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Full Length Research Paper

Hydroponic culture of *Gladiolus tristis*: Application of paclobutrazol for flowering and height control

S. G. Milandri[1], C. P. Laubscher[1]* and P. A. Ndakidemi[2]

[1]Faculty of Applied Sciences, Cape Peninsula University of Technology, P.O. Box 652, Cape Town 8000, South Africa.
[2]Research and Technology Promotion, Cape Peninsula University of Technology, Cape Town 8000, South Africa.

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***Gladiolus tristis* (ever-flowering gladiolus) was tested for its potential as a flowering potted plant, using the growth retardant paclobutrazol. The treatments included a control, 2, 4, 8 and 16 mg active ingredient (a.i.) per pot and were applied when the longest leaves reached 15 cm. All treatments reduced perpendicular leaf height. Inflorescence heights were significantly affected by paclobutrazol. The flower spikes of plants treated with 2, 4 and 8 mg a.i. per pot were only marginally shorter than the control, while the height of plants treated with 16 mg was significantly reduced. All plants reached first-flower anthesis within a month from 22 weeks after planting. Flowering was staggered throughout the month, from the control through to plants treated with 16 mg a.i., with the control flowering from 166 days after planting, gradually increasing to 178 for 2 mg, 181 for 4 mg, 183 for 8 mg, and 186 for 16 mg a.i./pot. The average number of flowers produced per pot significantly dropped with increasing strength of a.i. applied. The control produced an average of three flowers while plants treated with 16 mg a.i produced less than one.**

Key words: Flower industry, flowering, growth retardant, leaf length, potted plants.

INTRODUCTION

Gladiolus is one of the world's leading floral crops and remains highly popular as their beautiful inflorescences are available in an array of colours (Katoch et al*.,* 2003; Aebig et al., 2005). No other plant of southern Africa has contributed more to the horticultural world than the genus *Gladiolus*, even though the potential of only a few species has been reached (Rycroft, 1972). *Gladiolus* is the largest genus of the family Iridaceae, comprised of some 255 species, which are found in Africa, Europe and the Middle East (Williams et al., 1986; Takatsu et al., 2001).

Gladiolus and other tall geophytes have traditionally been used for cut-flower production or garden subjects (Caixeta-Filho et al., 2000), but the research of Barzilay et al. (1992) indicates that the use of the growth retardant paclobutrazol, enables the production of potted *Gladiolus*. Successful reduction of a plant's height through the use of growth retardants, will determine whether a particular species can be produced as a potted plant (Menhenett, 1984), with such plants having the added benefit of being enjoyed as they grow.

It is important that when using growth retardants to produce flowering potted plants, leaf and inflorescence height should be reduced, without plant shape or flower size being influenced (Al-Khassawneh et al., 2006). Wainwright and Bithell (1986) found paclobutrazol to be more versatile than many other growth retardants as it can be applied by spraying, drenching or combining with the growing medium.

In South Africa and other parts of the world, there is a continued demand for new and interesting flowering potted plants (Barzilay et al., 1992) over and above conventional genera such as *Dianthus*, *Rosa* and *Chrysanthemum* (Gonzalez et al., 1998). The vast diversity of flora in South Africa has been largely overlooked by the public due to some facet of the species morphology that makes it commercially unviable. Examples of this can be seen in other irids such as the genus *Watsonia*, which with its long flower spike and sword-like leaves is unsuit-

*Corresponding author. E-mail: laubscherc@cput.ac.za. Tel: +2721-460-3198. Fax: +2721-460-3193.

Abbreviations: a.i. = Active ingredient; paclobutrazol = (±)-(R*,R*)-β-[(4-chlorophenyl)methyl]-α-(1,1-dimethyl)-1H-1,2,4-triazole-1-ethanol.

able for container production, unless dwarfed (Thompson et al., 2005). *Gladiolus tristis* (Family: Iridaceae) is a South African geophyte found in the winter rainfall area of the Western Cape (Delpierre and Du Plessis, 1974). It has several advantages over the typical *Gladiolus* hybrids in that it emits a fragrant perfume, flowers in early spring (Gonzalez et al., 1998) and produces up to ten beautiful yellow, star-shaped flowers (Delpierre and Du Plessis, 1974).

