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Analysis of stem height feature in *Sarcococca ruscifolia* Stapf seedlings obtained from two types of cuttings using different rooting substrates

Mirona ALBU (POPESCU)[1], Veronica SĂRĂȚEANU[2], Orsolya BORSAI[3], Sandor RÓZSA[3], Daniela POȘTA[4]

[1] University of Life Sciences "King Mihai I" from Timisoara, Faculty of Engineering and Applied Technologies, Department, of Genetic Engineering e-mail: Mirona.popescu@madr.ro
[2] University of Life Sciences "King Mihai I" from Timisoara, Faculty of Agriculture, Department of Agricultural Technologies e-mail: veronica_sarateanu@usvt.ro
[3] University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Faculty of Horticulture and Business in Rural Development, Department, Horticulture and Landscaping e-mail: orsolya.borsai@usamvcluj.ro, rozsa.sandor@usamvcluj.ro
[4]University of Life Sciences "King Mihai I" from Timisoara, Faculty of Engineering and Applied Technologies, Department of Horticulture, e-mail: danielaposta@usvt.ro

* Corresponding author: danielaposta@usvt.ro, veronica_sarateanu@usvt.ro

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Abstract
The spreading area of the species *Sarcococca ruscifolia* Stapf. is Asia. The maximum height of this shrub species is 1 m. The bush is compact, with persistent leaves over the winter, the flowers are white, they appear in December-January, and the fruits are red. It is a shade species, but it also develops in partial shade. This work is a continuation of a work from the previous year [1]. Cuttings with ring and heel of the species *Sarcococca rustifolia* Stapf., represented the biological material. The experiment was carried out in the greenhouse of the Arboriculture discipline, at the Didactic and Research Base of the "King Mihai I" University of Life Sciences from Timisoara. This work analyses the relationship between the height of the seedling and the rooting substrates. According to the results obtained, the height differences between different substrate variants and rooting biostimulators were used for the obtaining of *Sarcococca ruscifolia* Stapf., cuttings were very different compared to the others, many of them showing highly significantly positive differences and a few distinctly significantly positive differences and significantly positive differences.

Keywords: *Sarcococca ruscifolia* Stapf., cuttings**,** rooting substrate.

Introduction

The species *Sarcococca ruscifolia* Stapf., is spread in Asia, and the maximum height reaches about 1 m. The species has a compact bush and evergreen leaves, white flowers are flowering in December-January and the fruits are coloured in red. It is a shade species, but it also grows in partial shade [1]. The species *Sarcococca conzattii* (Standl.) I. M. Johnst., has been identified (and contested) in Central America [7] [16]. Species in the genus *Sarcococca* are considered drought tolerant [6], growing in drought conditions being a great challenge for numerous plant species. Even if *Sarcococca ruscifolia* Stapf., belongs to *Buxaceae* family, it is resistant to *Cydalima perspecalis* Walk. (box tree moth), compared to *Buxus sempervirens*, species from the same family [2, 8,9,10]. Six pregnane alkaloids were isolated from the root of *Sarcococca ruscifolia*. All the compounds were evaluated for their inhibitory activities against several types of cancer cells [17]. Also, two new steroidal alkaloids were found in the roots of *Sarcococca ruscifolia* and their structures were elucidated based on NMR and MS data [12]. In folk medicine, the stems and leaves of *Sarcococca* plants were used to treat rheumatism without side effects [13]. In an experiment, before sowing, the seeds of *Sarcococca confusa* were treated with ethyl methanesulfonate (EMS) at different concentrations and exposure times to observe the effect on seed germination [11]. A study was conducted to demonstrate that the inoculation of ornamental

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plants grown in greenhouses and in the field with mycorrhizae leads to the achievement of symbiosis and obtaining economic advantages for the growers [5]. A case study was conducted with Sweet Box (*Sarcococca* sp.) and Garden Rose (*Rosa*) on the growth and selection of woody nursery plants assisted by high-yield field phenotyping using UAV (drone or unmanned aerial vehicle) images. The traits are visually tracked and include ornamental traits, but also stress tolerance [4]. The multitude of UAV phenotyping applications either currently under development or already applied in agricultural crops is opening the way for the introduction of UAV and image analysis in woody ornamental and nursery plant breeding programs. For woody ornamentals, breeding towards compactness, improved or novel leaf and flower morphology, abundant flowering, and improved resistance to diseases, drought, cold, and other abiotic stresses is important [3].

