Gibberellic acid and water regime in the flowering induction of Brassocattleya and Cattleya hybrid orchids

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ABSTRACT

The influence of gibberellic acid (GA\(_3\)) and water regime was evaluated in the flowering induction and quality of two orchid hybrids belonging to the genera Cattleya (C.) and Brassocattleya (Bc.). The experiment was carried out in the Biotechnology and Orchid Culture Sector of Shunji Nishimura Technology Foundation, Pompéia, São Paulo State, Brazil. Five GA\(_3\) concentrations (0, 125, 250, 500 and 1,000 mg L\(^{-1}\)) were tested through four consecutive leaf applications in adult plants that had already flowered at least once, besides two water conditions (one and four irrigations per week). Applications were performed in October and November for Bc. Marcella Koss and in January and February for C. Irene Holguin. Flowering could not be induced in the latter by gibberellic acid. In Bc. Marcella Koss, the application of 250 mg L\(^{-1}\) GA\(_3\), combined with decreased irrigation frequency induced flowering in around 83% plants. By using the same GA\(_3\) concentration but frequent irrigation, only 17% plants were induced to flower. The number and size of flowers increased after application of higher GA\(_3\) concentrations. This work allowed developing a commercial technique with the use of gibberellic acid (GA\(_3\)) to induce flowering in Bc. Marcella Koss hybrid orchid.

Keywords: Ornamental plants, flowering, quality, pulverization, plant growth regulator, water suppression.

RESUMO

Ácido giberélico e regime hídrico na indução do florescimento de orquídeas Brassocattleya e Cattleya híbridas

No presente trabalho foi avaliada a influência do ácido giberélico e do regime hídrico na indução e qualidade do florescimento de duas orquídeas híbridas dos gêneros Cattleya (C.) e Brassocattleya (Bc.). O experimento foi realizado no Setor de Biotecnologia e Orquidicultura da Fundação Shunji Nishimura de Tecnologia, Pompéia-SP. Foram testadas cinco concentrações de GA\(_3\) (0, 125, 250, 500 e 1,000 mg L\(^{-1}\)) em quatro aplicações consecutivas via pulverização foliar, em plantas adultas que já haviam florescido ao menos uma vez, além de duas condições hídricas (uma e quatro irrigações por semana). As aplicações foram feitas nos meses de outubro e novembro para Bc. Marcella Koss e janeiro e fevereiro para C. Irene Holguin. Não foi possível induzir a floração em Cattleya Irene Holguin com o uso de ácido giberélico. Para Bc. Marcella Koss, a aplicação de 250 mg L\(^{-1}\) de GA\(_3\), associado à diminuição na frequência de irrigação, induziu cerca de 83% das plantas ao florescimento. Na mesma concentração de GA\(_3\), porém em condições de irrigação frequente, apenas 17% das plantas foram induzidas a florescer. O número e o tamanho das flores aumentaram com a aplicação de concentrações maiores de GA\(_3\) utilizadas no experimento. A realização deste trabalho permitiu desenvolver uma técnica comercial com o uso de ácido giberélico (GA\(_3\)) para a indução do florescimento do híbrido de orquídea Bc. Marcella Koss.

Palavras-chave: Plantas ornamentais, floração, qualidade, pulverização, regulador vegetal, supressão de água.

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sprouts in the spring but does not flower before autumn. In this period, spathes become dry and all originated sprouts flower simultaneously. These flowering features are transmitted to descendant hybrids of crossbreeding involving such species. The second group can be photoperiodically manipulated and flowers twice a year.

Although the number of researches involving ornamental species has currently increased, most of them focus on the nutrition of species (Amaral et al., 2009) and cultivars (Ludwig et al., 2008; Villas Bôas et al., 2008), and few current studies have investigated plant growth regulators and their effect on flowering induction and quality.

Gibberellins are biochemically described as tetracyclic diterpene acids and are associated with flowering induction in several species. When exogenously applied, these plant growth regulators lead to petal growth and flowering induction in long-day plants under conditions of short days. The opposite can occur in some exceptions (Cid, 2000).

*Philodendron* cv. Black Cardinal plants were induced to flower under non-inductive conditions through application of gibberellic acid (GA$_3$) at 125, 250, 500 and 1,000 mg L$^{-1}$, increasing flowering percentage and inflorescence number per plant with increasing concentrations (Chen et al., 2003). In flower cultivation, other species have their flowering induced by GA$_3$ applied via pulverization, such as *Dieffenbachia* (Henny, 1980), *Zantedeschia* (Corr & Widmer, 1987) and *Anthurium* (Henny & Hamilton, 1992).

Chen et al. (1997) reported that flowering can be induced in *Phalaenopsis* cv. Leda with the application of GA$_3$ under conditions of high temperatures, non-inductive to flowering.

Several species are induced to flower after a period of drought or lower rainfall (Taiz & Zeiger, 2004). As examples, coffee (Drinnan & Menzel, 1995), citrus (Ribeiro et al., 2006) and orchids of the genus *Cattleya* (Cardoso & Israel, 2005) can be mentioned.

