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Phenotypic Correlations among Pollen Quality and Morphological Traits of *Saintpaulia*

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Abstract

In order to estimate the correlation between pollen viability, germination and the morphological traits, 15 *Saintpaulia* genotypes were analysed. Pollen viability was obtained by staining with potassium iodide (25%) and germination was estimated using solid nutrient medium (15% sucrose, 85% humidity, 22 °C temperature). Several morphological traits such as number of flowers, diameter of leaves rosette, number of leaves, length and width of leaves and petiole length were evaluated to determine growth indices. The results obtained indicated that 'Hot Pink Bell' genotype achieved the highest number of flowers and the largest diameter of leaves rosette. Genotypes 'Tomahawks' and *S. grotei* recorded the highest number of leaves. Higher width of leaves values was obtained in 'Aloha Orchid', while genotype 'Park Avenue Blue' was noted for a high length of leaves. Positive correlations were recorded among viability and germination in *S. jonantha, S. rupicola* and *S. grotei*. Significant positive correlation was registered between pollen viability and the number of flowers, but also between germination and the number of flowers per plant. The results indicated a possible correlation between viability, germination capacity and the morphological traits in most genotypes studied.

Keywords: African violet, breeding, germination, number of flowers, morphological traits, viability

Introduction

The ornamental plant industry follows an upward trend across the globe. The most popular potted plants are *Begonia*, *Ficus*, *Anthurium*, *Chrysanthemum*, *Rosa*, *Saintpaulia* and *Spathiphyllum* (Ghasemi *et al*., 2012).

Saintpaulia Wendl. are popular ornamental plants all over the world with high economical value in horticulture (Daud and Taha, 2008; Ghasemi *et al*., 2012; Miranto, 2005). Some species are subject of breeding methods since 100 years ago (Kolehmainen and Korpelainen, 2008). The interest of breeders is to create new cultivars with superior morphological characters; this is the explanation for the existence of more than 2,000 African violet cultivars (Kolehmainen and Mutikainen, 2007).

Fang and Traore (2011) reported that due to various intraspecific hybridizations, spontaneous mutations and selections with ameliorative purposes were obtained for African violets, with an extremely varied palette. This species have a slight tendency to mutations and genetic drift, which creates valuable genetic material resources (Robey, 1988).

African violets (*Saintpaulia* Wendl.) have a distribution in the Eastern Arc Mountains, in the coastal lowlands in South-East Kenya and Eastern Tanzania (Kolehmainen and Korpelainen, 2008; Miranto, 2005). The species in this genus grow and develop in shaded areas with acidic soils, in a climate with high temperatures and humidity (Fang and Traore, 2011).

The African violets have a good capacity of producing ornamental hybrids, but the exogenous factors may sometimes raise incompatibility barriers (Fang and Traore, 2011; Gudadhe and Dhoran, 2012; Harrison *et al*., 1999).

The purpose of the undertaken research was to select genotypes with characteristics of interest in view of breeding works and to enhance the possibility of enriching the germplasm fund with new genotypes. The study of correlations might contribute to the improvement of the process of choosing the most valuable genitors (Baciu *et al.,* 2010).

The success of breeding depends on various factors, of genetic, climatic and economic order (Kahn *et al.,* 2013). Inducing of artificial variability is based on the knowledge of correlations established between two variables or between different plant characteristics (Barros *et al.,* 2010; Sestraş *et al.,* 2012). In this respect, the current research was initiated to determine the close and direct correlation between genotype, viability and pollen germination and the morphological traits in African violets.

The obtained results allow the selection and recommendation of valuable genotypes in economic terms (Gudadhe and Dhoran, 2012).