Material and Method

The present research started in 2023, the results from the previous year being already published in a scientific work [1]. The height of the seedlings in relation to the rooting substrates was analysed [14, 15].

The biological material was represented by cuttings of the species *Sarcococca ruscifolia* Stapf., with a ring and heel (Figure 1).

Figure 1. Ring and heel cuttings of *Sarcococca ruscifolia* Stapf. (original)

The experiment was polyfactorial, there were planted two types of *Sarcococca ruscifolia* Stapf. cuttings: with ring and heel. There were applied combined two factors, respectively two rooting biostimulators (Razormin and Radifarm) and five types of substrates (Figure 2). The cuttings with ring and heel were harvested on 20.02.2023, in the morning from Iulius Mall Park, Timișoara (western Romania). The experiment was carried out in the propagation greenhouse of the Arboriculture discipline, at the Didactic and Research Base of the University of Life Sciences "King Mihai I" from Timișoara.

The biometric features considered in the present research were: plant height (cm), plant diameter (cm), number of roots and main root length (cm). The analysed data were collected on May 30th 2023. There was analysed the influence of cutting type and substrate on the analysed biometric features. Statistical methods used were descriptive statistics, the data being processed with JASP software 0.18.1.0. (JASP, 2020).

Results and Discussion

The experimental results refer to the height of the seedlings of *Sarcococca ruscifolia* Stapf. are presented in Table 1. Between the substrate variants used, the differences are significant in terms of the height of the seedlings of *Sarcococca ruscifolia* Stapf. (H - cm).

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Figure 2. Cuttings placed in rooting substrates (original)

Figure 3. Cuttings watered with Radifarm and Razormin (original)

Table 1. Analysis of variance (ANOVA) for characterizing the height of seedlings

ANOVA - H (cm)

Cases	Sum of Squares	df	Mean Square	F	p
heel/ring	60.053	1	60.053	90.823	< 0.001
Variant	800.301	14	57.164	86.454	< 0.001
heel/ring ✻ Variant	11.321	14	0.809	1.223	0.255
Residuals	277.710	420	0.661		

Note. Type III Sum of Squares

The results regarding the height of the cuttings show significant differences between the types of cuttings, namely between heel and ring. Also, between the substrate variants used, the differences are significant regarding the height of the cuttings of *Sarcococca ruscifolia* Stapf. (H - cm). In the case of the two combined factors (type of cutting and substrate variant), the response is very different from one combination of factors to another.

Table 2. Comparative analysis of cutting height of *Sarcococca ruscifolia* Stapf., depending on the type of cutting

Post Hoc Comparisons - heel/ring

			95% CI for Mean Difference					
		Mean Difference	Lower	Upper	SE	t	p_{tukey}	
heel	ring	-0.731	-0.881	-0.580	0.077	-9.530	< 0.001	***

*** p < 0.001

Note. Results are averaged over the levels of: Variant

According to the result obtained, the height differences between the two types of cuttings of *Sarcococca ruscifolia* Stapf., are very significantly positively different from each other.

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Table 3. Comparative analysis of the height of *Sarcococca ruscifolia* Stapf., cuttings depending on the substrate variant used

