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Effect of Chlormequat and GA_3 on Growth and Flowering of Calla (*Zantedeschia rehmannii*)

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Abstract. Growth and flowering of calax (*Zantedeschia rehmannii*) were studied. Gibberellic acid (GA_3) was applied at 0, 250 or 500 ppm either as a preplanting treatment for rhizomes (15- min soak) or as a foliar spray and chlormequat (CCC) was applied at 0, 1000 or 3000 ppm either as a preplanting treatment for rhizomes (10-min soak) or as a soil drench when shoots were 2 to 3 cm long. GA_3 rhizome soaking significantly increased the number of flower produced. Chlomequat rhisome soaking or applied as a soil drench significantly limited plant height if not treated with GA_3. GA_3 and CCC sequentially treated interacted significantly reduced height and increased flowering. Treatment with GA_3 overcame the dwarfing effect of CCC, while CCC alone treatment limited flower production.

Production of malformed flowers was noticed on rhizomes treated with GA_3 with no malformed flowers on control plants. The preplant soaking of rhizomes in either GA_3 or CCC was more effective than the foliar spray or soil drench. Commercial producers of *Z. rehmannii* may wish to consider the use of GA_3 in combination with chlormequat to produce plants with an aesthetically pleasing shape and adequate flower production.

Introduction

The calla lily "*Zantedeschia* spp." is produced and marketed as a cut flower and a flowering pot plant for its attractive spathes, commonly refered to the flowers [1]. The recent availability of *Zantedeschia hybrids* with large flowers of various colors has made this plant a popular cut flower in New Zealand, Japan, Europe and the United States. Despite its popularity all over the world this plant was not introduced to Saudi Arabia thus did not evaluate under central region conditions (Riyadh area) in the Kingdom.

To be most effective as flowering pot plants, an increase in the number of flowers per plant is desirable. Gibberellic acid (GA_3) has been effective in promoting

flowering in several genera of the Araceae. *Aglaeonema* plants treated with spray application of GA_3 flowered, whereas control plants did not [2]. Maximal flower production from *Zantedeschia* was obtained by treatment with GA_3 [3] and [1].

Chlormequat (CCC) (2-chloroethyl-trimethylammonium chloride) was reported to reduce plant height, hasten flowering and increase the tendency to branching of several plants [4]. When *Zantedeschia* plants are grown as flowering pot plant, height control by application of a plant growth retardant may be necessary [1]. Paclobutrazol effectively control height, but ancymidol did not in the concentrations on calla plants [5].

The objectives of this study were to examine the effects and interactions of GA_3 and cycocel treatments on growth and flowering of *Zantedeschia*. The influence of presoaking of rhizomes and drench applications of either GA_3 or CCC was also compared with foliar spray applications.

Materials and Methods

The present work was carried out in the fiber glasshouse of the Agricultural Research Experimental Station at Dirab, College of Agriculture, King Saud University during November 1991 to July 1992. Five to 7 cm diameter *Zantedeschia rehmannii* tubers were obtained from Holland and stored dry at 5°C for 30 days. Tubers were planted on the 10th of November 1991 in 30 cm plastic pots containing soil mixture of 1 peat: 1 sand. The pots were placed in the greenhouse in the ornamental units in Dirab Station. Similar sets of the experiment were placed in a different location to represent second replicate in the Experimental Station under similar environmental conditions. The average of the two sets of experiments was recorded in the tables as one mean. The plants were regularly irrigated. Kristalon as a complete fertilizer (19N - 6P - 20k) was applied at the rate of 3 g/pot every two weeks.

