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VEGETATIVE PROPAGATION IN JADE TREE USING ROOTING BIOSTIMULATORS OF STEM CUTTINGS

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Abstract

The present study analyzed the influence of some bioactive substances on vegetative propagation based on stem cuttings of Crassula ovata (Miller) Druce (jade tree). Stem cuttings were taken from the source plants for vegetation propagation. The cuttings were 5 cm long, 0.6 cm in diameter and had two pairs of leaves, with a high degree of uniformity. Three biostimulant products were used, Raiza, Rhyzo and Sangral, along with a control variant (Ct). A peat substrate, Klasmann TS3, was used for rooting. The cuttings treated with the biostimulating products and those from the control variant were placed on the rooting substrate on June 16, 2022. The number of roots (RN) and the length of roots (RL) were evaluated at three times during the study period; June 30 (t1), July 7 (t2) and July 14 (t3). The variation of RN and RL in relation to time (days) during the study period was described by polynomial equations of the 2nd degree, under statistical safety conditions (p<0.01). According to PCA, PC1 explained 60.665% of variance, and PC2 explained 26.216% of variance. Associated with the Sangral product were RN-t2 and RN-t3 parameters, and associated with the Raiza and Rhyzo products were RN-t1 parameters and especially root length, RL-t1, RL-t2 and RL-t3. Under the aspect of the increase in the formation of the number of roots, based on the recorded values, it was found that the Sangral product generated a stronger rooting (RN-t2-I = 4.92; RN-t3-I = 3.25), and with regard to the length of the roots (RL), the Rhyzo product generated the largest increases (RL-t2-I = 1.03 cm, respectively RN-t3-I = 1.49 cm).

Key words: *Crassula ovata, jade tree, rooting biostimulators, stem cuttings, vegetative propagation*

INTRODUCTION

Crassula ovata (Miller) Druce, is part of the *Crassulaceae* Family, is native to South Africa and Mozambique, and as an ornamental apartment plant (indoor spaces) is used throughout the world [2, 31]. *Crassula ovata* is a plant known under different popular or common names, such as "jade tree", "friendship tree", "money tree", etc.

Crassula ovata is a perennial, succulent plant with many branches, with a bushy appearance. The stems are thick, branched, fleshy, and juicy, up to 30-45 cm high. The leaves are oval-rounded, waxy, juicy, positioned opposite each other on the stems, dark green. The flowers appear very rarely, especially in plants grown ornamentally indoors and are positioned on the top of the white or light pink flower stalks [26].

Crassula ovata is cultivated as an ornamental plant through its leaves. In very bright spaces, the color of the leaves takes on a reddish tint. Although light is important for *Crassula ovata* it is recommended to avoid intense light in the midday hours [12]. In the conditions of our country (temperate continental climate), the plants are kept in the conditions of the cold season (autumn / winter) indoors, and in the spring / summer season the plants can be placed in open spaces (gardens, parks).

Crassula ovata plants are sensitive to some pathogenic and harmful species (eg *Botrytis* sp., *Fusarium oxysporum*, woolly louse) [9, 28].

In the natural conditions (native area), *Crassula ovata* is a component of thicket vegetation, with mixed vegetation, on rocky and dry hilly areas, and shows certain adaptations to the surface of the leaves with a role in the utilization of water from atmospheric humidity [2, 13, 16].

Substrates with a light texture (peat or peat and sand), well-drained [25], represent suitable growing and growing environments for *Crassula ovata*.

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Different species of Crassula, including *Crassula ovata*, have been studied in relation to certain adaptations to water availability and regime [13]. CAM-type metabolism facilitates *C. ovata* to reduce water losses from the leaves, without limiting the photosynthesis process [17].

Some studies have evaluated utilities in the pharmaceutical field and the antimicrobial and phytochemical activity of the *Crassula ovata* species was studied on different strains of bacteria [18, 22].

Propagation of *Crassula ovata* plants can be done by techniques specific to the group of succulent ornamental plants (*Crassulaceae*), by leaf or stem cuttings, based on the principles of vegetative propagation, or by "*in vitro*" propagation [1, 3, 21].

The propagation of *Crassula ovata* by leaf cuttings was studied in relation to different bioactive substances influences [7].

The study evaluated the vegetative propagation by stem cuttings in *Crassula ovata*, under the influence of three rooting biostimulator products.

MATERIALS AND METHODS

Vegetative propagation in jad tree, *Crassula ovata* species, was studied by stem cuttings technique, under the influence of three rooting biostimulators. Uniform cuttings, 5 cm long, 0.6 cm in diameter, with two pairs of leaves were taken from the source plants, Figure 1.