Post Hoc Comparisons - Variant

			95% CI for Mean Difference					
		Mean Difference	Lower	Upper	SE	t	p_{tukey}	
V00	V01	-0.493	-1.210	0.223	0.210	-2.350	0.554	
	V02	-2.313	-3.030	-1.597	0.210	-11.018	< 0.001	***
	V03	-2.990	-3.706	-2.274	0.210	-14.241	< 0.001	***
	V04	-0.307	-1.023	0.410	0.210	-1.461	0.981	
	V05	-0.387	-1.103	0.330	0.210	-1.842	0.880	
	V06	-0.860	-1.576	-0.144	0.210	-4.096	0.004	**
	V07	-2.943	-3.660	-2.227	0.210	-14.019	< 0.001	***
	V08	-3.463	-4.180	-2.747	0.210	-16.496	< 0.001	***
	V09	-0.740	-1.456	-0.024	0.210	-3.525	0.035	*
	V10	-0.164	-0.880	0.553	0.210	-0.780	1.000	
	V11	-0.857	-1.573	-0.140	0.210	-4.080	0.005	**
	V12	-3.080	-3.796	-2.364	0.210	-14.670	< 0.001	***
	V13	-3.997	-4.713	-3.280	0.210	-19.036	< 0.001	***
	V14	-1.157	-1.873	-0.440	0.210	-5.509	< 0.001	***
V01	V02	-1.820	-2.536	-1.104	0.210	-8.669	< 0.001	***
	V03	-2.497	-3.213	-1.780	0.210	-11.891	< 0.001	***
	V04	0.187	-0.530	0.903	0.210	0.889	1.000	
	V05	0.107	-0.610	0.823	0.210	0.508	1.000	
	V06	-0.367	-1.083	0.350	0.210	-1.746	0.917	
	V07	-2.450	-3.166	-1.734	0.210	-11.669	< 0.001	***
	V08	-2.970	-3.686	-2.254	0.210	-14.146	< 0.001	***
	V09	-0.247	-0.963	0.470	0.210	-1.175	0.998	
	V10	0.330	-0.387	1.046	0.210	1.570	0.964	
	V11	-0.363	-1.080	0.353	0.210	-1.731	0.923	
	V12	-2.587	-3.303	-1.870	0.210	-12.320	< 0.001	***
	V13	-3.503	-4.220	-2.787	0.210	-16.686	< 0.001	***
	V14	-0.663	-1.380	0.053	0.210	-3.159	0.104	
V02	V03	-0.677	-1.393	0.040	0.210	-3.223	0.087	
	V04	2.007	1.290	2.723	0.210	9.558	< 0.001	***
	V05	1.927	1.210	2.643	0.210	9.177	< 0.001	***
	V06	1.453	0.737	2.170	0.210	6.922	< 0.001	***
	V07	-0.630	-1.346	0.086	0.210	-3.001	0.158	
	V08	-1.150	-1.866	-0.434	0.210	-5.477	< 0.001	***
	V09	1.573	0.857	2.290	0.210	7.494	< 0.001	***
	V10	2.150	1.433	2.866	0.210	10.239	< 0.001	***
	V11	1.457	0.740	2.173	0.210	6.938	< 0.001	***
	V12	-0.767	-1.483	-0.050	0.210	-3.652	0.023	*
	V13	-1.683	-2.400	-0.967	0.210	-8.018	< 0.001	***
	V14	1.157	0.440	1.873	0.210	5.509	< 0.001	***
V03	V04	2.683	1.967	3.400	0.210	12.781	< 0.001	***
	V05	2.603	1.887	3.320	0.210	12.399	< 0.001	***
	V06	2.130	1.414	2.846	0.210	10.145	< 0.001	***

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Post Hoc Comparisons - Variant

			95% CI for Mean Difference					
		Mean Difference	Lower	Upper	SE	t	p_{tukey}	
	V07	0.047	-0.670	0.763	0.210	0.222	1.000	
	V08	-0.473	-1.190	0.243	0.210	-2.254	0.625	
	V09	2.250	1.534	2.966	0.210	10.717	< 0.001	***
	V10	2.826	2.110	3.543	0.210	13.462	< 0.001	***
	V11	2.133	1.417	2.850	0.210	10.161	< 0.001	***
	V12	-0.090	-0.806	0.626	0.210	-0.429	1.000	
	V13	-1.007	-1.723	-0.290	0.210	-4.795	< 0.001	***
	V14	1.833	1.117	2.550	0.210	8.732	< 0.001	***
V04	V05	-0.080	-0.796	0.636	0.210	-0.381	1.000	
	V06	-0.553	-1.270	0.163	0.210	-2.635	0.349	
	V07	-2.637	-3.353	-1.920	0.210	-12.558	< 0.001	***
	V08	-3.157	-3.873	-2.440	0.210	-15.035	< 0.001	***
	V09	-0.433	-1.150	0.283	0.210	-2.064	0.758	
	V10	0.143	-0.573	0.859	0.210	0.681	1.000	
	V11	-0.550	-1.266	0.166	0.210	-2.620	0.360	
	V12	-2.773	-3.490	-2.057	0.210	-13.209	< 0.001	***
	V13	-3.690	-4.406	-2.974	0.210	-17.575	< 0.001	***
	V14	-0.850	-1.566	-0.134	0.210	-4.048	0.005	**
V05	V06	-0.473	-1.190	0.243	0.210	-2.254	0.625	
	V07	-2.557	-3.273	-1.840	0.210	-12.177	< 0.001	***
	V08	-3.077	-3.793	-2.360	0.210	-14.654	< 0.001	***
	V09	-0.353	-1.070	0.363	0.210	-1.683	0.937	
	V10	0.223	-0.493	0.939	0.210	1.062	0.999	
	V11	-0.470	-1.186	0.246	0.210	-2.239	0.637	
	V12	-2.693	-3.410	-1.977	0.210	-12.828	< 0.001	***
	V13	-3.610	-4.326	-2.894	0.210	-17.194	< 0.001	***
	V14	-0.770	-1.486	-0.054	0.210	-3.667	0.022	*
V06	V07	-2.083	-2.800	-1.367	0.210	-9.923	< 0.001	***
	V08	-2.603	-3.320	-1.887	0.210	-12.399	< 0.001	***
	V09	0.120	-0.596	0.836	0.210	0.572	1.000	
	V10	0.696	-0.020	1.413	0.210	3.317	0.067	
	V11	0.003	-0.713	0.720	0.210	0.016	1.000	
	V12	-2.220	-2.936	-1.504	0.210	-10.574	< 0.001	***
	V13	-3.137	-3.853	-2.420	0.210	-14.940	< .001	***
	V14	-0.297	-1.013	0.420	0.210	-1.413	0.986	
V07	V08	-0.520	-1.236	0.196	0.210	-2.477	0.460	
	V09	2.203	1.487	2.920	0.210	10.494	< 0.001	***
	V10	2.780	2.063	3.496	0.210	13.239	< 0.001	***
	V11	2.087	1.370	2.803	0.210	9.939	< 0.001	***
	V12	-0.137	-0.853	0.580	0.210	-0.651	1.000	
	V13	-1.053	-1.770	-0.337	0.210	-5.017	< 0.001	***
	V14	1.787	1.070	2.503	0.210	8.510	< 0.001	***
V08	V09	2.723	2.007	3.440	0.210	12.971	< 0.001	***
	V10	3.300	2.583	4.016	0.210	15.716	< 0.001	***

