jasminum parkeri*: A Critically Endangered Wild Ornamental Woody Shrub from Western Himalaya. *Agronomy*, 11(2), 331. https://doi.org/10.3390/agronomy11020331

Manda, M., Nicu, C., Vasca-Zamfir, D. (2019), Study on The Vegetative Propagation of Seven Sedum L. Species Cultivated Outdoors. *Scientific Papers. Series B, Horticulture,* Vol. LXIII, Issue 1, Print ISSN 2285-5653, 447-452.

Mohd Don, S. M., Abdul Hamid, N. M., Taha, H., Sukri, R. S., &Metali, F. (2021). Vegetative Propagation of Hoya imperialis and Hoya coronaria by Stem Cutting and Micropropagation. *Tropical Life Sciences Research,* 32(3), 1â€"23. doi:10.21315/tls

Myatt, G.J., Johnson, W.P. (2014). *Making Sense Of Data I: A Practical Guide To Exploratory Data Analysis And Data Mining*, New Jersey, USA,John Wiley and Sons Publishing House,

Nicu, C., Manda, M. (2021) Propagation and vegetative growth of some *Coleus blumei*Benth. cultivars*, Annals of the University of Craiova, Series Biology, Horticulture, Food products processing technology, Environmental engineering,* DOI: 10.52846/bhfe.26.2021.18, Vol 26, 117-124

Ochoa, J., Bañón, S., Fernández, J.A., González, A., Franco, J.A. (2003). Influence of cutting position and rooting media on rhysogenesis in Oleander cuttings. *Acta Hortic*, 608, 101-106.

Roberto, S.R., & Colombo, R.C. (2020). Innovation in Propagation of Fruit, Vegetable and Ornamental Plants. *Horticulturae*, 6, 23.

Simion, C., Anton, D. (2009). Research concerning generative and vegetative propagation on *Nerium Oleander* L. *Journal of Horticulture, Forestry and Biotechnology*, 13, 306-309.

Șelaru, E. (2006). *Plante de apartament*, EdițiaII.București, RO, ed. Ceres

Șelaru, E. (2007). *Cultura florilor de grădină*, București, RO, Ed. Ceres

Thirumalachar, M. (1944) Wilting of Shoots in Scented Geranium (*Pelargonium odoratissimum*). *Nature* 154, 515–516.https://doi.org/10.1038/154515b0

Toma, F. (2009). *Floricultură și artă florală, Specii utilizate ca plante în ghivece pentru decorul interioarelor*. Ed. INVEL-Multimedia, vol 3:82-83.

Toma, F., Petra, S., Zamfir-Vasca, D., Pricope, A. (2012) Studies concerning the influence of some technological care upon the production, growing and blossoming of *Pelargonium peltatum* plants. *Scientific Papers. Series B. Horticulture*, Vol. LVI, ISSN-L 2285-5653, 389-396.

Vázquez, S., Martín, A., Garcia, M., Español, C.P., & Navarro, E. (2016). Metal uptake of *Nerium oleander* from aerial and underground organs and its use as a biomonitoring tool for airborne metallic pollution in cities. *Environmental Science and Pollution Research*, 23, 7582-7594.

Vila, I., Sales, E., Ollero, J., Muñoz-Bertomeu, J., Segura, J., & Arrillaga, I. (2010). Micropropagation of Oleander (*Nerium oleander* L.). *Hortscience*, 45, 98-102.