The treatments were as follows:

Trt. 1 = control
Trt. 2 = 250 ppm GA_3 soaking rhizome for 15 min before planting
Trt. 3 = 250 ppm GA_3 leaf spray
Trt. 4 = 500 ppm GA_3 soaking rhizome for 15 min before planting
Trt. 5 = 500 ppm GA_3 leaf spray
Trt. 6 = 1000 ppm CCC soaking rhizome for 15 min before planting
Trt. 7 = 1000 ppm CCC soil drench after 10 days of planting
Trt. 8 = 3000 ppm CCC soaking rhizome for 15 min before planting
Trt. 9 = 3000 ppm CCC soil drench after 10 days of planting
Trt. 10 = 250 ppm GA_3 soaking rhizome for 15 min before planting + 1000 ppm CCC soil drench after 10 days of planting
Trt. 11 = 500 ppm GA_3 soaking rhizome for 15 min before planting + 3000 ppm CCC soil drench after 10 days of planting

Data collected

1. Plant height was measured from pot rim to the tallest leaf.
2. Leaf width was measured at the widest point and leaf length was measured from the base to the tip of the leaf blade.
3. The date of first flower (anthesis).
4. Number of shoots per rhizome.
5. Total number of flowers during the six months of the experiment duration.

Each treatment consisted of four replications with six plants each. Plants were arranged in a factorial randomized complete block design.

Results

1. GA_3 and CCC effects on plant height

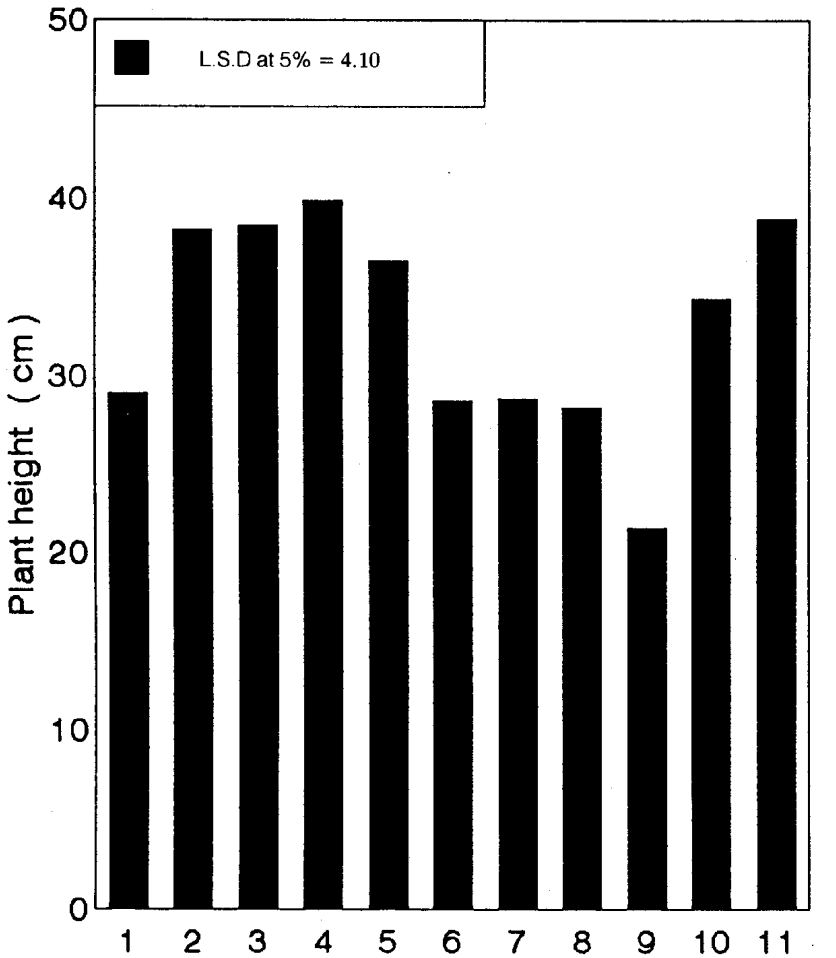
GA_3 treatments either as rhizome soaking or leaf spray significantly increased the height of Zantedeschia plants (Fig. 1). Both 250 and 500 ppm concentrations effectively stimulated plant growth. On the contrary, plant height was not affected by signly CCC treatments with one exception in which treatment of rhizomes with 3000 CCC inhibited the growth of Zantedeschia plants. GA_3 treatment sequentially applied with CCC significantly increased the plant height at both concentrations and overcame the limitation of plant height caused by CCC.