A propagation variant without cuttings treatments (control, Ct) and three variants with cuttings treated with biostimulating substances for the rooting process were considered. 20 cuttings were used for each experimental variant, in three repetitions.


Photo 1. Source plants, *Crassula ovata* species
Source: original picture, photo of the authors.

The biostimulating products were used: Raiza (Raiza-Mix), Rhyzo and Sangral.

Raiza is a rooting biostimulator, based on a liquid formula containing amino acids (12%), nutrients (N, B, Cu, Fe, Mn, Mo, Zn), phytohormones of natural origin and other bioactive substances (the bioactive substances come from from extracts of *Ascophyllum nodosum* algae). The product is certified for organic agriculture. Rhyzo is a product with a biostimulating role of the rooting process, packaged in powder form. In the active composition it has free amino acids (58.0%), nitrogen (9.8%), phosphorus (5.0%), and rooting bio-inducers (1.9%). Sangral is a product with a biostimulating rooting role, packaged in powder form.

The cuttings from the control variant and those treated with biostimulating substances (figure 2) were rooted in uniform conditions, on Klasmann TS3 peat substrate [34].

Photo 2. Example of a cutting used for vegetative propagation, *Crassula ovata*
Source: original picture, photo of the authors.

The peat substrate presented an extra fine structure (0 – 5.00 mm granulation), slightly acidic reaction (pH=6.00, H_2O, v/v 1:2.5), with a supplement of nitrogen nutrients (140 mg N/l), phosphorus (100 mg P_2O_5/l), potassium (180 mg K_2O/l), magnesium (100 mg Mg/l), trace elements (chelated iron, EDTA).

The cuttings treated with the control variant (Ct) were placed on the rooting substrate on June 16, 2022.

In order to evaluate the influence of the applied treatments on the rooting process, within the vegetative propagation of the *Crassula ovata* species, determinations were made regarding the number of roots (RN) and root length (RL) at three moments during the study period; June 30 (t1), July 7 (t2) and July 14 (t3).

The experimental data recorded regarding RN and RL on the experimental variants were statistically analyzed by appropriate methods. The standard error (SE) was calculated on the data set related to the determination moments (t1 to t3).

Regression analysis was used to find out the variation of rooting parameters (RN, RL) in relation to time on each experimental variant. PCA analysis (correlation), in which the level of explanation of the variance based on PC1 and PC2 was evaluated.

The increase generated by the treatments applied in the rooting process (RN, RL) was calculated in relation to the control variant.

For data processing and graphic representations, the calculation module in EXCEL and the PAST software were used [10].

RESULTS AND DISCUSSIONS

Vegetative propagation by stem cuttings in the *Crassula ovata* species was analyzed through the prism of treatments with biostimulating substances applied to the cuttings, compared with the control variant. The rooting process was evaluated through the prism of two representative indicators, the number of roots formed and the length of the roots at different moments of time, during the study period.

Although the stem or leaf cuttings of the species under study have the ability to emit roots naturally, without stimulating treatments, it is desirable to obtain a high rate of propagation, with vigorous plants, through the propagation process.

The values recorded for the rooting process (RN, RL) on the experimental variants are presented in Table 1 and Table 2.

Table 1. Root number (RN) values in relations to rooting biostimulators, *Crassula ovata*

Experimental variants	RN -t1	RN -t2	RN -t3
Control (Ct)	0	6.33	7.88
Raiza	3.40	9.60	8.50
Rhyzo	2.33	8.60	9.30
Sangral	1.00	11.25	11.13
SE	±0.69	±1.02	±0.7

Source: original data, obtained from experiment.

Table 2. Root length (RL) values in relations to rooting biostimulators, *Crassula ovata*

Experimental variants	RL -t1	RL -t2	RL -t3
Control (Ct)	0	1.07	2.16
Raiza	0.28	1.40	2.57
Rhyzo	0.47	2.10	3.65
Sangral	0.20	1.30	2.79
SE	±0.08	±0.22	±0.31

Source: original data from experiment.

The variation of the number of roots (RN) and the length of roots (RN) in the biological material for vegetative propagation was analyzed during the study period, under the influence of the three biostimulating substances used.

The variation of RN and RL, in relation to time (days), during the study period, was described by polynomial equations of 2nd degree, in conditions of statistical safety ($p<0.01$), and with graphic representation in Figure 1, for RN parameter, and in Figure 2 for RL parameter, respectively.

