Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 21, Issue 4, 2021
PRINT ISSN 2284-7995, E-ISSN 2285-3952

STUDY ON VEGETATIVE PROPAGATION OF SOME SAINTPAULIA GENOTYPES

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Abstract

The present study evaluated the vegetative propagation of Saintpaulia (African violets). Five genotypes of Saintpaulia were used: Saintpaulia ionantha Shades of Autumn (G1), Saintpaulia ionantha Zoja (G2), Saintpaulia ionantha Delft (G3), Saintpaulia ionantha Milky Way Trail (G4) and Saintpaulia ionantha Tongwenis (G5). Three growth substrates consisting of sand (San, Gs1), sand and peat (San/Pea, 1:1 mixture, Gs2) and perlite and peat (Per/Pea, 1:1, Gs3 mixture) were used. From the combination of genotypes with growth substrates, 15 experimental variants were obtained. The experiment was organized in a protected space, with 15 leaf cuttings on each variant, in three repetitions. The number of rooted shoots (Sn) and the length of the roots (Rl) were evaluated. Compared to the experience average, there were positive differences in statistical safety conditions for variants V2, V7, V8 and V14 (for LSD0.1%). Negative differences in statistical safety conditions were recorded in variants V3, V4, V6 and V15 (for LSD0.1%), and in variants V10 and V12 (for LSD1%). According to the PCA, PC1 explained 85.684% of the variance, and PC2 explained 14.316% of the variance. Cluster analysis led to the grouping of variants based on Euclidean distances, in relation to the values generated for Sn and Rl, in statistical safety conditions (Coph.corr = 0.784). The result was two distinct clusters, with several subclusters each. The analysis of SDI values found the highest level of similarity between variants G1-Gs1 and G4-Gs1 (SDI = 0.3607), followed by variants G2-Gs2 and G4-Gs1 (SDI = 0.4000), respectively by variants GG4-Gs2 with G5-Gs2 (SDI = 0.5900).

Key words: *growth substrate, leaf cuttings, PCA, Saintpaulia, vegetative propagation*

INTRODUCTION

Ornamental plants with flowers or leaves in pots are of great decorative interest for indoor and outdoor spaces (for a certain period of the year) both in public spaces and in private and family spaces [29].
Some studies have been made on costs and aspects of a technical, economic, social, market nature, as well as the consumer profile, in relation to different categories of potted ornamental plants [24], [41], [12], [4], [23], [33].
Numerous species (genotypes, varieties) fall into this category of ornamental plants (in pots), and their cultivation requires specific substrates or growth media [5], [16], [20], [21], [6], [13], [38]. Among the species of decorative plants with potted flowers is *Saintpaulia ionantha* H. Wendl [42].
Growing substrates can be represented by a single component (peat, sand, vermiculite etc.), or mixtures of two or more components, in order to ensure optimal conditions in relation to the specifics of ornamental plants [39].
The multiplication of ornamental plants can be done both generative and vegetative methods, with advantages and disadvantages in relation to the plant species [2], [11], [35], [37], [18].
Vegetative propagation is easy for many species of ornamental plants [14], [28], [34], [36], and can be done even in private-family spaces, respecting some minimum requirements.
The propagation conditions of ornamental plants, as well as those following the production of biological material, are very important for ensuring and maintaining the quality of plants for market (commercial aspect), as well as later during use (ornamental aspect) [15].
The conditions of multiplication, growth, as well as post-production conditions (eg storage, transport), can have major effects on

the commercial and ornamental quality of plants.

The flower market is very dynamic, with a differentiated weight in relation to the category of flowers (cut flowers, potted flowers, and biological material), season or off-season, category of beneficiaries, destination of use, etc., and as a result, some studies addressed the dynamic role of this component in the market [7].

The interest for the propagation methods of the ornamental plants is very high for technical, economic, social reasons, and different studies have approached this aspect [26], [27].

Saintpaulia has been studied on the basis of different indices and morphological and physiological parameters, in relation to *In vitro* multiplication, bioactive substances and ex vitro conditions [19], [8], [43].

Viable commercial production will require cultivation techniques that produce flowering plants throughout the year [44].