From visual observation, the natural growth habit of *G. tristis* seems too spindly for pot plant production, yet the application of paclobutrazol may induce economically viable results. Research into growth retardants like paclobutrazol could prove useful to the horticultural industry by enabling the production of previously unavailable and/or unusual species such as *G. tristis*. Apart from the experiments of Barzilay et al. (1992) we are unaware of other research concerning the effect of growth retardants in the production dwarfed *Gladiolus* potted plants.

Testing *G. tristis* with different concentrations of paclobutrazol will show which treatment produces desirable results without altering flower numbers and effectively reducing leaf and flower height. The aim of this study was therefore to determine whether *G. tristis* responded favourably to different concentrations of the growth retardant paclobutrazol and to assess its efficacy in pot-plant production.

MATERIALS AND METHOD

Experimental

The experiment was conducted in an environmentally controlled greenhouse, at the nursery of the Cape Peninsula University of Technology in Cape Town, South Africa. The experiment started at the end of March and continued for 26 weeks. Dormant corms (spring flowering species), averaging 1.3 cm in diameter, were individually planted into 9.5 cm pots (upper diameter) containing perlite. Each corm was planted to the average height of the rootstock (±1.5 cm). Five plastic trays (53 x 43 cm), each functioning as different treatments, were set up on a galvanized, steel table (2 x 0.85 m). A capillary mat composed of foam rubber (1.5 cm thick) and covered by a layer of under-felt were cut to fit into the base of each tray. An under-felt wick (5 x 60 cm) was placed below the layer of under-felt and into a raised container (49 x 36 x 19 cm) containing the nutrient solution. The nutrient solution was comprised of dH_2O and CHEMICULT® [Chemicult Products (pty) ltd, 133 Camps Bay, South Africa, 8040] (2 g/L). Each tray, containing ten pots, was supplied with dH_2O water, and the pH was maintained at 5.8. Every pot functioned as an experimental unit and was placed randomly within one of the five trays. The greenhouse is fitted with Alunet (40% shade screen), where temperature and humidity were monitored on a weekly basis. Midday temperatures fluctuated between 16 - 20°C and relative humidity between 39 - 86%.

Medium drench and concentration

Dormant *G. tristis* corms were planted untreated on the 9th March 2007. Paclobutrazol (CULTAR®) (Syngenta Ltd. 22 Daniel Str. Brackenfell. South Africa) was applied as a single, post-emergent medium-drench when the longest leaf had reached 15 cm in length (5 - 6 weeks after planting). Pots were drenched with 2, 4, 8 or 16 mg paclobutrazol, applied in 50 ml of dH_2O. The control remained untreated.

Data collection

Perpendicular inflorescence and leaf heights (medium level to tip), and flower number were recorded on a weekly basis, at midday. Leaf height was measured from emergence while the measurement of inflorescence height and flower number started from 21 weeks.

Statistical analysis

Mean values of the perpendicular inflorescence and leaf heights, days to flowering and flower number were analysed using 1-way analysis of variance (ANOVA). These computations were done with the software program STATISTICA. The Fisher least significance difference (L.S.D.) was used to compare treatment means at $P \leq 0.05$ level of significance (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The medium-drench treatments of 2, 4, 8 or 16 mg a.i. per pot significantly ($P \leq 0.05$) reduced perpendicular leaf height with the increasing strength of a.i. applied (Figure 1). The leaves of all plants except those treated with 16 mg gradually caught up to the control as the a.i. lost effect. During the 19th week (73% through the test), the longest leaves of plants treated with 2. and 4 mg a.i. extended beyond the control, ending of the test (26 weeks in total) at 101% and 104% longer than the control respectively. This is likely due to the fact that paclobutrazol with its half-life of between 3 and 12 months (Adriansen and Odgaard, 1997) gradually lost effect which saw plants treated with 2 and 4 mg a.i. counteracting the retardation and outgrowing the control. Growth of the longest leaf ended at first flower anthesis. Within the last two weeks, the longest leaves of the control and plants treated with 2 and 4 mg a.i. started reducing in length, while plants treated with 8 and 16 mg a.i. continued growing. This was likely due to recession of growth 1 - 3 weeks after flowering. The longest leaves of plants treated with 8 mg a.i. exceeded the control in the last week, while those treated with 16 mg a.i. were shorter than the control (Figure 1).