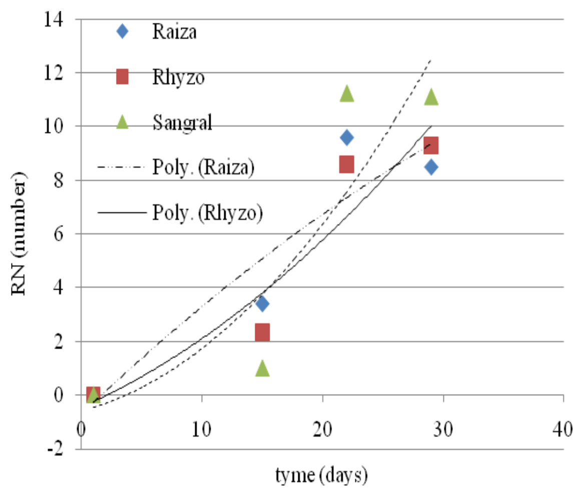

Fig. 1. Graphical representation of RN parameter in relation to time (t, days), under the rooting biostimulators influence, *Crassula ovata*
Source: Original graph, based on experimental data.

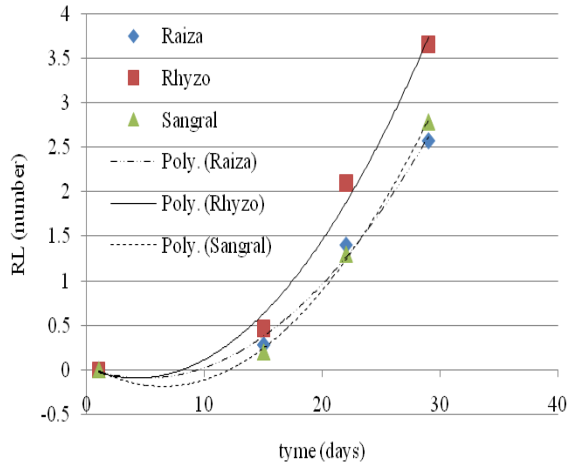

Fig. 2. Graphical representation of RL parameter in relation to time (t, days) under the rooting biostimulators influence, *Crassula ovata*
Source: Original graph based on experimental data.

Based on PCA, the diagram in Figure 3 was obtained, which includes the variants distribution, in relation to the registered effect on the rooting parameters (RN and RL) studied. The control variant (Ct) was placed on independent position in relations to studied parameters (RN, RL), as biplot.

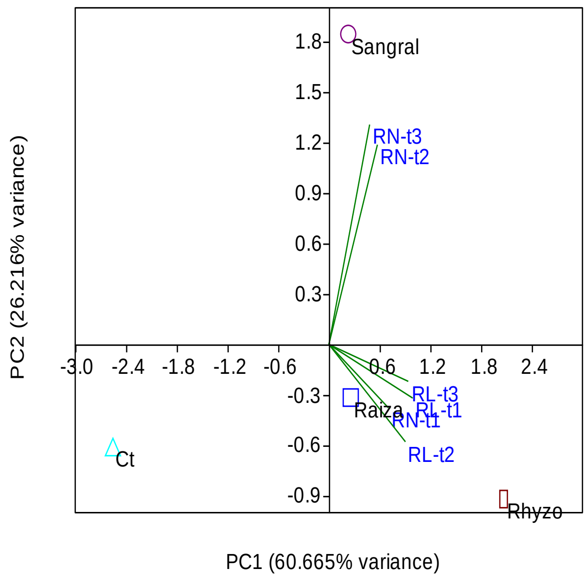

Fig. 3. PCA diagram, as regard the distribution of variants in relation to rooting parameters, *Crassula ovata*
Source: Original graph based on experimental data.