Sustainable flower production is increasingly being promoted through environmentally friendly practices [3]. Some natural polysaccharides and their derivatives are studied and used in horticulture to stimulate plant growth [40].

Different species of potted ornamental plants have been studied in relation to certain pathogenic species in indoor spaces or gardens [17]. Non-destructive methods of plants foliar study was also promoted, based on imaging analysis [9], [10].

The present study addressed the vegetative propagation of five Saintpaulia genotypes in relation to different growing substrates, in order to obtain decorative plants in pots.

MATERIALS AND METHODS

Vegetative propagation has been studied in order to obtain decorative flowers. The biological material was represented by five genotypes in Saintpaulia: *Saintpaulia ionantha* Shades of Autumn (G1); *Saintpaulia ionantha* Zoja (G2); *Saintpaulia ionantha* Delft (G3); *Saintpaulia ionantha* Milky way Trail (G4); *Saintpaulia ionantha* Tongwenis (G5), figure 1. Leaf cuttings were taken from each genotype.

Saintpaulia ionantha Shades of Autumn (G1)	*Saintpaulia ionantha* Zoja (G2)	*Saintpaulia ionantha* Delft (G3)	*Saintpaulia ionantha* Milky way Trail (G4)	*Saintpaulia ionantha* Tongwenis (G5)

Fig. 1. Saintpaulia genotypes studied for vegetative propagation by leaf shoots
Source: Original images from the experiment.

Three growth substrates (Gs) consisting of sand (San, Gs1), sand and peat (San / Pea, Gs2) and perlite and peat (Per / Pea, Gs3) were prepared. The mixtures of sand and peat (Gs2), respectively perlite and peat (Gs3) were made in a 1:1 ratio between the components. The experiment was organized in a protected space, with 15 leaf cuttings on each variant, in three repetitions.

To stimulate rooting, the cuttings were treated with Radistim.

The number of rooted shoots (Sn) in each variant and the length of the roots (Rl) were evaluated.

Experimental data were analyzed by Variance Analysis, ANOVA test, PCA, Cluster Analysis. To evaluate the differences between the variants, the values LSD5%, LSD1% and LAS0.1% (Limits of Significance of Differences) were calculated. For the safety of the data, the F test, the values R^2, p, the cophenetic coefficient were taken into account.

PAST software [22] and EXCEL calculation modules were used to process data and make distribution graphs.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 21, Issue 4, 2021
PRINT ISSN 2284-7995, E-ISSN 2285-3952

RESULTS AND DISCUSSIONS

Leaf cuttings from the five Saintpaulia genotypes were rooted for vegetative propagation in three types of growing substrates, sand (San, G1), sand and peat (San/Pea, G2) and perlite and peat (Per/Pea, G3). The number of rooted cuttings in each genotype and growing substrate was evaluated.

For the evaluation of the differences between the variants and their significance, the Variance Analysiswas used, and the results are presented in Table 1.

Compared to the experience average, there were positive differences in statistical safety conditions for variants V2, V7, V8 and V14 (for LSD0.1%). Negative differences in statistical safety conditions were recorded in variants V3, V4, V6 and V15 (for LSD0.1%), and in variants V10 and V12 (for LSD1%). Other differences were also registered but without statistical assurance.

Table 1. Number of shoots rooted to Saintpaulia genotypes studied according to the growing substrate

Genotype and Growth substrate	Trial variant	Mean values	Differences and Significance
G1-Gs1	V1	8.50	-0.46
G1-Gs2	V2	10.78	1.82***
G1-Gs3	V3	7.11	-1.85ººº
G2-Gs1	V4	7.50	-1.46ººº
G2-Gs2	V5	9.30	0.34
G2-Gs3	V6	5.91	-3.05ººº
G3-Gs1	V7	11.21	2.25***
G3-Gs2	V8	12.41	3.45***
G3-Gs3	V9	8.83	-0.13
G4-Gs1	V10	8.24	-0.73ºº
G4-Gs2	V11	9.68	0.72*
G4-Gs3	V12	8.05	-0.92ºº
G5-Gs1	V13	9.17	0.20
G5-Gs2	V14	10.03	1.07***
G5-Gs3	V15	7.445	-1.52ººº
Control (experiment average)		8.96	-
Limits of Significance of Differences (LSD)		LSD5%=0.538; LSD1%=0.724; LSD0.1%=0.963	

Source: original values calculated based on the experimental data obtained.