Materials and methods

Plant material and pollen samples

The biological material was represented by three species and twelve cultivars: 'Red Velvet' (S1), 'Jolly Red' (S2), 'Aloha Orchid' (S3), 'Hot Pink Bell' (S4), 'Park Avenue Blue' (S5), 'Lucky Ladybug' (S6), 'Crimson Ice' (S7), *Saintpaulia jonantha*

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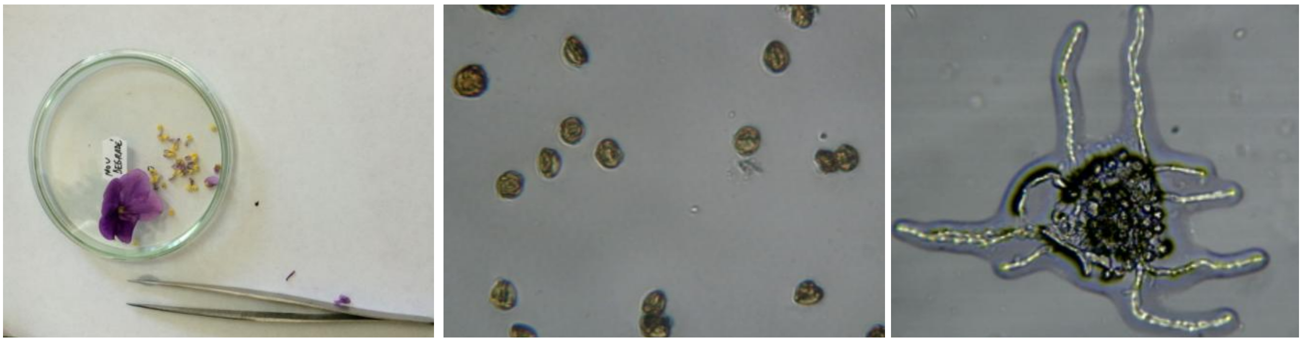

Fig. 1. 'Aloha Orchid's (S3) viability test by staining with potassium iodide (25%) and pollen grain germination on solid medium (15% sucrose)

H. Wendl. (S8), 'White Queen' (S9), 'Painted Silk' (S10), 'Pink Pussycat' (S11), 'Buffalo Hunt' (S12), *Saintpaulia rupicola* B. L. Burtt (S13), 'Tomahawks' (S14), *Saintpaulia grotei* Engl. (S15). Number of flowers, diameter of leaves rosette, number of leaves, width of leaves, length of leaves and petiole length were measured to calculate several growth indices.

The pollen of 15 *Saintpaulia* genotypes was collected in October from acclimatized and cultivated plants under the same environmental conditions (84% average air humidity, 23 °C average temperature) at the didactic greenhouse of the Department of Floriculture within the University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca (UASVM-CN).

Pollen viability test by staining

In order to determine the viability test, anthers were collected and treated with Carnoy's solution for 2 hours, after which they were washed in 80% ethanol according to Sestraş (2012) and Huang *et al.* (2004). Ten visual fields were monitored using Aigo Digital Microscope EV5610 (Beijing Aigo Research Institute of Precision Instrument Co., Ltd). Counters were made in five replications for each genotype. The pollen grain that stained brown was considered viable and the transparent one was unviable.

In vitro pollen germination

To determine germination, pollen grains were sow on solid nutrient medium (15% sucrose), according to the methodology used by Bodhipadma *et al.* (2013) and Gudadhe and Dhoran (2012). Counting of pollen grains was made on ten fields in five replications using the same microscope (Fig. 1).

Statistical analysis

Morphological traits of the studied *Saintpaulia* genotypes were analysed using the ANOVA and means separated with the Duncan's test. The correlations between genotype, pollen viability, germination and different phenotypic traits were performed using Pearson index (Sestraş *et al.*, 2012).

Results and discussions

Morphological traits

The variability of morphological traits of the 15 *Saintpaulia* genotypes is presented in Table 1. According to the obtained results, S4 genotype achieved the highest number of flowers (25.0) and the largest diameter of leaves rosette (41.1 cm). The lowest number of flower was recorded in S15 (8.67). Genotypes S6 (14.23), S13 (14.33) and S14 (14.33) had similar values for the number of flowers. The highest number of leaves was recorded in S14 (40.67) and S15 (40.00) genotypes. A high number of leaves was registered in S2 (34.33), differing statistically from S14.

