distribution was obtained by shaking 3 replicate samples on a Tyler Portable Sieve Shaker (W.S. Tyler Inc., 8200 Tyler Blvd. Mentor, Ohio) for 20 min. The medium was amended with the equivalent of 4.2 kg·m$^{-3}$ of dolomitic limestone, and 93 g of medium were placed in 28 plastic bags. Seven replicate bags of medium were amended with 0, 33, 200, or 1200 g Al·m$^{-3}$ from aluminum acetate (13.2% Al), and radioactive superphosphate [8.7% P, 300 μCi·g$^{-1}$P (1 Ci = 37 GBq)] was added to each bag at a rate equivalent to 270 g P·m$^{-3}$. Each bag was hand shaken for 1 min after addition of aluminum acetate and superphosphate, 19 g of deionized water were added, and each bag was again shaken for 1 min. Bags of media were incubated at 25°C in a Precision Incubator Model 818 (SGA/Precision Scientific Group, Chicago, IL 60647). Deionized water was added to each medium about every 2 days during incubation to maintain 11% volumetric moisture (20% gravimetric).

After 30 days, medium in each bag was placed in a polyvinyl chloride column (4 × 15 cm) described previously (9). Columns, supported by a metal frame in the laboratory (21° to 26°C), were arranged in a completely randomized design. Each column was leached the first day with 48 ml of deionized water (pH 5.5) in 3 hr. Thereafter, each column received 16 ml in 1 hr, daily, until termination of the experiment on day 77. For 21 consecutive days and every 4th day thereafter, leachate volume was recorded; pH determined using a Corning Model 12 pH meter (Corning Glass Works, Medfield, MA 02052); and an aliquot placed in a scintillation vial containing 10 ml of Scintiverse II (Fisher Scientific Co., 711 Forbes Ave., Pittsburgh, PA 15219). Radioactivity in each sample was determined by liquid scintillation spectrophotometry techniques (8). Corrections were made for background and decay. Quantity of $^{32}$P leached from each column for 21 consecutive days was calculated as a percentage of $^{32}$P initially placed in each column and analyzed after arcsin transformations. Leachate $^{32}$P concentrations were calculated from radioactivity of the leachate. Leachate concentrations were regressed with time (1) and slopes compared by a modified *t* test (2).

The percentage of $^{32}$P amendment leached on day 1 and during days 1–21 decreased with increasing Al amendment rates (Table 1). Reduction in $^{32}$P leached on day 1 was not directly related to leachate volume, which averaged between 17 and 24 ml on day 1 and 231 and 242 ml for days 1–21.

Leachate pH on day 1 and days 1–21 averaged 4.6, 4.7, 5.7, and 6.6; and 5.5, 5.5, 5.9, and 7.3 for 0, 33, 200, and 1200 g Al·m$^{-3}$, respectively. However, it is doubtful the reduction in $^{32}$P leached was a result of hydrogen ion concentration, since, in previous experimentation (9), more $^{32}$P leached with higher pH. Also, acid soils usually have increased anion adsorption (7).

Leaching rate of $^{32}$P on days 1, 7, 14, and 21 decreased with each Al amendment rate (Fig. 1). Leaching rate was greater on days 61, 69, and 77 for the unamended medium than for medium amended with 200 g Al·m$^{-3}$, indicating the Al amendment may have resulted in a stronger P retention than indigenous medium components. However, the μg $^{32}$P per ml of leachate were greater [as determined by HSD (1% level), data not shown] on days 20 through 77 for the 200 g·m$^{-3}$ amendment than for the unamended medium.

These data indicate that $^{32}$P leaching was reduced with aluminum acetate. After 21 days of leaching, 80% of the $^{32}$P amendment leached from the medium not amended with aluminum; whereas only 0.3% leached when amended with Al at 1200 g·m$^{-3}$. Leachate $^{32}$P levels ranged from 840, 711, 91, and 2.0 μg·ml$^{-1}$ on day 1 to 2.3, 3.3, 7.6, and 0.9 μg·ml$^{-1}$ on day 77 for Al amendments of 0, 33, 200, and 1200 g·m$^{-3}$, respectively.

