

Full Length Research Paper

Effect of gibberellic acid on the quality of chrysanthemum (*Dendranthema grandiflora* L.) cv. Faroe

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The aim of the present work was to evaluate the quality of chrysanthemum cultivar Faroe, subjected to different gibberellic acid (GA₃) concentrations applied to the field. The treatments were composed of four doses of GA₃ (0, 15, 30 and 45 mg L⁻¹) applied at the beginning of the formation of bottom floral (28 days after transplanting of seedlings). According to the results, a single low concentration of GA₃ application did not interfere with the phenotypic characteristics of the chrysanthemum cultivar Faroe.

Key words: *Dendranthema grandiflora*, height, diameter, flowering.

INTRODUCTION

The use of plant growth regulators has been highlighted as a very common practice in agriculture. According to Tan and Marbach (2000), plant growth regulators are organic substances with important functions in regulating growth, and acting as inhibiting stimulants, depending on its concentration and other intrinsic characteristics of the plant. Among the groups with the possibility of hormone use is exogenous gibberellin (Taiz and Zeiger, 2004). Gibberellic acid (GA₃) has been used to increase the length or height of plants, increase the number of flowers and induce flowering (Medina and Saavedra, 1999; Taiz and Zeiger, 2004).

According to some works, it is possible to note the efficiency of application of GA₃ in the field of quality flowers. Sung and Chang (2000) observed in rhododendron (*Rhododendron pulchrum*) that the application of GA₃ was effective on the growth of buds and flowers per plant.

Blázquez et al. (2002) observed the early flowering by GA₃ application, especially in short-day plants of the genus *Arabidopsis*. The times of application and use of the concentration of 120 mg L⁻¹ gibberellic acid (GA₃) affected the stem diameter of chrysanthemum cultivar Yoko ono (Vieira et al., 2011). Bulbous plants, such as dahlia (Khan and Tewari, 2003), revealed an increase in height on the stems at different concentrations. In Anthurium (*Anthurium andreaeanum*), these applications were neither able to increase the height, nor stimulate flowering stage (Wang et al., 1999). Similar results were observed for Al-khassawneh et al. (2006) on growth and flowering of *Iris nigricans* Dinsm.

The results of the studies on the effectiveness of GA₃ on flowers are contradictory. Thus, the objective of this study was to evaluate the use of low concentrations of GA₃ applied to the field on the phenotypic characteristics of the stems of chrysanthemum cultivar Faroe.

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Abbreviations: GA₃, Gibberellic acid; ABA, abscisic acid.

MATERIALS AND METHODS

The experiment was conducted in plastic greenhouses in Cordeir-



Figure 1. Formation of floral bottom.

rópolis, São Paulo, Brazil (22° 28' 55" S, 47° 27' 24" W). Medium sized seedlings of chrysanthemum (*Dendranthema grandiflora* Tzvelev) cultivar Faroe were used and were characterized by dichotomous leaves with alternate disposition on the stem, and a globular inflorescence formed by small white petals, but not visible internal disk flowers. In the cultivation conditions of Cordeirópolis, plants were cultivated for 7½ weeks for flower induction.

The experimental design was randomized blocks, each containing four plots. Treatments were composed of four doses (0, 15, 30 and 45 mg L⁻¹) of GA₃ (Pro-Gibb® - 10%, Valent). GA₃ was applied at the beginning of flower bud formation (28 days after transplanting of seedlings). Plants (stems) were sprayed in the morning with 100 ml of each concentration for each treatment (Figure 1). Experiments were carried out on 40 plants for each treatment (cultivated at a density of 64 plants/m²) with four replicates, after which plants on the borders were discarded. In all the treatments, 30 ml/100 L⁻¹ of a non-ionic surfactant (Extravon®, Syngenta Agro S/A) was used to improve wetting, and spray distribution was added. The apparatus used for GA₃ application was a CO₂ backpack tank equipped with a sprayer nozzle-shaped fan.

The flowers were harvested at approximately 95% of ligules expanded (Figure 2). Immediately after harvest, the height and stem diameter were analyzed, and the flower diameter, ligule length, number of flowers and reaction time (induction of flowering) of the 12 stems were identified within each parcel of each treatment. To measure the height of the stem, we used a tape made in inches, and a caliper reading of stem diameter. The parameters, flower diameter and length of ligule, were measured by a ruler in centimetre, and the number of flowers and reaction time (induction of flowering) was measured by counting the days after transplanting of seedlings.