The ANOVA test confirmed the presence of the variance and the statistical safety of the experimental data set regarding the shoot number obtained for the Saintpaulia genotypes studied in relation to the growth substrate (Table 2).

Table 2. ANOVA test for experimental data on the studied Saintpaulia genotypes

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	66.1664	2	33.0832	106.943	7.76E-14	8.93051
Columns	50.5579	14	3.61128	11.6737	3.3E-08	3.93187
Error	8.66187	28	0.30935			
Total	125.386	44				

Source: original data obtained by calculations.

Statistical analysis of the frequency of values for shoots number showed a normal distribution (Figure 2).

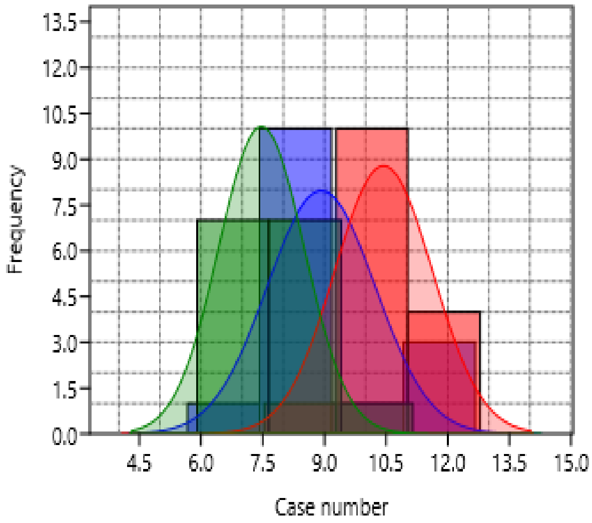

Fig. 2. Distribution histogram of shoots values in Saintpaulia genotype studied (San – blue colour; San/Pea – red colour; Per/Pea – gren colour)

Source: original graph, generated based on experimental values.

In the conditions of the three growing substrates and of the obtained cuttings, for the length of the cuttings roots were registered values between 0.5 cm (G1-Gs3) and 4.65 cm (G3-Gs2, G5-Gs2), Figure 3.

According to PCA, the distribution diagram of the experimental variants in relation to shoot number (Sn) and root lenght (Rl) was obtained for the shoots of the 5 Saintpaulia genotypes studied, Figure 4.

PC1 explained 85.684% of variance, and PC2 explained 14.316% of variance.