2. GA_3 and CCC effects on days to first flower

Preplant treatment of rhizomes with either 250 or 500 ppm GA_3 led to the promotion of flower initiation by 6 days earlier than the control plants (Fig. 2). On the contrary, all CCC singly treatments significantly delayed the initiation of the flowers by 5-7 days. However, treatments with 250 ppm GA_3 sequentially applied with 1000 ppm CCC also significantly delayed the flower initiation by 5 days.

3. GA_3 and CCC Effects on The Total Number of Flowers

Only preplanting soaking of rhizomes with either 250 or 500 ppm GA_3 resulted in significantly higher number of open flowers per plant (Fig. 3). Foliar spray of GA_3 on leaf surfaces was ineffective in increasing yield of flowers (Fig. 3). On the other hand, all singly applied CCC treatments either as soaking for rhizomes or foliar spray were effective in decreasing the flower production over the flowering season compared with the control. On the contrary, when GA_3 sequentially applied with CCC either as soaking or soil drench, the total number of flowers were significantly increased.



Trt. 1 = control
Trt. 2 = 250 ppm GA_3 soaking rhizome
Trt. 3 = 250 ppm GA_3 leaf spray
Trt. 4 = 500 ppm GA_3 soaking rhizome
Trt. 5 = 500 ppm GA_3 leaf spray
Trt. 6 = 1000 ppm CCC soaking rhizome
Trt. 7 = 1000 ppm CCC soil drench
Trt. 8 = 3000 ppm CCC soaking rhizome
Trt. 9 = 3000 ppm CCC soil drench
Trt. 10 = 250 ppm GA_3 (soaking) + 1000 ppm CCC (drench)
Trt. 11 = 500 ppm GA_3 (soaking) + 3000 ppm CCC (drench)

Fig. 1. Effect of GA_3 and chlormequat (CCC) treatments on plant height of *Zantedschia rehmannii*