Analysis of variance was performed to detect differences between treatment means, which were separated by Tukey's test ($P < 0.05$) using SAS software.

RESULTS AND DISCUSSION

According to Table 1, no significant effect was

observed for the different concentrations of GA₃ on the phenotypic characteristics of stems of chrysanthemum cultivar Faroe. One factor that may not have contributed to stem height is the time of application. Since the plants were sprayed at a time not earlier than 28 days after transplanting of the seedlings, it did not differ between treatments after harvest (86 days), with an average height of 113.06 cm. According to Grzesil (1989), GA₃ application in order to stretch the stem may be more related to the time of application than the product concentration. Schmidt et al. (2003) observed in chrysanthemum cultivar Viking that when applications were made early, the effect on final height of the stems was even more pronounced with the use of lower concentrations.

Besides the time of application, the type of gibberellin can be more active in a plant than in another (Taiz and Zeiger, 2004), as well as the concentration used and the number of applications (Mielke, 2005). In Better rose, an application of GA₃ at concentrations of 10 to 100 mg L⁻¹ increased the stem height and weight of fresh cut flowers (Castro, 1998). In Hemerocallis hybrid 'Graziela Barroso', the results indicated that the optimal number of applications went up twice, differing statistically from all other applications (Ottmann, 2006). The balance between the hormones is a factor that can determine the effectiveness of a hormone alone or when grouped. Taiz and Zeiger (2004) assumed that the increase in plant height can be attributed to auxin because it can induce the synthesis of gibberellins and vice versa, and can also cause cell elongation. Tawar et al. (2003) noted an increase in the stem height of Gladiolus 'Jester', with applications of GA₃ (100, 150, 200 and 250 mg L⁻¹), indole-3-acetic acid (IAA, 100 and 250 mg L⁻¹) and N⁶ benzyl adenine



Figure 2. Harvest of chrysanthemum Faroe.

Table 1. Phenotypic characteristics of chrysanthemum Faroe in response to the applied gibberellic acid (GA_3) in the field; Cordeirópolis (SP), 2007.

GA_3 (mg L ⁻¹)	Fenometric parameter					
	Ah (cm)	Dh (cm)	Df (cm)	Cl (cm)	Nf	Cc (days)
0	112.57 ^a	0.5136 ^a	4.973 ^a	1.15 ^a	16.0 ^a	53 ^a
15	112.96 ^a	0.5138 ^a	4.962 ^a	1.15 ^a	16.0 ^a	53 ^a
30	113.25 ^a	0.5133 ^a	4.974 ^a	1.16 ^a	15.0 ^a	53 ^a
45	113.48 ^a	0.5171 ^a	4.973 ^a	1.15 ^a	16.0 ^a	53 ^a
Mean	113.06	0.514	4.973	1.15	15.75	53
CV%	4.86	6.43	5.06	4.71	5.89	-

Ah, stem height; Dh, stem diameter; Df, flower diameter; Cl, ligule length; Nf, number of flower; Cc, induction flower. Means followed by same column do not differ by Tukey's test (0.05%).

(BA, 50 and 100 mg L⁻¹), and found that this increase followed the concentration of the respective plant growth regulators. However, high concentrations may also cause an increase in height, which can compromise the product at the time of distribution (Khan and Tewari, 2003).

In this study, a comparison of the control with the other treatments showed no change in stem diameter, with an average of 0.514 cm; although, the study of Gulewska-Kulikowski et al. (2000) was conditioned upon the exogenous application of gibberellin beyond the structure, the site of action and the sensitivity of the target organ. This means that the role played by gibberellins in the control of phase change is complex, varying among species and involving interactions with other factors (Taiz and Zeiger, 2004). Schmidt et al.

(2003), working with chrysanthemum cultivar Viking in a concentration of 200 mg L⁻¹, reported that applications made for the fourth week after planting showed minor changes, while for applications made in the second week, there was no change in the diameter of the stem. Analyzing the diameter of the flower with a mean of 4.97 cm, this characteristic was not significantly influenced by concentrations of GA_3 . This response referred to the slow growth of chrysanthemum flower disk Faroe, since there were no differences in the length of ligules, averaging 1.15 cm.