Associated with the Sangral product was parameters RN-t2 and RN-t3. This confirms the fact that the number of roots was more strongly influenced by the Sangral product. Associated with Raiza and Rhyzo products were associated parameters RN-t1, and especially root length, RL-t1, RL-t2 and RL-t3. This confirms the fact that the two products had a stronger effect on the growth in the length of the roots. PC1 explained 60.665% of variance, and PC2 explained 26.216% of variance. The increase (I) recorded in the rooting process (RN, RL), generated by the treatments applied to *Crassula ovata* cuttings, compared to the control variant, was calculated. The values recorded at the t2 and t3 moments of determination were taken into account. In terms of the number of roots, based on the recorded values, it was found that the Sangral product generated stronger rooting (RN-t2-I = 4.92; RN-t3-I = 3.25) compared to the other two products tested. The Raiza product generated intermediate values for RN at time t2 (RN-t2-I = 3.27) and lower values at time t3 (RN-t2-I = 0.63). The Rhyzo product generated values of RN at the level of RN-t2-I = 2.27 in moment t2, respectively RN-t3-I = 1.43 in moment t3. With regard to root length (RL), the Rhyzo product generated the greatest growth (RL-t2-I = 1.03 cm, respectively RN-t3-I = 1.49 cm). The graphic distribution of the growth of the two rooting parameters under the influence of the three biostimulators tested is presented in Figure 4. Samples of the rooted cuttings, at the t3 determination moment, in relation to biostimulators tested, are shown in Figure 5.

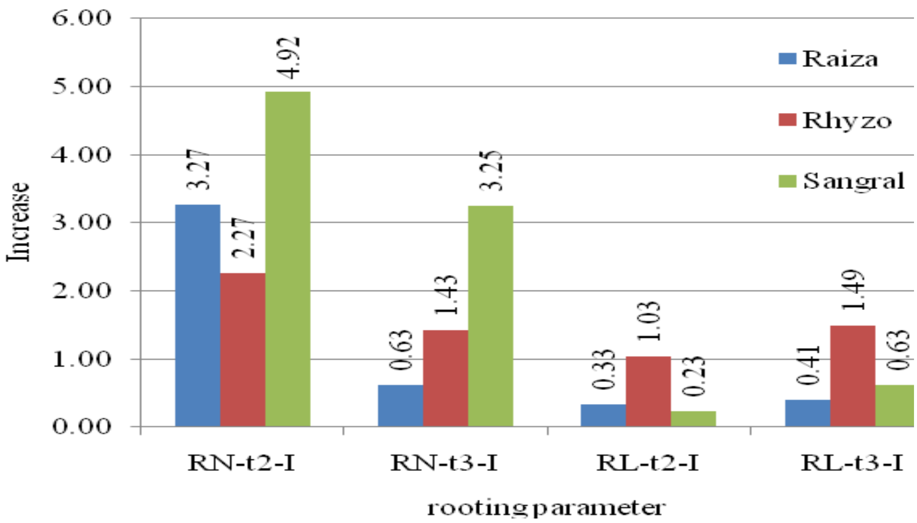

Fig.4. Graphic representation of increase (I) for studied parameters, in relation to the tested biostimulators, *Crassula ovata* species
Source: Original graph, based on calculated data.

Fig. 5. Sample of the rooted cuttings, in relation to tested biostimulators; Raiza (left), Rhyzo (middle), Sangral (right), *Crassula ovata*
Source: original picture, photos of the authors

The business with ornamental plants (propagation, growth, and marketing) can contribute to supplementing income for different categories and socio-economic conditions [20].

For an adequate management, knowledge regarding the eco-physiological requirements of plants, growing technologies, but also information regarding cost-benefit analyzes are necessary [20].

In the context of the conditions in urban habitats and ecosystems, highlighted by specific indices in certain studies [5, 11], plants tolerant to water stress, with good utilization of limited water resources (eg *Crassula ovata*, but also others), can represent an alternative in certain arrangements and ornamental structures in open spaces [23, 29].

Growing technologies and new genotypes bring improvements in the cultivation of ornamental plants, but at the same time there are different challenges regarding the market, production costs, changing environmental factors, the risk of stress factors or attack by new or old diseases and pests [4].

Regarding the propagation of ornamental plants (generative and vegetative), methods based on vegetative propagation have been developed and perfected that facilitate obtaining quality biological material, with genetic characteristics identical to the "source plant" [24]. Different bioactive substances with the role of stimulating the rooting process have been synthesized and tested in various species and groups of ornamental plants, propagation and growth conditions, so that the selection and use of appropriate products is easy for vegetative propagation [8, 15, 30]. At the same time, different types of substrates for rooting and plant growth were studied and tested, in relation to different species of horticultural plants, by stages in the reproduction process and plant age categories [14, 25, 32, 33]. Imaging plant analysis techniques facilitate the rapid estimation of possible pathogenic effects, with prompt interventions (detachment of affected leaves, local treatments etc.), without affecting the overall ornamental appearance of the respective plants [6]. The vegetative propagation of some ornamental plants (the jade tree, in this study) for commercial purposes, can be an alternative for supplementing sources of income, against the background of the socio-economic problems of the last period (associated with Covid 19, the post-Covid period, the energy crisis, etc.). Studies on the feasibility of business with ornamental plants during the Covid pandemic highlighted the feasibility of such businesses (with ornamental plants) in a certain socio-economic context [19, 27]. Besides the fact that it is a relaxing activity, the business with ornamental plants can train different age categories (eg children, elderly people), it can be done outside of a basic work schedule (as a complementary activity), so the benefits can be multiple.