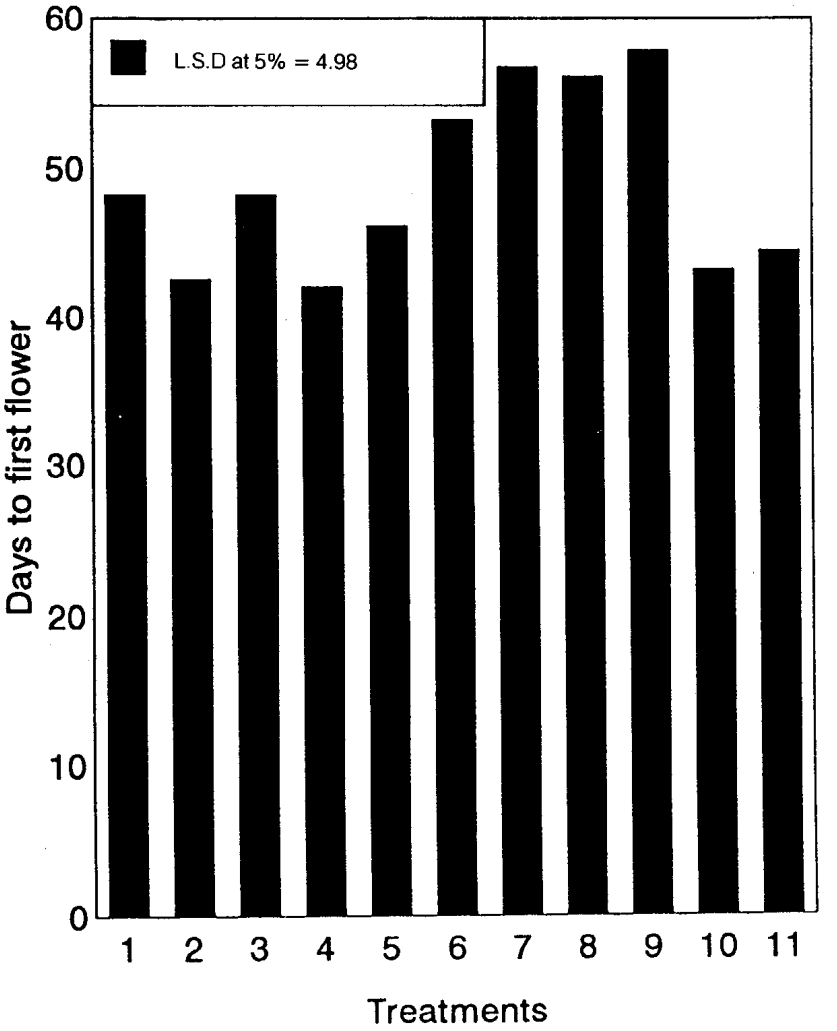


Fig. 2. Effect of GA_3 and chlormequat (CCC) treatments on days to first flower of *Zantedschia rehmannii*

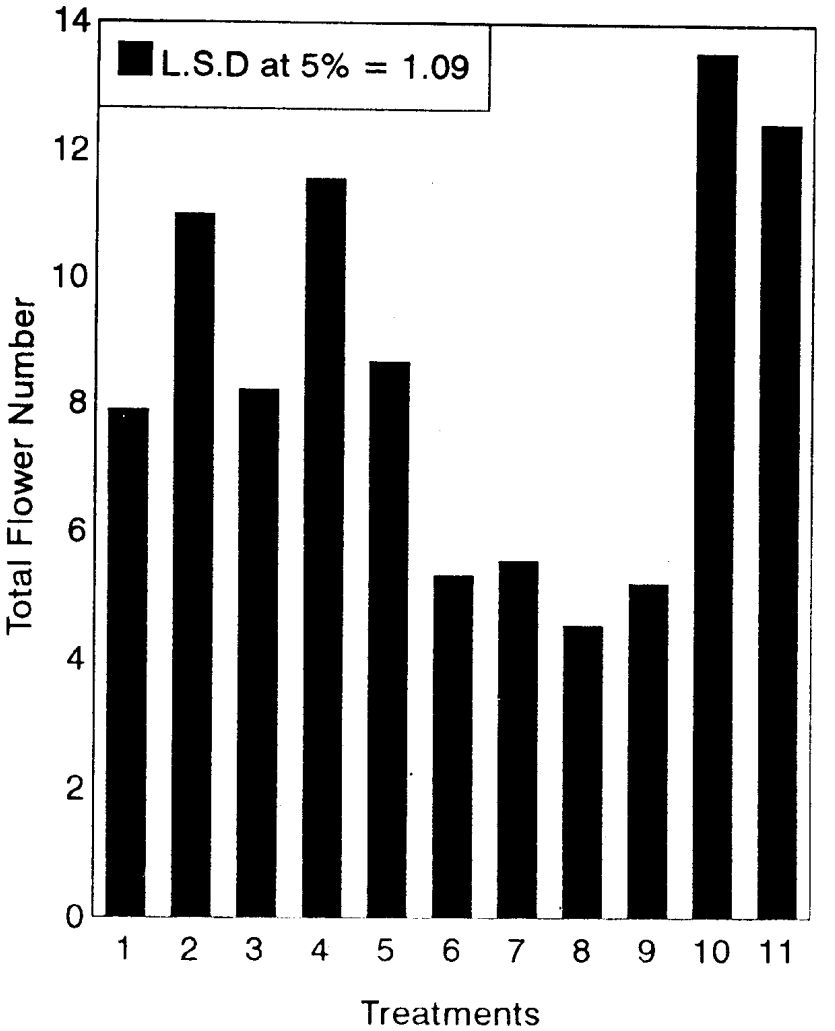


Fig. 3. Effect of GA_3 and chlormequat (CCC) treatments on total number of flowers of *Zantedschia rehmannii*