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# Growth Retardants as an Aid to Adapting Freesia to Pot Culture


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***Abstract.*** **Freesia (*Freesia hybrida* Bailey) corms were treated with paclobutrazol or ancymidol as a 5 mg a.i. soil drench, or with paclobutrazol as a 250 ppm preplant corm soak treatment. Both growth retardants significantly reduced plant height and inflorescence length, but had no effect on number of flowering spikes per pot or number of days to flowering. The preplant corm soak treatment was even more effective for height control than the soil drench application. Both compounds can be used to reduce plant height, allowing the adaptation of freesia to pot plant culture. Chemical names used: β-[(4-chlorophenyl)methyl]-α-(1,1-dimethylethyl)-1*H*-1,2,4 triazole-l-ethanol (paclobutrazol) and α-cyclopropyl-α-(4-methoxyphenyl)-5-pyrimidi nemethanol (ancymidol).**


Freesia is grown extensively in Europe and Japan as a cut flower crop. Freesia corms produce a vividly colored and fragrant inflorescence 30–50 cm long in 4 to 5 months in the greenhouse. The plants require cool temperatures (10° to 15°C) for both growth and floral initiation (2) and could therefore become an important winter greenhouse crop in the United States for either cut flower production or pot plant production.

Adaptation to pot plant culture has been limited because the leaves and long flowering spikes require staking or wire-frame supports to maintain an upright growth habit (1). Growth retardants, however, have been used to prevent excessive stem growth in Easter lily (4) and tulip (3) when these crops are produced as potted plants. This report describes our results using ancymidol and paclobutrazol as a soil drench or as a preplant corm treatment for height control of freesia.

Nondormant freesia corms were obtained commercially. Five corms were potted in 15.2 cm pots in a mix of sphagnum peat (50%) and vermiculite (50%) (v/v). The media con-


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Table 1. The effect of 5 mg a.i. ancymidol and paclobutrazol applied as a soil drench on plant height, inflorescence number, inflorescence length, and days to flowering of 5 cultivars of *Freesia hybrida*.

| Cultivar | Treatment | Plant ht (cm) | Inflores-cence no. | Inflores-cence lenght (cm)[z] | Days to flowering |
|---|---|---|---|---|---|
| Oberon | Control | 63.2 a[y] | 6.6 a | 47.5 a | 96.0 a |
| | Ancymidol | 27.6 cd | 5.5 ab | 8.4 c | 110.6 a |
| | Paclobutrazol | 25.6 cd | 5.4 ab | 3.4 c | 107.2 a |
| Ballerina | Control | 56.0 a | 5.8 ab | 42.7 a | 93.0 a |
| | Ancymidol | 36.6 bc | 5.2 ab | 9.8 c | 94.1 a |
| | Paclobutrazol | 30.2 c | 5.0 ab | 4.6 c | 92.6 a |
| Melanie | Control | 44.8 b | 6.2 a | 34.2 b | 107.6 a |
| | Ancymidol | 20.6 cde | 6.0 a | 5.9 c | 117.0 a |
| | Paclobutrazol | 17.5 de | 5.0 ab | 2.9 c | 117.4 a |
| Washington | Control | 37.2 bc | 6.6 a | 36.1 ab | 91.6 a |
| | Ancymidol | 18.6 de | 5.0 ab | 6.4 c | 101.8 a |
| | Paclobutrazol | 20.7 cde | 5.3 ab | 3.8 c | 100.5 a |
| Rosalinda | Control | 37.0 bc | 3.6 ab | 30.7 b | 100.5 a |
| | Ancymidol | 12.0 e | 2.8 ab | 4.6 c | 110.2 a |
| | Paclobutrazol | 14.8 de | 2.0 b | 3.5 c | 108.8 a |
| *Significance* | | | | | |
| Main effects | | | | | |
| Variety | | * | * | * | NS |
| Treatment | | * | NS | * | NS |
| Interactions | | * | NS | * | NS |
| Variety × treatment | | | | | |

[z]Measured to basal flower on inflorescence.
[y]Means in each column separated by HSD, $P = 0.05$ (N = 25).
[NS], *Nonsignificant or significant at ($P = 0.05$).

