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Cattleya Aurora's Little Ian: a novelty mini semper-flowering material and a genetic parameter for superior clone selection

Nelson B Machado-Neto [1]*; Jessica F Fileti [1]; Ceci C Custódio [1]

[1]Universidade do Oeste Paulista, (Unoeste), Presidente Prudente-SP, Brasil; nbmneto@unoeste.br; jessica_ff5@hotmail.com; ceci@unoeste.br

ABSTRACT

Orchids are an important horticultural culture. *Cattleya* and its allies are among the most used ornamental group of this plant family. *Cattleya* hybrids normally are big pot plants with a determined flowering season (spring, summer, autumn or winter), so a small plant with vivid and multi-flowered spikes coloured and non-determined flowering season is desired. The hybrid *Cattleya* Aurora's Little Ian is a new small pink-reddish hybrid flower, producing over four small to medium flowers per bunch. For the first time there is a description of a parameter, petal width, with heritability estimation and efficient to select superior clones derived from plants of the Section Cyrtolaelia in the *Cattleya* hybrid group. It could be easily grown either at shade house or at windowsill emitting shoots and flowering freely in each new shoot, independent of photo or thermoperiod, as long as it is kept in good growing conditions.

Keywords: Plant breeding, orchid hybrid, selection, small plants.

RESUMO

***Cattleya* Aurora's Little Ian: uma novidade em flores pequenas de floração frequente**

As orquídeas são uma cultura hortícola importante. *Cattleya* e seus aliados estão entre os grupos ornamentais mais utilizados desta família de plantas. Os híbridos de *Cattleya* normalmente são plantas grandes de vasos e com estação de floração determinada (primavera, verão, outono ou inverno). Portanto, uma planta pequena com hastes multiflorais e flores multicoloridas, sem uma estação de floração definida é desejada. *Cattleya* Aurora's Little Ian é um híbrido novo, pequeno, de flor rosa-avermelhada, produzindo mais de quatro flores pequenas a médias por haste. Pela primeira vez há a descrição de um parâmetro, a largura de pétala, com cálculos de herdabilidade e eficiência para selecionar clones superiores derivados de plantas da Seção Cyrtolaelia do grupo de híbridos de *Cattleya*. Ela pode ser facilmente cultivada tanto em casa de vegetação quanto em ambientes internos, emitindo brotações e florescendo livremente a cada novo broto independentemente de foto ou termoperíodo, desde que mantida em boas condições de cultivo.

Palavras-chave: Melhoramento de plantas, híbrido de orquídeas, seleção, plantas pequenas.

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Cattleya and its hybrids are among the most valuable flowers and its development is slow when compared with the *Phalaenopsis* including *Vanda*, *Dendrobium, Oncidium, Cymbidium* and *Catasetum* alliances which have relatively fast development of new materials (De & Medhi, 2015; Colombo *et al*., 2017; Stulzer *et al*., 2019). The Brazilian flower production is demanding for selected new materials, especially in orchids (Cardoso *et al*., 2016) and other tropical species (Junqueira & Peetz, 2014).

With a production area of 15,000 ha of ornamental plants, the internal market registered revenues of R$ 5.4 billion in 2014, when compared with the two previous years (2012-2013), this sector has an improvement of 6.17%. The greatest producer was São Paulo with circa 46% of the area and 37% of profits. The increase in the *per capita* year consumption increased 7.71% in the same period (Neves & Pinto, 2015). On the other hand, the exportation of flowers and tropical plants is showing a decrease from 2004 to 2013, with a decline of 8.43% when compared with 2012 (Junqueira & Peetz, 2017).

A breeding program has been established in the Orquidário Aurora, in Taciba-SP, since 1999, mainly for *Cattleya* hybrids, focused on small flowering plants, because today the free space available in the houses is limited and the old-style hybrids are even tall plants. Some of the breeding plans focus on the use of the rock growing *Cattleya* (ex-Brazilian *Laelias* section Parviflorae Brieger) transferred to genus *Sophronitis* by Van Den Berg *et al.* (2000) and then to *Cattleya* (Van den Berg *et al*., 2009) as a parent because they transfer multiflora and compact small-sized plants characteristics to the offspring.

Methods used for breeding

Cattleya Aurora's Little Ian is a novelty hybrid developed using *C. [Sl.]* Marriottiana (2/1896 an old hybrid obtained through crosses between *Cattleya coccinea* and *C. crispata*) as female parent and x *C. walkeriana* as a male parent. The capsule developed for ten months, and was collected when

showed the first signs of maturation. It was kept in an envelope paper and allowed to ripe naturally in a chamber over a layer of silica gel.