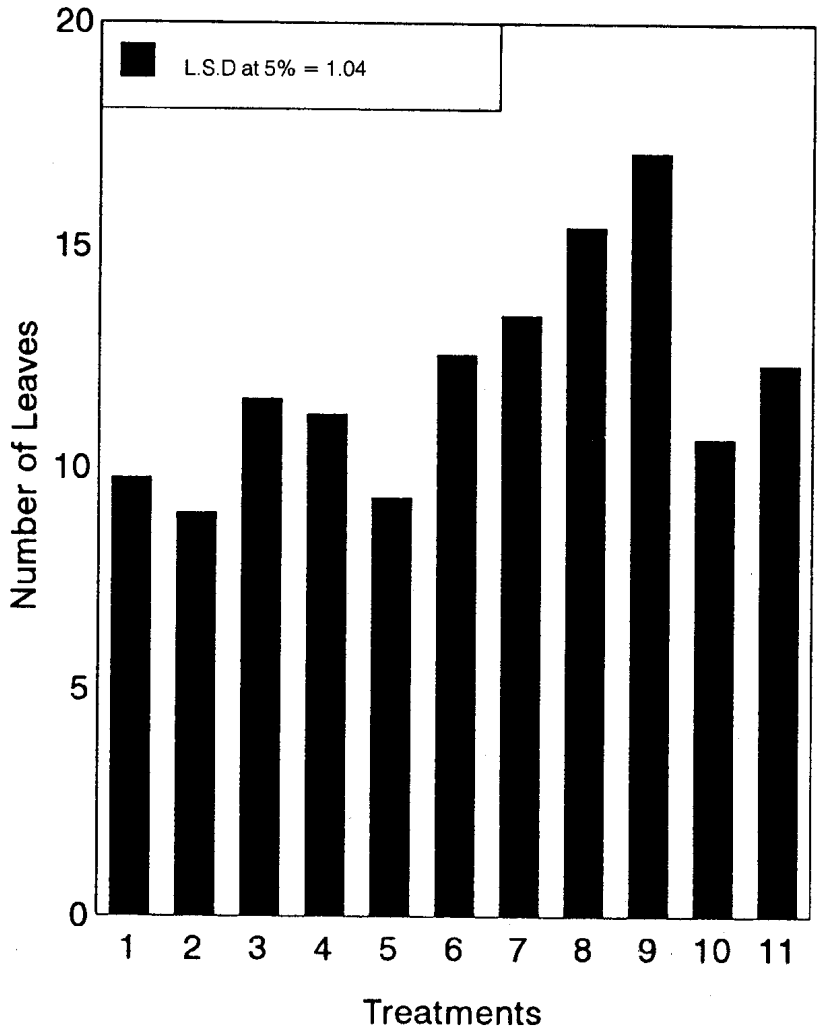


Fig. 4. Effect of GA_3 and chlormequat (CCC) treatments on number of leaves of *Zantedschia rehmannii*

4. GA_3 and CCC effects on the number of leaves

Most of GA_3 and CCC treatments increased the number of leaves per plant with few exceptions (Fig. 4). Preplanting soaking of rhizomes in 250 ppm GA_3 and leaf spray with 500 ppm GA_3 did not affect the number of leaves per plant. The highest number of leaves was obtained when the rhizomes were soaked in 3000 ppm CCC (17.11) compared with the control 9.78 leaves/plant).