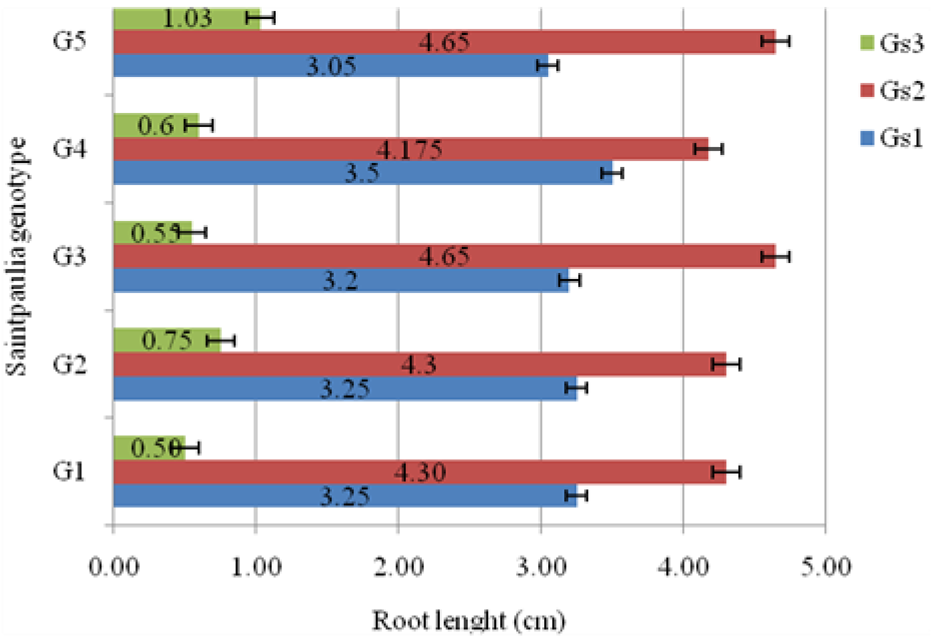

Fig. 3. Graphic distribution of root length values in relation to Saintpaulia genotype and growth substrate
Source: original graph, generated based on experimental values.

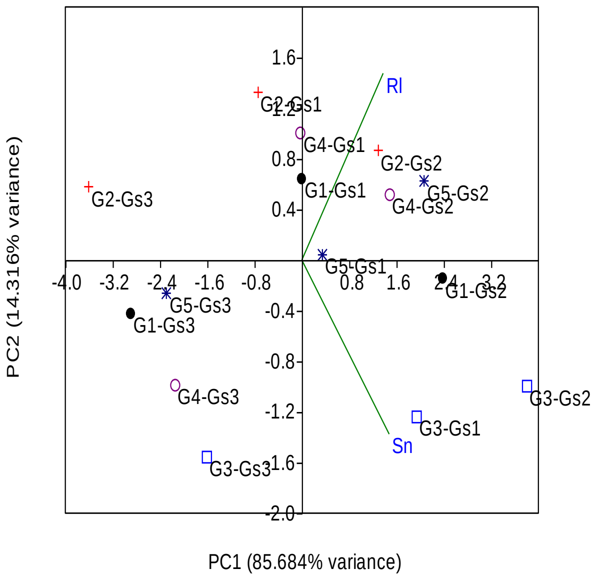

Fig. 4. PCA diagram regarding the distribution of experimental variants for vegetative propagation in Saintpaulia
Source: original diagram generated based on experimental data.

From the analysis of the distribution of variants, it was found the association of some variants (genotype x growth substrate) with Sn and Rl, which confirms the dependence of these genotypes on the growth substrate (G1-Gs2, G2-Gs2, G3-Gs1, G3-Gs2, G4 -Gs2, G5-Gs1, and G5-Gs2). The close position was at variants G1-Gs1, G2-Gs1, and G4-Gs1.

On the other hand, an independent position of other variants was found in relation to Sn and R1, which shows a certain independence of these genotypes from the growth substrate (G1-Gs3, G2-Gs3, G3-Gs3, G4-Gs3 and G5-Gs3). This shows that all variants with the Gs3 substrate (Per/Pea) generated low results on Sn and Rl in the multiplication of the Saintpaulia genotypes studied.

Cluster analysis led to the grouping of variants based on Euclidean distances, in relation to the values generated for Sn and Rl, in statistical safety conditions (Coph.corr = 0.784), Figure 5.

From the analysis of the grouping of variants based on similarity in the generation of results, it was found the formation of two distinct clusters. A C1 cluster contains variants on the Gs3 growth substrate (Per/ Pea), which provided the lowest multiplication rate under the experimental conditions for all five Saintpaulia genotypes studied.

Cluster C2 comprises the other variants grouped in three subclusters. The V8 variant (G3-Gs2) with the best results regarding the vegetative propagation in the study conditions was placed on an independent position.