CONCLUSIONS

In the process of vegetative propagation in the species *Crassula ovata*, the stem cuttings responded differently to the action of the treatments with the tested bioactive products. The Sangral product strongly influenced the number of roots of the stem cuttings (RN-t2-I = 4.92; RN-t3-I = 3.25) compared to the other two products tested. In terms of root length (RL), the Rhyzo product had a stronger effect (RL-t2-I = 1.03 cm, respectively RN-t3-I = 1.49 cm), compared to the other products.

The Raiza product generated intermediate values for RN at time t2 (RN-t2-I = 3.27) and lower values at time t3 (RN-t2-I = 0.63).

Each biostimulator product tested generated better values in the rooting process of the cuttings, compared to the control variant. The associated use of the products, in the interest of the roots number stimulating (Sangral), and the roots length (Rhyzo), can be a better option for obtaining vigorous plants in the process of vegetative reproduction in the *Crassula ovata* species.

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REFERENCES

[1]Ahmed, A.B.A., Amar, D.I., Taha, R.M., 2014, Indirect regeneration and somatic embryogenesis from leaf and stem explants of *Crassula ovata* (Mill.) Druce – An ornamental medicinal plant, International Scholarly and Scientific Research & Innovation, 8(12):1274-1277.

[2]Bramwell, A., 2015, Garden guides: Crassula jade plant. Santa Monica, CA, USA: Garden Guides. http://www.gardenguides.com/139174-crassula-jade-plant.html, Accesed on 25 August, 2022.

[3]Cabahug, R.A.M., Nam, S.Y., Lim, K.B., Jeon, J.K., Hwang, Y.-J., 2012, Propagation techniques for ornamental succulents, Flower Research Journal, 26(3):90-101.

[4]Cardoso, J.C., Vendrame, W.A., 2022, Innovation in propagation and cultivation of ornamental plants, Horticulturae, 8:229.

[5]Datcu, A.D., Sala, F., Ianovici, N., 2017, Studies regarding some morphometric and biomass allocation parameters in the urban habitat on *Plantago major*, Research Journal of Agricultural Science, 49(4):96-102.

[6]Drienovsky, R., Nicolin, A.L., Rujescu, C., Sala, F., 2017, Scan Sick & Healthy Leaf – A software application for the determination of the degree of the leaves attack, Research Journal of Agricultural Science, 49(4):225-233.

[7]Dubé, V., 2018, The effects of cytokinins on *Crassula ovata*, https://www.mcgill.ca/plant/files/plant/veronique_dube_jade_plant_summary.pdf, Accessed on 02 September, 2022.

[8]Ficko, S.A., Naeth, M.A., 2021, Root development on cuttings of seven arctic shrub species for revegetation, Artic, Antarctic, and Alpine Research, 53(1):237-251.

[9]Garibaldi, A., Bertetti, D., Pensa, P., Poli, A., Gullino, M.L., 2011, First report of *Fusarium oxysporum* causing wilt on jade plant (*Crassula ovata*) in Italy, Plant Dis., 95(9):1191.

[10]Hammer, Ø., Harper, D.A.T., Ryan, P.D., 2001, PAST: Paleontological statistics software package for education and data analysis, Palaeontologia Electronica, 4(1):1-9.

[11]Herbei, M.V., Sala F., 2020, Evaluation of urban areas by remote sensing methods in relation to climatic conditions: Case study City of Timisoara, Carpathian Journal of Earth and Environmental Sciences, 15(2): 327-337.

[12]Hoyt, R., 2015, Problems growing Crassula ovata. SFGate Home Guides. San Francisco, CA, USA. http://homeguides.sfgate.com/problems-growing-crassula-ovata-28106.html, Accessed on 02 September, 2022.

[13]Jones, L.A., 2011, Anatomical adaptations of four Crassula species to water availability, Bioscience Horizons, 4(1):13-22.

[14]Kim, J.K., Shawon, M.R.A., An, J.H., Yun, Y.J., Park, S.J., Na, J.K., Choi, K.Y., 2021, Influence of substrate composition and container size on the growth of tissue culture propagated apple rootstock plants, Agronomy, 11:2450.