Seeds were disinfected for 10 minutes using 5 g L^{-1} of sodium dichloroisocyanurate solution added with 100 µL of Tween 80 as a wetting agent and mixed by inverting the tubes by hand during this period (Machado Neto & Custódio, 2005). Thereafter, seeds were washed twice in distilled autoclaved water and sown in a ½ strength MS media (Murashige & Skoog, 1962) with 20 g L^{-1} sucrose and 8 g L^{-1} agar; the pH of the media was adjusted to 5.6 and the media was autoclaved and distributed in Petri dishes (60 mm diameter). After 60 days, seedlings were transferred into flasks and allowed to grow for 90 days when the plants were replanted into another flask, repeating this procedure until the seedlings are ≥15 mm high. Seedlings were removed from the flasks, washed carefully to wash off any agar debris, immersed in a solution containing 2 g L^{-1} methyl tiophanate for one hour. The solution was drained and the seedlings were allowed to dry overnight.

The seedlings were planted in community pots using sphagnum moss as substrates and received weekly fertilization using a hydrosoluble feeding with a 20:20:20 formula at 1 g L^{-1}. If pests or diseases were found the needed care was taken. After one year the plants were transferred to individual pots (5 cm) filled with 1/3 gravel and a pine bark potting mix of fine granulometry (<5mm) and chopped sphagnum moss (1:1, v:v). When the plants were tall enough, they were transferred to 10 cm pots with 1/3 gravel of medium granulometry (<12mm) until flowering and maintained in the same conditions of fertilization describe above.

Flower selection traits

Although many criteria are relevant for selection, e.g. earliness and color (Cardoso, 2010; Cardoso *et al*., 2016; Colombo *et al*., 2017), just one paper related genetic parameters of the flower estimated or defined for the selection of superior clones (Machado Neto, 2019). The first blooms appeared six years after seed harvesting in 2004.

Flowers of all plants of the hybrid population were measured (Figure 1, Table 1).

Selection differential was calculated as following (Borém *et al*., 2021):

$$SD = \bar{X}_s - \bar{X}_o \quad (1)$$

where SD is the selection differential, $\bar{x}_s$ is the mean of the selected plants in a specific characteristic and $\bar{x}_0$ is the mean of the whole population.

The genetic gain with selection was calculated, for four characters: natural diameter (D), dorsal sepal width (Dsp); petal width (PW) and labellum mid lobe (LML) (Figure 1), to decide which flower trait or traits would be preferable for selection, based on (2) following the methodology of Machado Neto (2019):

$$G_S = h^2 \times SD \quad (2)$$

where G_s is the gain with selection, h^2 the trait heritability and SD the selection differential, calculated as the difference between the mean of the original population and that of the selected plants.

Character heritability h^2 was calculated as in (3):

$$h^2 = \frac{\sigma_F^2 - \sigma_E^2}{\sigma_F^2} \quad (3)$$

where σ_F^2 is the variance of the hybrid population and σ_E^2 the environmental variability measured as the mean of the two parent plants.

The percentage of genetic gain, for each character, was calculated as in (4):

$$G_{S\%} = \left(\frac{G_S}{\overline{X_0}}\right) \times 100 \quad (4)$$

Where *GS* is the gain with selection and $\overline{X_0}$ the mean of the initial population.

The mean of the superior population ($\overline{X}_s$) was calculated as in (5):

$$\overline{X}_s = \overline{X}_0 + G_s \quad (5)$$

These values were calculated for all characters described above. The dorsal sepal (Dsp) was measured but not used as selection criterion.

The possible number of genes (*n*) was calculated by the formula:

$$n = \frac{R^2}{8\sigma_G^2}$$

where R^2 is the square of SD (1) and σ_G^2 is the genetic variance, obtained by the $\sigma_F^2 - \sigma_E^2$ as described above (3).

All variables, in the parental clones and in the offspring, were compared by the Bonferroni "t" test ($p \leq 0.05$). A correlation analysis was made with all

Table 1. Morphological characters of parents and gene calculation - *Cattleya walkeriana* and *Cattleya* Marriotiana (2/1896) – and its offspring *Cattleya* Aurora´s Little Ian (F_1). Taciba, Unoeste/Orquidário Aurora, 2018-2019.