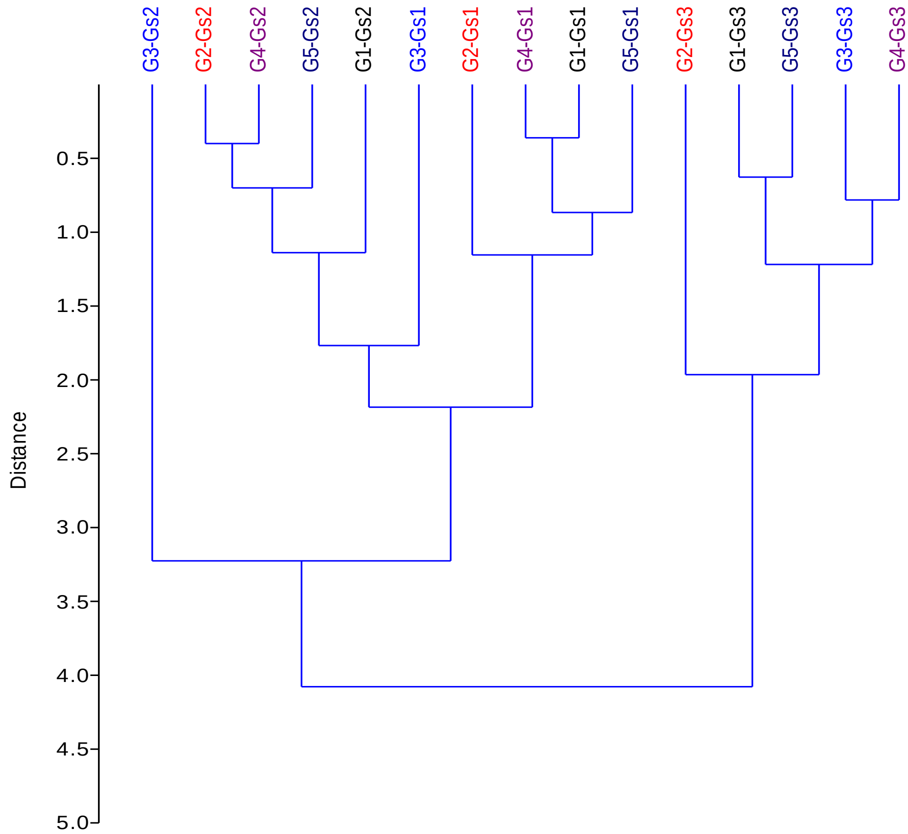

Fig. 5. Dendrogram of variants regarding vegetative propagation in Saintpaulia, in relation to genotype and growth substrate
Source: original diagram generated based on experimental data.

Within a C2-1 subcluster, four variants were grouped, associated with the growth substrate Gs1, respectively variants V1 (G1-Gs1), V4 (G2-Gs1), V10 (G4-Gs1) and V13 (G5-Gs1). The variants V2 (G1-Gs2), V5 (G2-Gs2), V7 (G3-Gs1), V11 (G4-Gs2) and V14 (G5-Gs2) were grouped in subcluster C2-2.

The analysis of SDI values found the highest level of similarity between variants G1-Gs1 and G4-Gs1 (SDI = 0.3607), followed by variants G2-Gs2 and G4-Gs1 (SDI = 0.4000), respectively by variants GG4-Gs2 with G5-Gs2 (SDI = 0.5900), Table 3.

In the present study, the product Radistim was used as a biostimulator for rooting cuttings in the Saintpaulia genotypes studied. Various bioactive substances are of interest for ornamental horticultural species in relation to propagation methods, quality of biological material, stimulation of growth and development, flowering, tolerance to stressors [29], [1].

Biostimulating substances are useful for vegetative propagation of plants in order to stimulate rooting and obtain quality biological material. Mladenović et al. (2016) [30] eported favorable results on vegetative propagation in Saintpaulia by treating leaf cuttings with biostimulators (Incit-1, Incit-5).

In relation to vegetative propagation, the favorable effect of biostimulating substances has been registered in different ornamental species [32], [25], [31].

From the analysis of the data obtained regarding the vegetative multiplication of the five studied Saintpaulia genotypes, of the PCA diagram and of the Euclidean distribution dendrogram, can be chosen those growth substrates that ensured a better multiplication rate, in relation to each genotype.

The G3 genotype (Saintpaulia ionantha Delft) had the best propagation rate compared to the other genotypes studied, due to the high ecological plasticity in relation to the growing substrate.

The substrate consisting of a mixture of sand and peat (Gs2) provided a better rate of multiplication by leaf cuttings in most of the Saintpaulia genotypes studied, compared to the other two substrates tested (Gs1 and Gs3).