The width of leaves varied from 2.47 cm (S15) to 6.33 cm (S3). A good result concerning this trait was obtained by S10 (6.30 cm), but not differing statistically from S3. The data processed and interpreted with the Duncan's test show that the highest value for the length of leaves was registered in S5 genotype (6.77 cm). Appropriate values were obtained by S2 (6.30 cm), S3 (6.43 cm), S4 (6.00 cm), S12 (6.20) and S14 (6.03 cm). Morphological traits evaluation in *Saintpaulia* genotypes could be useful in order to choose the right genotypes for further breeding programs.

Phenotypic correlations

Within the experiments on *Saintpaulia* genotypes in the current study, statistically assured phenotypical correlations were recorded (Figs. 2 → 5) among the various characteristic analyzed.

Pollen viability and germination are important in fertilization process (Ahmad *et al.*, 2012; Francisco De Assis *et al.*, 2011), therefore the relationship between these two variables is vital (Petrişor *et al.*, 2012). The viability is a crucial parameter in obtaining the maximum potential of hybridization (Huang *et al.*, 2004). Thus, between the two indicators, there were registered positive and direct correlations for 'Aloha Orchid' (S3), 'Crimson Ice' (S7), *Saintpaulia jonantha* H. Wendl. (S8), *Saintpaulia rupicola* B. L. Burtt (S13) and *Saintpaulia grotei* Engl. (S15) genotypes, which demonstrated that the two variables change in the same direction, hence the higher the viability is, the better the pollen germination is also (Prasad *et al.*, 1999).

Fig. 2b illustrates the correlation between the germination capacity and the number of flowers. The genotypes among which this correlation was direct and highly significantly positive are: 'Red Velvet' (S1), 'Lucky Ladybug' (S6), *Saintpaulia jonantha* H. Wendl. (S8) and *Saintpaulia rupicola* B.L. Burtt (S13) genotypes.

To be noted that among genotypes 'Jolly Red' (S2), 'Aloha Orchid' (S3), 'Park Avenue Blue' (S5), *Saintpaulia jonantha* H. Wendl. (S8), 'White Queen' (S9), 'Buffalo Hunt' (S12), *Saintpaulia rupicola* BL Burtt (S13) and 'Tomahawks' (S14), the correlation between the pollen viability and the number of flowers was direct and positive, which was in agreement with the results obtained by Prasad *et al.* (1999) (Fig. 3a).

Table 1. Evaluation of variability of morphological traits in *Saintpaulia* genotypes

Genotype code	Morphological traits evaluated					
	No. of flowers	Diameter of leaves rosette (cm)	No. of leaves	Width of leaves (cm)	Length of leaves (cm)	Petiole length (cm)
S1	19.67^{bc}	24.77^{f}	17.33^{h}	3.67^{efg}	4.53^{fg}	5.30^{de}
S2	23.67^{ab}	29.87^{c}	34.33^{b}	6.00^{b}	6.30^{c}	5.00^{ef}
S3	16.67^{cd}	28.23^{e}	21.67^{g}	6.33^{a}	6.43^{b}	6.33^{d}
S4	25.00^{a}	41.10^{a}	30.67^{de}	5.10^{de}	6.00^{cd}	9.23^{a}
S5	13.67^{e}	29.00^{d}	32.00^{d}	5.50^{c}	6.77^{a}	8.87^{b}
S6	14.23^{d}	20.57^{g}	22.80^{fg}	3.70^{ef}	3.83^{gh}	3.90^{g}
S7	11.67^{f}	28.60^{e}	26.33^{efg}	5.13^{de}	5.00^{d}	5.13^{def}
S8	10.00^{g}	23.53^{fg}	22.33^{fg}	5.40^{d}	5.00^{e}	5.13^{def}
S9	19.00^{cd}	28.00^{f}	33.67^{b}	3.43^{g}	5.07^{f}	3.50^{h}
S10	13.67^{e}	21.93^{fg}	$30.00d^{ef}$	6.30^{a}	5.60^{e}	4.83^{g}
S11	13.67^{e}	17.17^{i}	17.33^{h}	$3.57f^{g}$	4.70^{fg}	5.43^{d}
S12	16.67^{cd}	35.40^{b}	33.67^{c}	5.67^{c}	6.20^{c}	4.87^{f}
S13	14.33^{d}	18.07^{h}	36.67^{b}	3.07^{g}	4.50^{fg}	6.33^{c}
S14	14.33^{d}	31.83^{b}	40.67^{a}	5.87^{c}	6.03^{cd}	$5.07d^{ef}$
S15	8.67^{g}	13.60^{j}	40.00^{a}	2.47^{g}	3.40^{h}	3.00^{i}