Inflorescence heights were affected by paclobutrazol (Figure 2). The flower spikes of plants treated with 2, 4 and 8 mg a.i. per pot were marginally shorter than the control, while the height of plants treated with 16 mg were significantly ($P \leq 0.05$) reduced (Figure 2). Plants treated with 2, 4 and 8 mg grew to 86%, 91% and 92% of the control respectively, while 16 mg a.i. only reached 69% of the control. In a similar study involving paclobutrazol, Thompson et al. (2005) also reported that drench applications of paclobutrazol had a dwarfing effect on inflorescence height in plants treated with different concentrations of the a.i.

The control and all treatments reached first-flower anth-

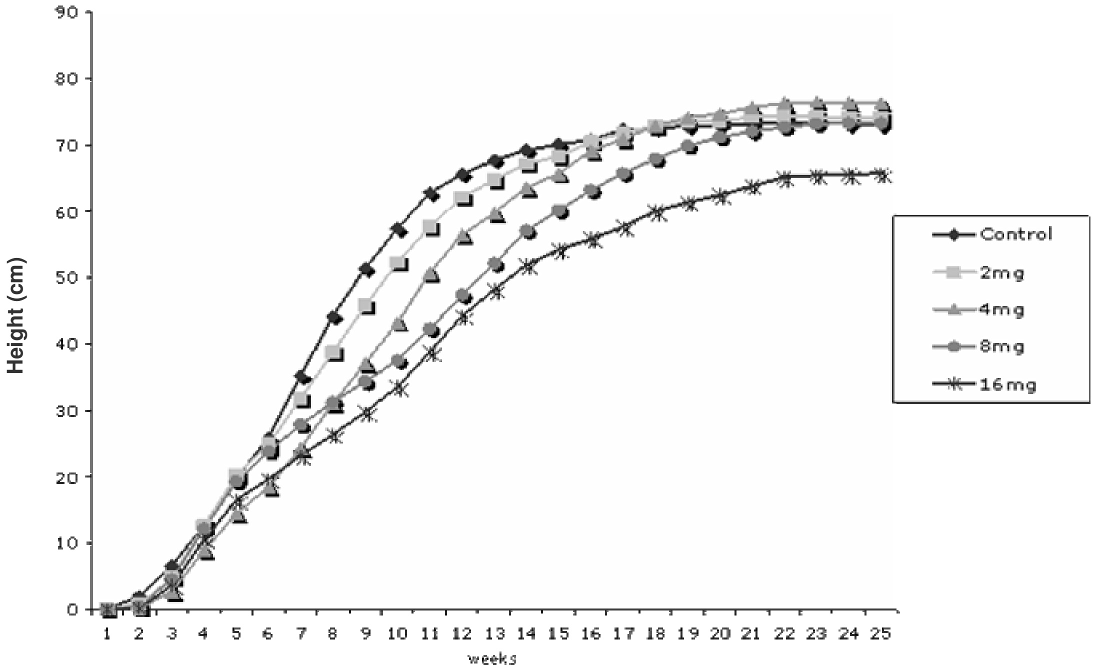

Figure 1. Effects of paclobutrazol supply on leaf height of *Gladiolus tristis* throughout the experimental period.