5. GA_3 and CCC effects on the number of shoots

Gibberellic acid treatment either as pre-soaking of rhizomes or leaf spray at both concentrations did not affect the shoot numbers of *Zantedeschia* plants (Fig. 5). In contrast, CCC at 3000 ppm either as soil drench or foliar spray increased the shoot yield by about 50%. However, the same CCC concentration (3000 ppm) increased the number of shoots by about (33%) when sequentially applied with higher level of GA_3 (500 ppm).

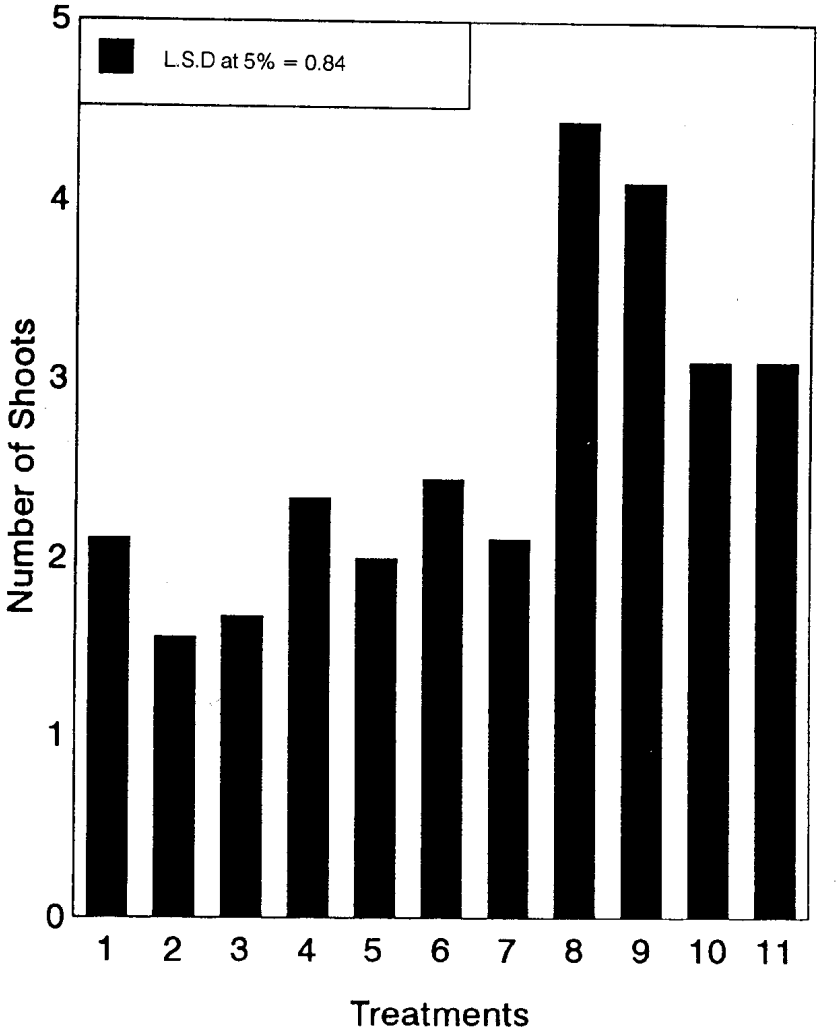


Fig. 5. Effect of GA_3 and chlormequat (CCC) treatments on number of shoots of *Zantedschia rehmannii*

6. GA_3 and CCC Effects on Flower Fresh Weight

It was noticed that, GA_3 in both concentrations applied either as presoaking of rhizomes or foliar spray led to malformed of quite few flowers. Despite that flower fresh weight of most tested plants was not significantly affected by various treatments with few exceptions (Fig. 6). Preplanting treatment of rhizomes with 500 ppm GA_3 resulted in significant (25%) decrease in flower fresh weight. Similarly, 1000 ppm