Notes: Values are means of 3 replications ± SD (2.05-2.43) no. of flowers, ± SD (1.29-1.54-2.43) diameter of leaves rosette, ± SD (2.88-3.42) number of leaves, ± SD (0.44-0.52) width of leaves, ± SD (0.38-0.45) length of leaves and ± SD (0.34-0.40) petiole length. Small letters represent the statistical differences at P<0.05% (Duncan test)

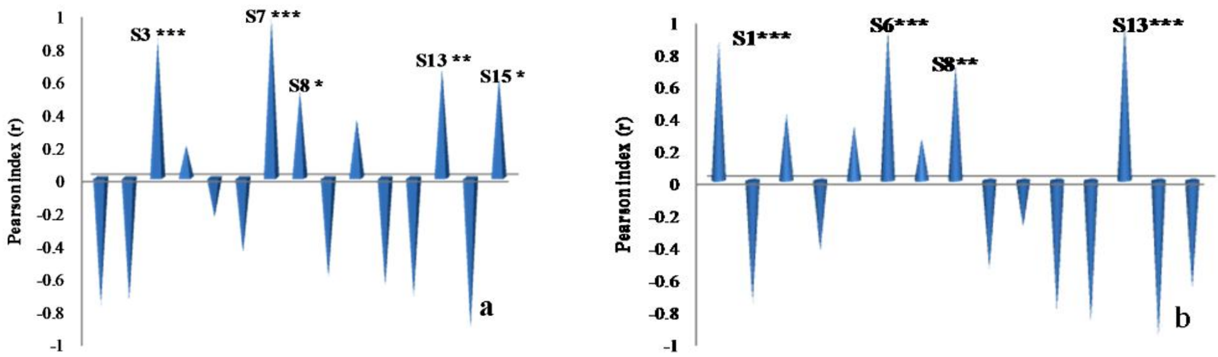

Fig. 2. Correlation between pollen viability x germination (**a**) and pollen germination x no. of flowers (**b**) in *Saintpaulia* genotypes (14 cases P5% = 0.497, P1% = 0.623, P0,1%=0.742 according to Sestraș *et al.,* 2012)

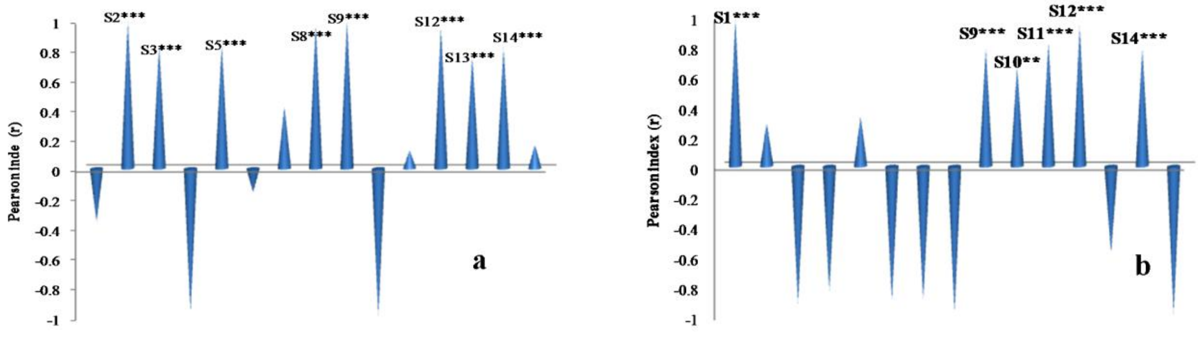

Fig. 3. Significant relationship between pollen viability x no. of flowers (**a**) and diameter of leaves rosette x petiole length (**b**) in *Saintpaulia* genotypes (14 cases P5% = 0.497, P1% = 0.623, P0,1%=0.742 according to Sestraș *et al.*, 2012)