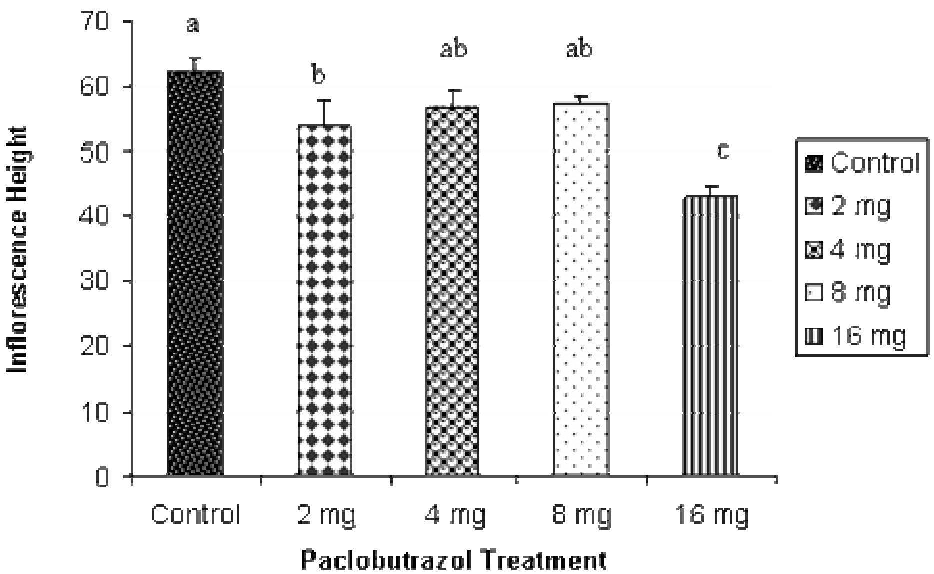

Figure 2. Effects of paclobutrazol supply on inflorescence height of *Gladiolus tristis*. Mean values within each bar followed by different letter differ significantly at $P \leq 0.05$ according to Fishers least significance difference.

esis within a month from 22 weeks after planting (Figure 3). Flowering was staggered throughout the month, from the control through to plants treated with 16 mg a.i. The control flowered from 166 days after planting, gradually incresing to 178 for 2 mg, 181 for 4 mg, 183 for 8 mg, and 186 for 16 mg a.i./pot. Kristensen and Adriansen, (1988) also found flowering was delayed in plants treated with strong applications of paclobutrazol. Delaying the time of first flower anthesis is beneficial to the producers of potted plants, as it extends the length of the flowering period. This essentially means that the plants will offer increased consumer satisfaction by lasting longer. In ad-

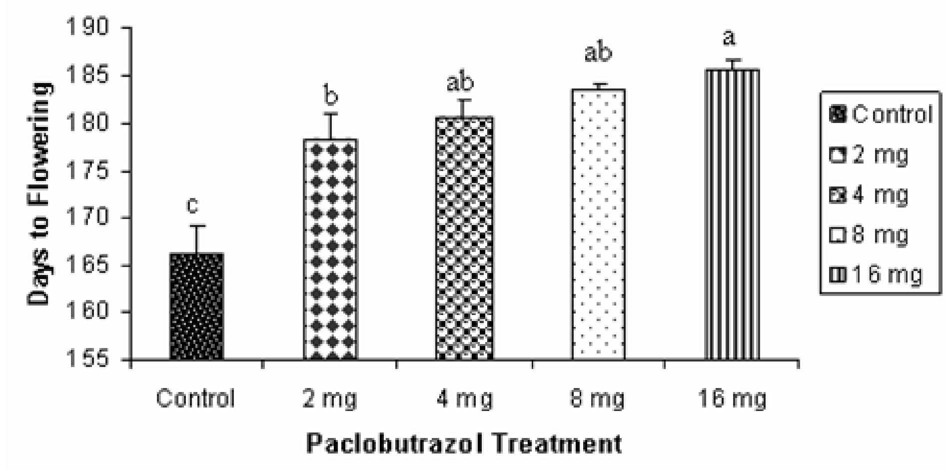

Figure 3. Effects of paclobutrazol supply on days to flowering of *Gladiolus tristis*. Mean values within each bar followed by different letter differ significantly at $P \leq 0.05$ according to Fishers least significance difference.