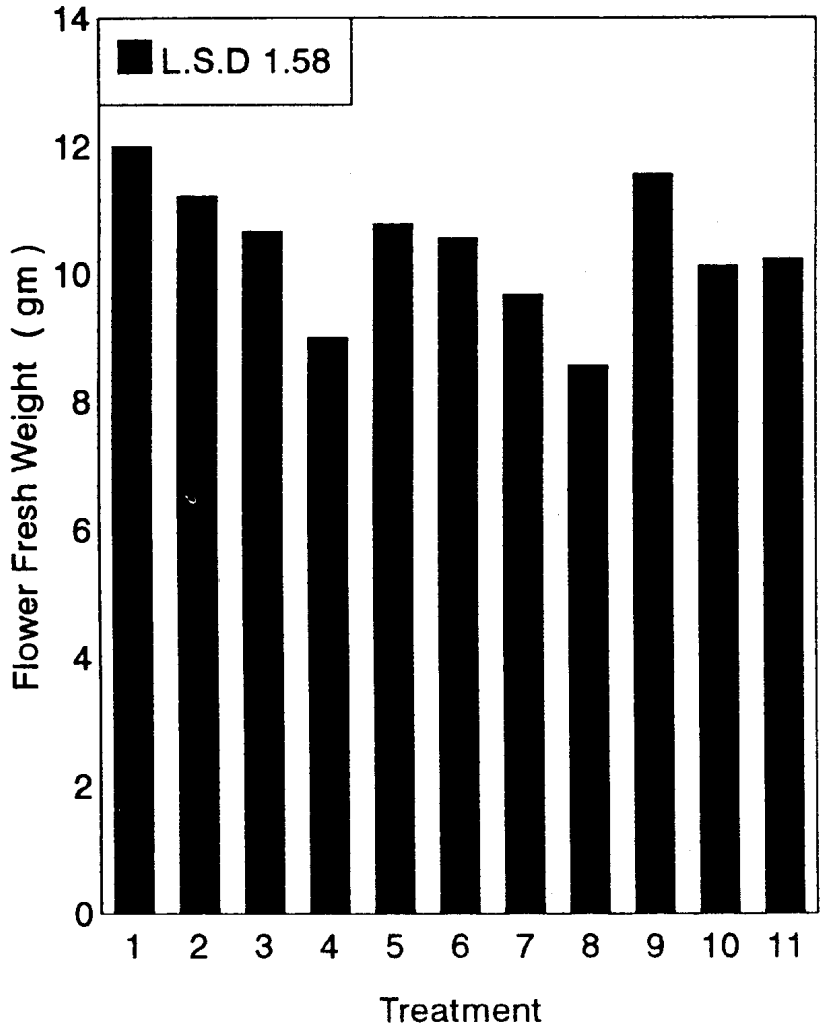


Fig. 6. Effect of GA_3 and chlormequat (CCC) treatments on flower fresh weight of *Zantedschia rehmannii*

CCC soaking of rhizomes gave about 20% decrease. Moreover, soil drench treatment of 3000 ppm CCC also decreased the flower fresh weight by about (25%) (Fig. 6).

Discussion

In this study Chlormequat (CCC) decreased plant height, delayed the flower initiations and significantly decreased flower yield. The maximum growth inhibition with respect to plant height and total number of leaves was achieved with 3000 ppm CCC as preplanting soaking of the rhizomes. However, the highest concentration (3000 ppm CCC) significantly reduced the fresh weight of the flowers. To our knowledge, no such reports were found in the literature concerning the effect of chlormequat on *Zantedeschia* plants. Ancymidol and paclobutrazol were effective as soil drenches for many plant species tested [6]. On the other hand, paclobutrazol did not affect flower form, color or size of *Zantedischia* plants [1] and [5], but time of anthesis was not affected by the application of ancymidol. In this study, preplanting treatments of rhizomes with either 250 or 500 ppm GA_3 led to increased flower production and enhanced flower initiation. GA_3 was effective in promoting flowering in Agloenema [2], Xanthosoma [7] and Caladium [8]. Similarly, in Dieffenbachia only GA_3 sprayed plants, flowered with increasing numbers of flowers per plant as GA_3 concentrations increased (250 to 1000 ppm) [9].