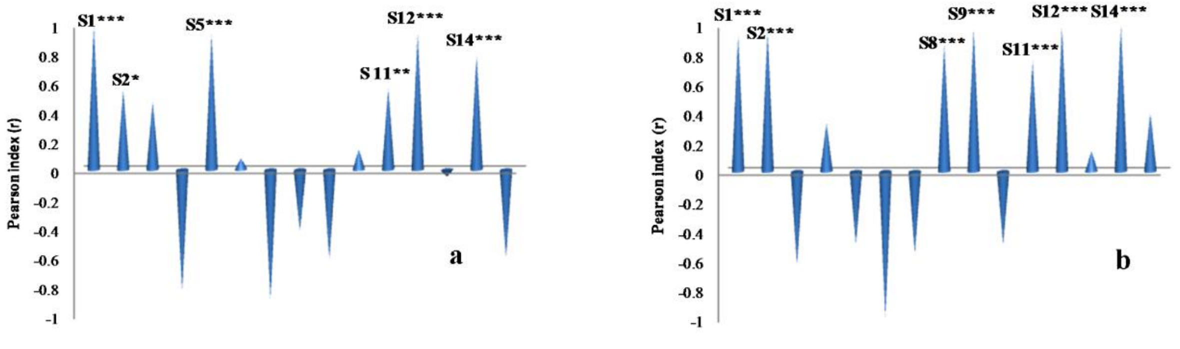

Fig. 4. Strong positive relationship between diameter of leaves rosette x no. of leaves (**a**) and no of leaves x width of leaves (**b**) in *Saintpaulia* genotypes (14 cases P5% = 0.497, P1% = 0.623, P0,1%=0.742 according to Sestraș *et al.*, 2012)

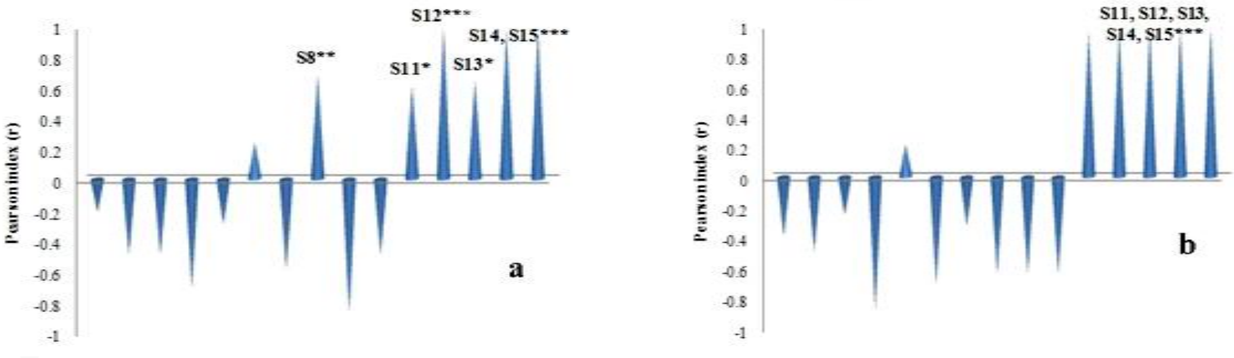

Fig. 5. Correlation between width of leaves x leaves length (**a**) and leaves length x petiole length (**b**) in *Saintpaulia* genotypes (14 cases P5% = 0.497, P1% = 0.623, P0,1%=0.742 according to Sestraș *et al.*, 2012)