Morphological characters	*Cattleya walkeriana*	*Cattleya* Marriotiana (2/1896)	*Cattleya* Aurora's Little Ian	Number of genes involved
Leaf width (mm)	42.28 a	27.10 b	23.02 b	9
Leaf length (mm)	97.48 b	139.00 a	84.37 b	2
Natural Diameter (mm)	81.33 a	46.31 c	58.08 b	1
Dorsal sepal width (mm)	25.5 a	21 b	16.67 b	1
Petal width (mm)	55.46 a	35 b	28.31 c	3
Labellum Mid Lobe (mm)	55.67 a	22 b	19.47 b	17
Flower number	2.8 c	6.3 a	3.7 b	6
Flowering period	May - October	August - September	January - December	

Means followed by different letters in the line are statistically different by Bonferroni "t" test ($p<0.05$).

parameters.

The natural flower diameter (D), with a h^2=0.95, when used as a selection factor, was positively related with Dsp, PW and LML, with $G_{s\%}$of 52.68; 43.58 and 72.67, respectively. However, using either PW or LML (Table 2), all traits were positively impacted, but D had smaller gains using these characters. Gains were lower for diameter, 22.44 and 17.71% using PW or LML, respectively. However, all other floral characters were positively impacted with values higher than 40% for each, with a great impact on the flower composition, making a better-shaped flower and improving the appearance. On the other hand, the use of D even, producing bigger flowers, did not produce better shaped flowers in appearance, so this parameter was not useful. In reality, *Cattleya* Marriotiana exhibited a strong effect of over dominance, presenting in most of the characters a decreasing of size, been these smaller than the mother, but leaf length was influenced by the *Cattleya walkeriana*. The character flower size and number of flowers were intermediary exhibiting a codominance effect.

In the scientific literature, this is the first description of a parameter, petal width (PW), to select genetically superior clones derived from plants of the Section Cyrtolaelia in the *Cattleya* hybrid group. This parameter (PW) was chosen because it has the highest genetic gains in all characters but natural diameter (D), which had the highest genetic gain in the D itself (Table 2). The correlation between all characters were highly significant among them (Table 3), but the correlation between PW and the other had the higher values.

The number of genes (Table 1) also exhibited that even been determined by only one gene D and Dsp were not good predictors but PW, determined by three genes, were more efficient. The other character LML had a large amount of genes (17) influencing it, it should be because it is a specialized petal with some changes in colour pattern, upward curvature of lateral lobes to cover the column and downward curvature of the medium lobe.

Morphological characteristics

Plants of *Cattleya* Little Ian are small-sized (maximum 20 cm high), unifoliate. The flowers are up to five in each inflorescence and without determination of flowering season, flowering from January to December as new growth develops. Because of the characteristic of free flowering, superior plants are being used as parental in many new crosses that are being made. The flowers are small-medium sized, from light pink to dark pink and with a dark mid lobe. The plant and flower characteristics were more influenced by the parent *C. (SL.)* Marriotinana than by *C. walkeriana*. (Table 1), exhibiting an overdominance of *C.* Marriotiana.

The superior clones, selected based upon the criteria described above, were separated and included as parents in our breeding program. The plants are currently maintained in black plastic pots filled with broken macadamia nut shells, in a shade house, fertigated weekly with a 30-10-30 NPK (0.22 g m^{-2}) and supplemented fortnightly with 0.11 g m^{-2} $MgSO_4$ and $CaCl_2$. The commonly used phytosanitary practices for orchid cultivation were applied.

Maintenance and distribution of plants

Table 2. Genetic parameters for selection of *Cattleya* Aurora's Little Ian and their impact on the selection differential (SD), gain with selection (G_s), percent gain with selection ($G_{s\%}$) and mean of improved population ($\bar{x}_s$) of flower traits such as diameter (D), dorsal sepal (Dsp), petal width (PW) and labellum mid lobe width (LML). Taciba, Unoeste/Orquidário Aurora, 2018-2019.

Selection criteria	Heritability (h^2)		SD*	**	§	§§
Diameter (mm)	0.95	D	10.24	9.49	29.07	68.33
		Dsp	1.43	0.98	52.68	15.00
		PW	4.14	2.65	43.58	26.00
		LML	2.70	2.41	72.67	19.17
Dorsal sepal (mm)	0.90	D	3.5	3.9	2.8	2.7
		Dsp	3.3	3.5	2.2	2.6
		PW	6.4	61.7	23.6	45.6
		LML	62.3	17.3	25.3	19.2
Petal width (mm)	0.76	D	7.91	7.33	22.44	66.00
		Dsp	3.09	1.98	106.10	16.67
		PW	5.80	3.71	61.14	27.67
		LML	2.86	2.56	77.17	19.33
Labellum mid lobe width (mm)	0.94	D	6.24	5.78	17.71	64.33
		Dsp	1.76	1.21	64.98	15.33
		PW	3.80	2.43	40.07	25.67
		LML	4.20	3.75	113.09	20.67

*Selection differential, **Gain with selection, §Percent gain with selection and §§Improved population mean.