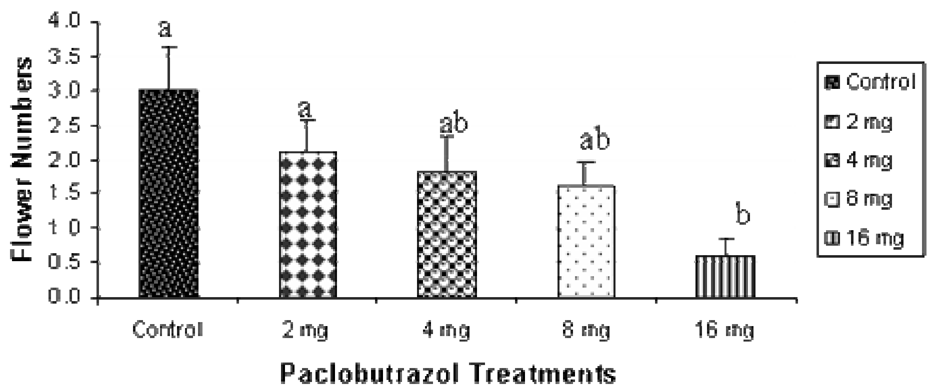

Figure 4. Effects of paclobutrazol supply on flower numbers of *Gladiolus tristis*. Mean values within each bar followed by different letter differ significantly at $P \leq 0.05$ according to Fishers least significance difference.

dition to this growers can adjust the time of flowering to accurately meet consumer demands.

Unlike the findings of Delpierre and Du Plessis (1974), *G. tristis* produced a maximum of not ten but five flowers, which is likely due to genotypic variation. Thus further testing on the commercialisation of *G. tristis* should be conducted on plants with a higher number of flowers. Barzilay et al. (1992) reported on the connection between reduced flower numbers and leaf length of chemically dwarfed *Gladioli*. A similar result was observed in our study when *G. tristis* was treated with 2, 4, 8 and 16 mg a.i./pot. The average number of flowers produced per pot gradually dropped with increasing strength of a.i. applied (Figure 4). The control produced an average of 3 flowers while plants treated with 16 mg a.i produced less than one.

Paclobutrazol is used in crops such as strawberries (Nishizawa, 1993) and cereals (Khalil and Hidayat-ur-Rahman, 1995) to influence flowering and reduce lodging. Further testing of paclobutrazol may lead to improved flower quality in potted plants, which could lead to higher marketability.

An experiment on *Carnations'* response to growth retardants (Banon et al., 2002), found that drench treatments were effective in reducing inflorescence height whereas Al-Khassawneh et al. (2006) found that its applications caused flowering delay. Therefore, determining the most effective application rate would thus be advisable to save money and produce the best results.

Quality standards of the flower markets are largely defined by the final customer who are insistent on quality with regards to price, appearance, inflorescence length and flower colour (Caixeta-Filho et al., 2000). Higher prices are paid for *Gladioli* with superior inflorescences (McKay et al., 1981). In our study, the visual qualities of *G. tristis* generally improved as the concentration of paclobutrazol increased, as leaves gradually became sturdier and greener.

Conclusion

In conclusion, investigation into the chemical induction of *G. tristis* for potted plants has produced interesting results, suggesting that these, and possibly other commercially undiscovered geophytes, have a future in the horticultural world. A single drench application of paclobutrozol on *G. tristis* was insufficient in producing marketable dwarf plants, and thus the combined use of a vacuum and drench treatment (Barzilay et al., 1992) may indeed produce commercially viable results.

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