Positive correlations were recorded between the diameter of plant rosette and the length of the leaf petioles for 'Red Velvet' (S1), 'White Queen' (S9), 'Painted Silk' (S10), 'Pink Pussycat' (S11), 'Buffalo Hunt' (S12) and 'Tomahawks' (S14) (Fig. 3b) genotypes. The leaf petiole can determine the position of leaves; hence, this correlation is also essential in terms of photosynthetic ratio, although in some cases the petiole length may indicate a lack of light intensity, due to an increase in cell size (Gonçalves *et al.,* 2005).

The Pearson's index value (r ≈ 1.00) showed significant positive correlations between the diameter of the leaves rosettes and the number of leaves in 'Red Velvet' (S1), 'Jolly Red' (S2), 'Park Avenue Blue' (S5), 'Pink Dolls' (S11), 'Buffalo Hunt' (S12) and 'Tomahawks' (S14) (Fig. 4) genotypes. An increased number of leaves mean a larger area of nutrition, higher energy transfer and therefore a better support for the development of pollen grain (Chanda and Singh, 2002).

The correlation between the number of leaves and their width was significantly positive for 'Red Velvet' (S1), 'Jolly Red' (S2), *Saintpaulia jonantha* H. Wendl. (S8), 'White Queen' (S9), 'Pink Pussycat' (S11), 'Buffalo Hunt' (S12) and 'Tomahawks' (S14) (Fig. 4b) genotypes. This correlation was influenced by the environmental conditions, the thickness of foliole and the size of cells (Chanda and Singh, 2002; Gonçalves *et al.,* 2005; Mokhtarpour *et al.*, 2010).

Positive correlations between the width of leaves and their length were also recorded in the following genotypes: *Saintpaulia jonantha* H. Wendl. (S8), 'Pink Pussycat' (S11), 'Buffalo Hunt' (S12), *Saintpaulia rupicola* B.L. Burtt (S13), 'Tomahawks' (S14), *Saintpaulia grotei* Engl. (S15) (Fig. 5). These parameters are important in the assessment of plant growth. Their analysis is required to determine growth indices, which give direct information on assimilation, photosynthetic performance, photochemical efficiency and a balanced development of plants (Gonçalves *et al.,* 2005; Mokhtarpour *et al.,* 2010). The correlation between the length of leaves and the length of the petiole was direct and positive in *Saintpaulia jonantha* H. Wendl. (S8), 'Pink Pussycat' (S11), 'Buffalo Hunt' (S12), *Saintpaulia rupicola* B.L. Burtt (S13), 'Tomahawks' (S14) and *Saintpaulia grotei* Engl. (S15) genotypes (Fig. 5b).

The correlations between the main phenotypical traits, viability and the germinability of palynomorphs depend on genotype, but can be influenced by exogenous factors, technological indicators and are in tight relation with the chemical composition of pollen (Sani *et al.*, 2013; Žilić *et al.*, 2014).

Conclusions

The obtained results showed that the analyzed morphological traits (number of flowers, diameter of leaves rosette, number of leaves, length and width of leaves, petiole length) are promising items to be considered in further breeding programs. Genotypes S3, S4, S5, S14 and S15 were noted with the highest values for the most important morphological characters. The correlations made between the main phenotypical traits revealed the existence of direct and positive correlations between the sustainability and the germinability of palymorphs in *Saintpaulia* H. Wendl genotypes. There were recorded significant positive correlations between pollen viability and the number of flowers, but also between germination and the number of flowers per plant. The genotypes recommended for breeding works are: 'Aloha Orchid', 'Crimson Ice', *Saintpaulia jonantha* H. Wendl, *Saintpaulia rupicola* B. L. Burtt and *Saintpaulia grotei* Engl. These genotypes came into evidence by very good pollen germination and experienced a high viability. The study of correlations between viability, germination of pollen and the morphological traits contributes in the improvement of the process of obtaining new cultivars and choosing the genitors in breeding.

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