Table 3. SDI values for the experimental variants regarding the vegetative propagation in Saintpaulia in relation to the growing substrate

	G1-Gs1	G1-Gs2	G1-Gs3	G2-Gs1	G2-Gs2	G2-Gs3	G3-Gs1	G3-Gs2	G3-Gs3	G4-Gs1	G4-Gs2	G4-Gs3	G5-Gs1	G5-Gs2	G5-Gs3
G1-Gs1		2.5102	3.0813	1.0000	1.3200	3.5997	2.7105	4.1531	2.7201	0.3607	1.4993	2.6879	0.6992	2.0739	2.4579
G1-Gs2	2.5102		5.2829	3.4440	1.4800	6.0266	1.1811	1.6672	4.2267	2.6630	1.1071	4.5981	2.0383	0.8277	4.6707
G1-Gs3	3.0813	5.2829		2.7775	4.3859	1.2258	4.9092	6.7315	1.7207	3.2058	4.4845	0.9453	3.2781	5.0743	0.6270
G2-Gs1	1.0000	3.4440	2.7775		2.0839	2.9628	3.7103	5.1057	3.0098	0.7811	2.3681	2.7065	1.6819	2.8915	2.2207
G2-Gs2	1.3200	1.4800	4.3859	2.0839		4.9086	2.2041	3.1296	3.7793	1.3280	0.4000	3.9054	1.2567	0.8096	3.7595
G2-Gs3	3.5997	6.0266	1.2258	2.9628	4.9086		5.8389	7.5802	2.9268	3.6044	5.0935	2.1453	3.9897	5.6731	1.5603
G3-Gs1	2.7105	1.1811	4.9092	3.7103	2.2041	5.8389		1.8822	3.5619	2.9851	1.8143	4.0921	2.0455	1.8695	4.3456
G3-Gs2	4.1531	1.6672	6.7315	5.1057	3.1296	7.5802	1.8822		5.4430	4.3257	2.7710	5.9508	3.6135	2.3800	6.1446
G3-Gs3	2.7201	4.2267	1.7207	3.0098	3.7793	2.9268	3.5619	5.4430		3.0084	3.7233	0.7816	2.5230	4.2720	1.4658
G4-Gs1	0.3607	2.6630	3.2058	0.7811	1.3280	3.6044	2.9851	4.3257	3.0084		1.5904	2.9062	1.0332	2.1276	2.5948
G4-Gs2	1.4993	1.1071	4.4845	2.3681	0.4000	5.0935	1.8143	2.7710	3.7233	1.5904		3.9291	1.2352	0.5900	3.8583
G4-Gs3	2.6879	4.5981	0.9453	2.7065	3.9054	2.1453	4.0921	5.9508	0.7816	2.9062	3.9291		2.6939	4.5081	0.7422
G5-Gs1	0.6992	2.0383	3.2781	1.6819	1.2567	3.9897	2.0455	3.6135	2.5230	1.0332	1.2352	2.6939		1.8165	2.6563
G5-Gs2	2.0739	0.8277	5.0743	2.8915	0.8096	5.6731	1.8695	2.3800	4.2720	2.1276	0.5900	4.5081	1.8165		4.4482
G5-Gs3	2.4579	4.6707	0.6270	2.2207	3.7595	1.5603	4.3456	6.1446	1.4658	2.5948	3.8583	0.7422	2.6563	4.4482	

Source: original values resulting from the analysis of experimental data.

CONCLUSIONS

The study on the vegetative propagation of the five Saintpaulia genotypes, on three growth substrates, highlighted the specific response of each genotype in relation to the growth substrate, in statistical safety conditions.

The Gs3 growth substrate (Per/Pea) provided the lowest propagation rate in all five Saintpaulia genotypes studied. The Gs2 growth substrate (San/Pea) facilitated the best propagation rate, by leaf cuttings, in most of the Saintpaulia genotypes studied.

The G3 genotype (*Saintpaulia ionantha* Delft) had the best propagation rate compared to the other genotypes studied, due to the high ecological plasticity in relation to the growing substrate.

ACKNOWLEDGEMENTS

The authors thank to the staff of the Didactic and Research Base of the Banat University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, Romania to facilitate this research.

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