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Post Hoc Comparisons - Variant

			95% CI for Mean Difference					
		Mean Difference	Lower	Upper	SE	t	p_{tukey}	
	V11	2.607	1.890	3.323	0.210	12.415	< 0.001	***
	V12	0.383	-0.333	1.100	0.210	1.826	0.887	
	V13	-0.533	-1.250	0.183	0.210	-2.540	0.414	
	V14	2.307	1.590	3.023	0.210	10.986	< 0.001	***
V09	V10	0.576	-0.140	1.293	0.210	2.745	0.282	
	V11	-0.117	-0.833	0.600	0.210	-0.556	1.000	
	V12	-2.340	-3.056	-1.624	0.210	-11.145	< 0.001	***
	V13	-3.257	-3.973	-2.540	0.210	-15.511	< 0.001	***
	V14	-0.417	-1.133	0.300	0.210	-1.985	0.807	
V10	V11	-0.693	-1.409	0.023	0.210	-3.301	0.070	
	V12	-2.916	-3.633	-2.200	0.210	-13.890	< 0.001	***
	V13	-3.833	-4.549	-3.117	0.210	-18.256	< 0.001	***
	V14	-0.993	-1.709	-0.277	0.210	-4.730	< 0.001	***
V11	V12	-2.223	-2.940	-1.507	0.210	-10.590	< 0.001	***
	V13	-3.140	-3.856	-2.424	0.210	-14.956	< 0.001	***
	V14	-0.300	-1.016	0.416	0.210	-1.429	0.984	
V12	V13	-0.917	-1.633	-0.200	0.210	-4.366	0.001	**
	V14	1.923	1.207	2.640	0.210	9.161	< 0.001	***
V13	V14	2.840	2.124	3.556	0.210	13.527	< 0.001	***

Note. Results are averaged over the levels of: heel/ring

Note. P-value and confidence intervals adjusted for comparing a family of 15 estimates (confidence intervals corrected using the Tukey method).

* p < 0.05, ** p < 0.01, *** p < 0.001

According to the results obtained, the height differences between the 14 substrate variants used to obtain cuttings of *Sarcococca ruscifolia* Stapf., in comparison are very different from each other, many of them being very significantly positive and a few distinctly significantly positive and significantly positive.

Conclusions

Significant differences in the height of *Sarcococca ruscifolia* Stapf., seedlings can be observed in the case of nutrient substrate variants.

According to the results obtained, the height differences between the 14 substrate variants were used to obtain cuttings of *Sarcococca ruscifolia* Stapf. in comparison are very different from each other, many of them being very significantly positive and some distinctly significantly positive and significantly positive.

The results highlight the fact that the type of cutting and the substrate variant influences the height of the cuttings obtained from *Sarcococca ruscifolia* Stapf., thus, the combined effect of the two factors must be taken into account.

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