In this study, GA_3 preplanting soaking treatment increased the total flower number by increasing the number of flowers per shoot even though there was no increase or decrease in shoot number compared with the control. On the contrary, despite the increase in the number of shoots as a result of CCC treatment, the total flower number was decreased. GA_3 may cause an increase in the available substrate at the time of floral initiation promoting flower [3], which might explain its flowering promoting effects.

The results of this experiment are compatible with other data which show that the preplanting soaking of rhizomes in either GA_3 or CCC was more effective than the foliar spray [3]. The ineffectiveness of foliar spray may be due to poor penetration. Our results indicated that GA_3 applied either as presoaking for rhizomes or foliar spray led to malformed of flowers and this flower malformation was noted in both GA_3 concentrations. These results agree with previous work [5] and [1].

In this study, *Zantedeschia* plants produced significantly more flowers when treated with GA_3 while CCC treatment significantly limited the number of flowers produced. Chlormequat also interacted with GA_3 treatment, when sequentially applied. Commercial producers of *Zantedeschia rehmannii* may wish to consider the use of GA_3 in combination with CCC to produce plants with an aesthetically pleasing shape and adequate flower production.

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تأثير السيكوسيل (CCC) وحمض الجبريلك (GA_3) كمنظمات نمو على نمو وإزهار الكلا

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(قدم للنشر في ١٤١٣/١/٦هـ؛ وقُبل للنشر في ١٤١٤/٧/٢٩هـ)

ملخص البحث. تم دراسة تأثير المعاملة بحمض الجبريلك (GA_3) بتركيزات ٢٥٠ و٥٠٠ جزء في المليون سواء أضيفت كغمر للدرنات قبل الزراعة لمدة ١٥ دقيقة أو أضيفت كرش على المجموع الخضري. كذلك عوملت ريزومات *Zantedeschia rehmanii* بمحلول Chlormequat (CCC) بتركيزات ١٠٠٠ أو ٣٠٠٠ جزء في المليون سواء غمرًا للدرنات لمدة ١٠ دقائق أو حقنًا في التربة. المجموعة الثالثة من النباتات عوملت بخليط من ٢٥٠ جزء في المليون GA_3 + ١٠٠٠ جزء في المليون CCC بالتتابع. أما المجموعة الرابعة فقد عوملت بالتركيزات المرتفعة من الخليط السابق (٥٠٠ جزء/المليون GA_3 + ٣٠٠٠ جزء/المليون CCC) بالتتابع. وعمومًا أظهرت النتائج أن GA_3 قد سبب زيادة جوهرية في ارتفاع النبات وكمية الأزهار المنتجة وعلى العكس فإن CCC سبب نقص معنوي في انخفاض ارتفاع النبات وعدد الأزهار. وفي حالة خلط الاثنين معًا فإن GA_3 سبب فعل عكسي للتأير المثبط لمنظم النمو CCC وسبب ارتفاع معنوي وزيادة في النمو والأزهار بالمقارنة بالكنترول.

لوحظ بعض التشوهات في شكل الأزهار للنباتات المعاملة بمادة GA_3 كذلك لوحظ أن تأثير غمر الريزومات قبل الزراعة سواء في مادة GA_3 أو CCC أكبر من معاملة الرش بالتركيز نفسه على الأوراق. يمكن التوصية لمنتجي هذا المحصول الاقتصادي المهم بأن تتم معاملة الريزومات بالغمر قبل الزراعة بمخلوط من ٢٥٠ جزء/المليون GA_3 + ١٠٠٠ جزء/المليون CCC للحصول على أكبر إنتاج للأزهار مع مجموع خضري متكامل جذاب.