The aim of this work was to evaluate the effect of water regime and gibberellic acid at different concentrations on the induction and quality of off-season flowering in *Cattleya* and *Brassocattleya* orchids.

**MATERIAL AND METHODS**

The experiment was carried out in the nursery of Shunji Nishimura Technology Foundation, located in Pompéia municipality, São Paulo State, Brazil, along 12 months between 2005 and 2006.

As plant material, two hybrids originated from the cultivation of shoot tips were used. The first tested hybrid was *Cattleya* Irene Holguín, which flowers in August/September and presents intense pink flowers and pink/yellow labellum. Extensively used in orchid trade for flower production, this hybrid originates sprouts with spathes between October and February, which remain dormant during short days, and its flowering occurs once in this time gap. The second tested hybrid was *Brassocattleya* Marcella Koss, which flowers in May and June. This intergeneric hybrid between *Brassavola* and *Cattleya* has light pink flowers and pink/yellow labellum and produces new sprouts throughout the year, which may or may not present spathes. In the non-inductive season, even sprouts with spathes do not produce flowers, and the flower bud dies before starting the normal flowering season. Therefore, only sprouts originated from March and April can flower. All plants had mean age of 6 years and 8-10 pseudobulbs each.

Plants were grown in hothouses of plastic and protected with 70% shade. Fertilization was interspersed at every week, using 1 g L$^{-1}$ of N-P-K formulations, 15-15-20 and 20-10-10, complemented with S (4%), Ca (1.10%), Mg (0.40%), Fe (0.10%), Zn (0.07%), Mn (0.06%), B (0.05%), Cu (0.05%) and Mo (0.02%). The cultivation substrate consisted of tree fern fiber at 75% and *Pinus* bark numbers 2 to 25%. Tree fern fiber was employed since pots had already been used for cultivation during four years, when it was still the main substrate employed for many ornamental species, including orchids. For plant cultivation, black plastic pots n.15 were used.

Besides control, treatments consisted of four GA$_3$ concentrations (125, 250, 500 and 1,000 mg L$^{-1}$) sprayed on leaves four times, and two irrigation conditions, totaling ten treatments designed in randomized blocks and in 5x2 factorial arrangement. Three blocks containing two plants each were used, totaling six plants per treatment.

GA$_3$, presenting a minimum of 95% purity was diluted in 4 mL hydrated alcohol at 92.8°GL, and 0.1% Tween 20$^o$ (Ethoxylated Sorbitan Monolaurate (nonionic surfactant)) was added to this solution before completing it with water. Controls were treated with water plus Tween 20$^o$ 0.1%.

Pulverizations were performed in October and November 2005 for *Bc*. Marcella Koss and in January and February 2006 for *C*. Irene Holguín, between 7 and 8 a.m., when the relative humidity is higher, favoring the product uptake. For this procedure, a knapsack mistblower (20 L, Jacto$^o$) attached to an X$_C$, conical nozzle was used, separating control plants in order to prevent contamination with residues. Around 70 mL solution was sprayed per plant on both leaf surfaces and in young roots, with 7-day interval between applications.

As to water regime, two irrigation conditions were adopted. In the first regime, irrigation was done four times a week through microsprinklers, whereas in the second one, plants were subjected to decreased irrigation frequency; thus, they were kept for 15 days without irrigation, followed by irrigation only once a week, also through microsprinklers. In the latter case, GA$_3$ applications started soon after 15 days without irrigation.

The effects of plant growth regulator and irrigation frequency were investigated considering aspects of flower production, such as flowering rate (%), number of flowered plants relative to the total used in each treatment, number of inflorescences and flowers obtained in the respective treatments, number of flowers per plant and diameter of flowers and petals of flowered plants (cm) by using a millimeter rule. Plants that did not flower received the value 0.
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Marcella Koss plants

The results were subjected to analysis of variance (F test) and means compared according to Tukey’s test at 5% significance. The obtained flowering rates were subjected to regression analysis to evaluate the effect of GA$_3$ levels. All statistical analyses were done by using the software SAS, following the user’s guide SAS/STAT (1990).

**RESULTS AND DISCUSSION**

There was no flowering induction in *Cattleya* Irene Holguin plants subjected to GA$_3$ application under non-inductive conditions, although high concentrations were used (four consecutive pulverizations of 1,000 mg L$^{-1}$ GA$_3$). The change in water regime to a situation of lower water availability did not affect flowering in that hybrid, even when GA$_3$ was concomitantly sprayed. In addition, GA$_3$ did not prevent flowering during the normal season when applied in July at concentrations up to 1,000 mg L$^{-1}$. These results lead to the conclusion that GA$_3$ application combined or not with water availability did not influence *Cattleya* Irene Holguin flowering.

Taiz & Zeiger (2004) reported that gibberellins can replace the requirement of long days for flowering in several species, stimulating flowering in some plants, but not in others.