Table 2. The effect of a preplant corm treatment of paclobutrazol on plant height and inflorescence length of 5 cultivars of *Freesia hybrida*[z].

| Cultivar | Treatment | Plant ht (cm) | Plant ht (% control) | Inflor-escence length (cm)[y] | Inflor-escence length (% control) |
|---|---|---|---|---|---|
| Oberon | Control | 63.2 a | 21 | 47.5 a | 5 |
| | Paclobutrazol | 13.4 c | | 2.4 b | |
| Ballerina | Control | 56.0 a | 36 | 42.7 a | 8 |
| | Paclobutrazol | 20.4 c | | 3.4 b | |
| Malanie | Control | 44.8 b | 25 | 34.2 a | 7 |
| | Paclobutrazol | 11.0 c | | 2.0 b | |
| Washington | Control | 37.2 b | 48 | 36.1 a | 9 |
| | Paclobutrazol | 17.8 c | | 3.2 b | |
| Rosalinda | Control | 37.0 b | 32 | 30.7 a | 10 |
| | Paclobutrazol | 12.0 c | | 3.0 b | |
| *Significance* (F-test) | | | | | |
| Main effects | | | | | |
| Variety | | * | | * | |
| treatment | | * | | * | |
| Interactions | | | | | |
| Variety × treatment | | * | | * | |

[z]Means in each column separated by HSD $P = 0.05$ (N = 25).
[y]Measured to basal flower on inflorescence.
*Significant at $P = 0.05$.

tained 4 kg of dolomitic lime, 1 kg (ON–8.7P–OK), 1.2 kg (5K–4.4P–4.2K), 0.03 kg of fritted trace elements, and 0.07 kg surfactant (granular). Upon emergence, plants were fertilized with 100 mg·liter$^{-1}$ (15N–6.6P–12.5K) on a constant basis as irrigation was required. Plants were grown on a single greenhouse bench at 10° to 15°C night temperature, 20° to 22° day temperature, during the course of the experiment. A Banrot (etridiazol 15%, thiophanate methyl 25%) fungicidal treatment was given at planting. Three weeks after planting, when shoots were 3 to 4 cm long, paclobutrazol and ancymidol were applied as a soil drench (5 mg a.i. in 100 ml/pot). Alternatively, corms were treated prior to planting by immersion in paclobutrazol (250 ppm, 4 hr). There were 5 replicates of each treatment for which plant height, inflorescence number, inflorescence length, and days to flowering were recorded. Data were analyzed by analysis of variance and means separated by HSD.

When applied as a soil drench, both ancymidol and paclobutrazol significantly reduced plant height in all cultivars tested (Table 1). The degree of height reduction ranged from 35% on 'Ballerina' to 68% on 'Rosalinda,' clearly indicating that varieties differ in their sensitivity to growth retardant treatment. All treated plants had an upright growth habit, and the degree of height reduction, with the exception of 'Ballerina,' was probably greater than needed for commerical purposes. Lower application rates should be tested for both ancymidol and paclobutrazol.

Inflorescence length was reduced in all varieties to an even greater extent than overall plant height, with a range from 77% on 'Ballerina' with ancymidol to 93% on 'Oberon' with paclobutrazol (Table 1). There were no significant effects, however, on the number of flowering spikes produced per pot or on the time of flowering, although there was a trend toward slightly delayed flowering dates for both growth retardants in all cultivars, with the exception of 'Ballerina' (Table 1).

The preplant corm treatment of paclobutrazol was even more effective than the soil drench in controlling plant height (Table 2). For all cultivars, height was drastically reduced from 52% on 'Washington' to 78% on 'Oberon'. Reduced immersion times or rates should result in a simple and inexpensive method of controlling plant height.

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