However, Bellé et al. (2006) working with the chrysanthemum cultivar Gompier observed small differences in the reduction of flower diameter. According to the same author, this reduction was not higher, because some

concentrations of GA₃ were applied, at most, twice. This situation of minimal differences in flower diameter in response to GA₃ and control photoperiod was also observed by Mello (2003).

In the literature, we observed that GA₃ generally caused an increase in the number of flower buds or the number of flowers or inflorescences. Contrary to the results of this work, where the average value found in chrysanthemum cultivar Faroe was 15.75 buds per stem, there was no significant difference between treatments. In podophyllum *Syngonium Schott* 'White Butterfly' treated with GA₃ (0, 10, 20, 40 and 80 mg L⁻¹), the best average number of flowers per plant (2.4) occurred in the treatment with 80 mg L⁻¹, when compared to the control treatment (Henny et al., 1999). However, a lower value was found in *Hemerocallis hybrida* 'Graziela Barroso' in the third application of GA₃, which produced 2.93 buds per plant (Ottmann, 2006). In strawberry (*Fragaria x ananassa* Duch. cultivars Seascape, Laguna and Camarosa) subjected to three concentrations of GA₃ (0, 50 and 200 mg L⁻¹), the best result for the number of flower buds and open flowers was found in the concentration of 50 mg L⁻¹ GA₃ in cultivar Seascape (Paroussi et al., 2002). In gerbera (*Gerbera jamesonii*), there was an increase in the number of flowers per plant through the application of GA₃ at concentrations of 50 and 100 mg L⁻¹ (Nair et al., 2002).

Dendranthema Tzevelev grandiflora 'Viking' (cut chrysanthemum / short-day plant) under four application times (2, 4, 8 and 10 weeks after the experimental period in summer / autumn), and GA₃ (0, 100, 200 and 300 mg L⁻¹) showed no significant difference between the concentrations of GA₃ to the number of flowers (Schmidt et al., 2003). These controversial results corroborate the assertion quoted earlier that the effect of a growth-regulating substance depends on the concentration, number and timing of application; although, the stage of plant growth and species or the cultivar treated also depends on environmental factors (Pereira and Adams, 1996).

According to Rodrigues and Leite (2004), environmental conditions affect the biosynthesis of gibberellins, and their occurrence in long days usually increased production of gibberellins than in short days. Moreover, the difference between daytime and nighttime temperatures may influence the levels of endogenous gibberellin (Thingnaes et al., 2003).

The cut chrysanthemum Faroe precocity was not obtained in the different treatments (0, 15, 30 and 45 mg L⁻¹). Under the conditions of Cordeirópolis (SP), it was observed that the reaction time (induction to flowering) to harvest was 53 days (7.5 weeks) on average. These results suggest that the regulation of flowering may be associated with specific GAs, but they do not prove that GA is the hypothetical flowering hormone. In fact, a certain level of GA is probably required for flowering and initiation of flower stalks in some species, but other routes are also needed so that this event occurs (Taiz

and Zeiger, 2004). Several studies have confirmed the earliness of flowering by GA₃ application. In the cyclamen, Concerto Scarlet 'Caruso' ® at a concentration of 45 mg L⁻¹ was the one with the larger plant precocity (Mielke, 2005). The application of GA₃ also accelerated flowering in *x Limonium* 'Misty Blue' when compared to the control, giving a higher percentage between 8 and 12.6% as compared to untreated plants (Garner and Armitage, 1996). Kamuro et al. (2001) studied the effect of a single application of GA₃ and abscisic acid in various proportions in the flowering plants of spinach, a long-day plant (LDP) in non-inductive periods (shorter days), and the best results for flowering (70 to 100%) were found in the proportions of 1: 5 mg L⁻¹ and 5: 5 mg L⁻¹ ABA/GA₃.

A model that has been postulated in this study shows that the flowering process would be regulated by several molecules, including gibberellins, cytokinins, sucrose and polyamines (Bewley et al., 2000). Moreover, Bernier et al. (1993) assumed that the mineral nutrition and water stress may play a secondary role in floral induction.

Conclusions

The use of low concentrations of 0, 15, 30 and 45 mg L⁻¹ gibberellic acid (GA₃) in a single application had no interference with the phenotypic characteristics of the stems of chrysanthemum cultivar Faroe, demonstrating the low action of gibberellin applied in the field.

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