GA$_3$ application between October and November induced flowering in *Brassocattleya* Marcella Koss plants during October, November, December and January, making such process earlier. According to Taiz & Zeiger (2004), exogenous application of gibberellins can lead to floral evocation in few short-day species under non-inductive conditions and in plants requiring cold to flower.

Both GA$_3$ concentrations and water stress affected flowering rate in *Br. Marcella Koss* (Figure 1). Under more frequent irrigation, the highest flowering rate (33%) was obtained after four applications of 1,000 mg L$^{-1}$. Lower irrigation frequency combined with GA$_3$ applications increased flowering rate in that hybrid, especially when four applications of 250 mg L$^{-1}$ GA$_3$ were combined with the second water regime, inducing flowering in around 83% plants (Figure 1). No flowering was detected under GA$_3$ application at 500 mg L$^{-1}$. These results reveal the need of water deficit and gibberellic acid at suitable concentration to induce flowering in plants, due to the synergistic effect between the tested factors.

Such variations in flowering rate under different GA$_3$ concentrations may be related to the multifactorial control model of flowering, explaining the differences among results from experiments involving application of plant growth regulators (Davies, 1995; Coll et al., 2003). In several commercial species, flowering induction requires more than one exogenous factor acting together. In coffee (*Coffeea arabica* L.), low temperatures are needed to induce flower buds. However, when the photoperiod is longer than 13h, inflorescences do not develop even under low temperatures (Drinnan & Menzel, 1995). Yamanishi (1995) reported a larger number of inflorescences and flower buds in pomelo (*Citrus grandis*) plants under low temperatures and trunk strangulation. The increased number of inflorescences and flowers was preceded by an increase in C/N ratio of pomelo leaves.

Control plants of *Br. Marcella Koss* did not flower under frequent irrigation. GA$_3$ application increased the number of flowers per plant, which was one flower/plant after treatment with the highest concentration (1,000 mg L$^{-1}$). Less frequent irrigations combined with GA$_3$ applications increased that number to 1.67 flowers/plant when this regulator was sprayed at 250 mg L$^{-1}$. These results lead to the conclusion that both gibberellic acid and low water availability are extremely important for a high-quality flowering in such orchid.

*Philodendron* ‘Black Cardinal’ plants were also induced to flower under non-inductive conditions after application of GA$_3$ at 125, 250, 500 and 1,000 mg L$^{-1}$, with increased flowering percentage and number of inflorescences per plant according to higher GA$_3$ concentrations (Chen et al., 2003). Flower diameter increased with higher GA$_3$ concentrations (Table 1). The

**Figure 1.** Flowering rate in *Brassocattleya* Marcella Koss plants treated with 0, 125, 250, 500 and 1,000 mg L$^{-1}$ gibberellic acid (GA$_3$) and subjected to two water regimes (one and four irrigations a week) (taxas de florescimento de *Brassocattleya* ‘Marcela Koss’ tratadas com 0, 125, 250, 500 e 1.000 mg L$^{-1}$ de ácido giberélico (GA$_3$) e duas condições hídricas (uma e quatro irrigações por semana). Pompéia, FSNT, 2006.

*First water regime: No significance for regression; Second water regime: y=0.00000131x$^3$ – 0.00187x$^2$ + 0.6x + 18.84. R$^2$=0.54

**GA$_3$ concentrations (mg L$^{-1}$)**

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<tr>
<th>GA$_3$ concentrations (mg L$^{-1}$)</th>
<th>Flowering rate (%)</th>
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<td>0</td>
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<td>125</td>
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<td>500</td>
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<td>1000</td>
<td>80</td>
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**F=3.00** (1st water regime)  
**F=4.77** (2nd water regime)
largest diameter (12.5 cm) was detected after four applications of 1,000 mg L⁻¹ under low water availability, whereas under high availability this value was 9.17 cm. Petal diameter also increased with higher GA₃ concentrations, and the highest value was obtained at 1,000 mg L⁻¹. Visually, flowers did not lose quality, keeping harmony, petal and sepal organization and flowering uniformity. Low mean values estimated for flowers and petals, even under the best treatments, were due to the absence of flowering in some plants, to which the value 0 was attributed.

Pulverization of gibberellic acid (GA₃) combined with water stress can be used on commercial scale to induce flowering in some orchid hybrids. This occurs because such a product has high aggregated value and low application cost, around R$0.24/plant. In Brassocattleya Koss, four applications of 250 mg L⁻¹ GA₃ at 7-day intervals combined with lower irrigation frequency induced flowering under unfavorable conditions, allowing an efficient flowering control. Besides, gibberellic acid increased the number of flowers per plant without influencing flowering quality. Hybrids correlated to Brassocattleya Koss, such as Brassocattleya Pastoral and Brassocattleya Pink Debutante, commercially important in orchid culture, likely present the same physiological response to GA₃. However, these and other hybrids should be separately tested, considering their genetic and physiological characteristics.

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