[15]Kisvarga, S., Farkas, D., Boronkay, G., Neményi, A., Orlóci, L., 2022, Effects of biostimulants in horticulture, with emphasis on ornamental plant production, Agronomy, 12:1043.

[16]Mahr, S., 2010, The Wisconsin master gardener program: jade plant. Madison, WI, USA: Master Gardener, University of Wisconsin Extension. http://wimastergardener.org/?q=JadePlant, Accessed on 02 September, 2022.

[17]Malan, C., Notten, A., 2005, Crassula ovata (Miller) Druce. PlantZAfrica. Silverton, South Africa: South Africa National Biodiversity Institute, http://www.plantzafrica.com/plantcd/crassovat.htm, Accessed on 02 September, 2022.

[18]Muiruri, M.D., Mwangi, W., 2016, Phytochemical and antimicrobial activity of (*Crassula ovata*) jade plant on different strains of bacteria, European Journal of Medicinal Plants, 11(1):1-12.

[19]Munajat, Sari, F.P., 2021, Feasibility study of ornamental plant business in Covid pandemic at Baturaja OKU South Sumatera, Journal Management, Business, and Accounting, 20(2):186-192.

[20] Nelson, I.U., Udo, E.S., Jacob, D.E., 2018, Profitability of ornamental plant business in Akwa Ibom State, Nigeria, Eurasian Journal of Forest Science, 6(1):35-43.

[21]Paterson, K.E., 1983, Polarity of regeneration in excised leaves of *Crassula argentea*. I. A role of auxin, Can. J. Bot., 61:1058-1063.

[22]Puga, T., Schafer, J., Buffalo, A., Agbedanu, P.N., 2022, Broad spectrum antimicrobial potential of Crassula ovata, bioRxiv 2022.01.20.477177; doi: https://doi.org/10.1101/2022.01.20.477177

[23]Rafi, Z.N., Kazemi, F., Tehranifar, A., 2019, Effects of various irrigation regimes on water use efficiency and visual quality of some ornamental herbaceous plants in the field, Agricultural Water Management, 212:78-87.

[24]Roberto, S.R., Colombo, R.C., 2020, Innovation in propagation of fruit, vegetable and ornamental plants, Horticulture, 6(2):23.

[25]Sala, F., 2011, Agrochimie, Ed. Eurobit (Agrochemistry, Eurobit Publishing House), Timisoara, pp. 534.

[26]Smith, G.F., Figueiredo, E., van Wyk, A.E., 2019, Chapter 3 - Crassulaceae in Southern Africa, Kalanchoe (Crassulaceae) in Southern Africa, Classification, Biology, and Cultivation, 17-22.

[27]Suminah, Suwarto, Sugihardjo, Anantanyu, S., Padmaningrum, D., 2021, Self reliance of ornamental plants agribusiness actors during the Covid pandemic in Surakarta, IOP Conf. Series: Earth and Environmental Science, 905:012062.

[28]Sun, F., Sun, S., Zhu, L., Duan, C., Zhu, Z., 2019, Confirmation of Fusarium oxysporum as a causal agent of mung bean wilt in China, Crop Protection, 117:77-85.

[29]Toscano, S., Ferrante, A., Romano, D., 2019,

Response of Mediterranean ornamental plants to drought stress, Horticulture, 5(1):6.

[30]Traversari, S., Cacini, S., Nesi, B., 2022, Seaweed extracts as substitutes of synthetic hormones for rooting promotion in rose cuttings, Horticulturae, 8:561.

[31]USDA-ARS, 2015, Germplasm Resources Information Network (GRIN). Online Database. Beltsville, Maryland, USA: National Germplasm Resources Laboratory. https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysearch.aspx, Accesed on 25 August, 2022.

[32]Yafuso, E.J., Fisher, P.R., Bohórquez, A.C., Altland, J.E., 2019, Water and air relations in propagation substrates, HortScience, 54(11):2024-2030.

[33]Yoon, A., Oh, H.E., Kim, S.Y., Park, Y.G., 2021, Plant growth regulators and rooting substrates affect growth and development of *Salix koriyanagi* cuttings, Rhizosphere, 20:100437.

[34]Seminte- ingrasaminte-turba.ro, 2022, Turba TS 3Fin-Seminte-Ingrasaminte,/Peat-Seeds-Fertilizers, https://seminte-ingrasaminte-turba.ro/product/ turba-ts-3-fin/, Accessed on 20 May, 2022.