Table 3. Pearson coefficient of the correlation between the chosen parameters natural diameter (D), dorsal sepal (Dsp), petal width (PW) and labellum mid lobe width (LML) for selection of *Cattleya* Aurora's Little Ian. Taciba, Unoeste/Orquidário Aurora, 2018-2019.

	D	*Dsp*	***Pw***	*LML*
D	1	-	-	-
Dsp	0.976 **	1	-	-
Pw	**0.979 ****	**0.960 ****	1	-
LML	0.958 **	0.953 **	**0.974 ****	1

**Correlation values are statistically significant by the "F" test ($p<0.01$).

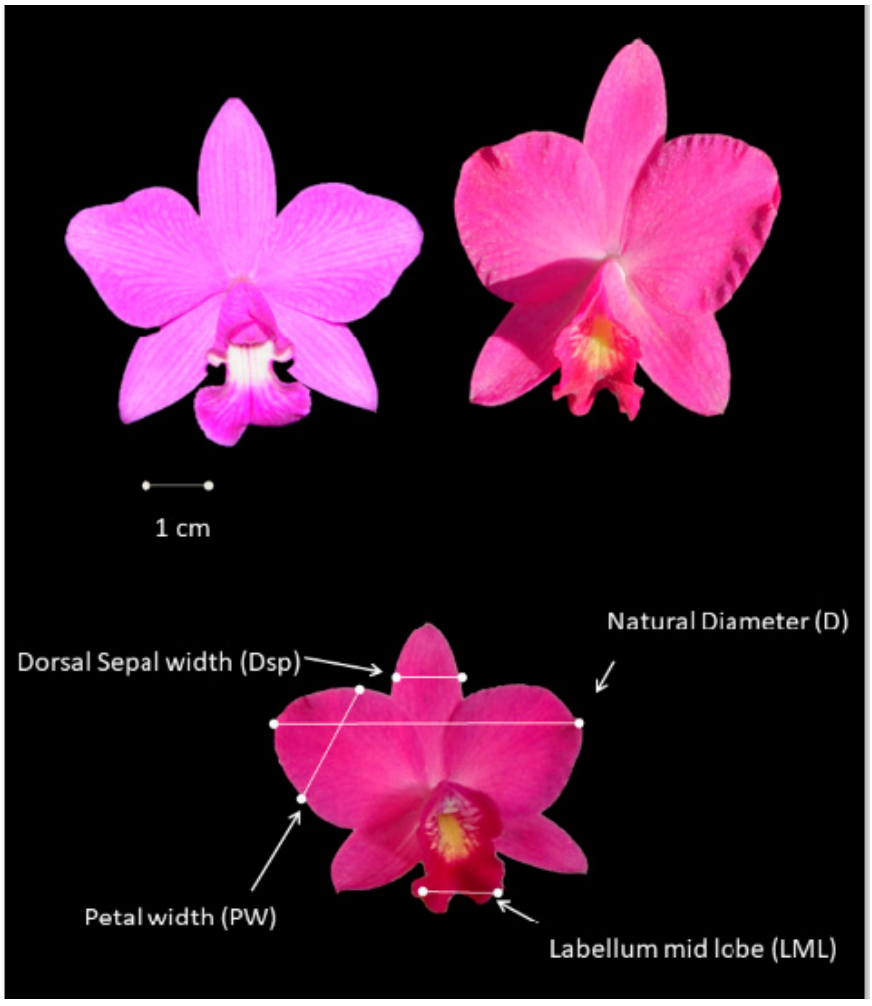

Figure 1. Different plants of *Cattleya* Little Ian and places of measurement of the flower segments. Taciba, Unoeste/Orquidário Aurora, 2018-2019.

The plants of Aurora's Little Ian are being maintained in the private Orquidário Aurora, located close to the state highway SP483, in Taciba, São Paulo and some other were sent to commercial growers.

Registration, protection, commercial dissemination and licensing

Cattleya Aurora's Little Ian is a hybrid registered by Nelson Barbosa Machado Neto in the Royal Horticultural Society under the number 24597, in November 2014 and is not under any protection Law or licensing of agreement.

For more informations

Rua Marilia 252, 19014-110 Presidente Prudente-SP

Email: nbmneto@gmail.com

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