Full Length Research Paper

The effects of flurprimidol concentrations and application methods on *Ornithogalum saundersiae* Bak. grown as a pot plant

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*Ornithogalum saundersiae* is an ornamental bulb plant originating from South Africa that is mostly grown for cut flowers. The aim of the study was to assess the possibility of producing *O. saundersiae* as a pot plant using flurprimidol. A retardant in the form of the Topflor 015 preparation was used at concentrations of 15 and 30 mg·dm$^{-3}$ as a pre-plant bulb soak, a soil drench or a foliar spray. Retardant applied as a foliar spray at a concentration of 30 mg·dm$^{-3}$ inhibited plant growth most effectively (by 52.5%), caused flowering delay and reduced the inflorescence and flower diameter. The plants obtained from the bulbs soaked in the retardant solution at a concentration of 30 mg·dm$^{-3}$ had the smallest plant diameter and the shortest leaves. The use of flurprimidol resulted plants with an increased relative chlorophyll content. Retardant used as a foliar spray increased the stomatal conductance, regardless of the solution concentration.

**Key words:** Geophytes, plant growth retardants, relative chlorophyll content (SPAD), stomatal conductance ($g_s$), Topflor.

**INTRODUCTION**

*Ornithogalum saundersiae* Bak., also called the giant chincherinchee, is an attractive bulb plant which naturally occurs in South Africa. It has ornamental white flowers arranged in several dozens on large inflorescences, which remain for a long time. The bulbs of this plant contain a lot of biologically active compounds, including OSW-1 saponins with anticancer activity (Morzycki and Wojtkielewicz, 2005). This species is mostly grown in Kenya and Israel for cut flowers and the value of their sales at the Dutch flower exchange has been growing steadily (Kariuki and Kako, 1999; Anonymous, 2009). So far, no scientific studies have been published on the cultivation of *O. saundersiae* as a pot plant.

The use of plant growth retardants (PGRs) to obtain low and compact plants allows for continuous broadening of the pot plant assortment to include new species and cultivars (Criley, 2005; Mello et al., 2012). Flurprimidol from the pyrimidine group [alpha-(1-methylethyl)-alpha-(4-(trifluoromethoxyphenyl)-5-pyrimidinemethanol] is used to reduce unwanted plant growth, while enhancing the quality of ornamentals (Currey et al., 2012; Fair et al., 2012; Sprzaczka and Laskowska, 2013). According to the literature (Whipker et al., 2011; Miller, 2013), the influence of flurprimidol on the morphological features and yield of plants varies and it largely depends on the species, concentration and the application method.

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So far, no information has been available on the use of plant growth retardants in the cultivation of *O. saundersiae*, and this is the reason why research was undertaken to determine the influence of flurprimidol on the morphological features, the relative chlorophyll content, the stomatal conductance and the flowering of *O. saundersiae* grown in pots.

**MATERIALS AND METHODS**

The studies were carried out in the Laboratory of Ornamental Plants at the Department of Horticulture West Pomeranian University of Technology in Szczecin (53° 25' N, 14° 32' E). *O. saundersiae* bulbs with a circumference of 12 to 14 cm were used in the experiment. Before planting, the bulbs were stored at 25°C. The bulbs were planted singly on 20 May 2011 in pots with a circumference of 15 cm filled with a medium consisting of a peat substrate with a pH of 6.5 with the addition of the multi-ingredient Hydrocomplex fertiliser (N18%-P11%-K18% plus microelements) at a dose of 5 g·dm⁻³. The plants were grown in a greenhouse under natural photoperiod conditions with temperatures at 22 to 26°C during the day and 16 to 18°C at night with a relative humidity of 65 to 80%.

The Topflor 015 SL preparation (SePRO Corporation, USA) contained 1.5% of flurprimidol and was used in the experiment. Retardant was applied as (1) a pre-plant bulb soak (for 60 min), (2) a soil drench (in the 5th week of the cultivation using 100 ml of the solution per pot) or (3) a foliar spray (in the 5th week of cultivation using 100 ml of the solution per plant). In each variant, two concentrations of the flurprimidol solution were used: 15 and 30 mg·dm⁻³. The control plants were not treated with the retardant. Total plant height (measured from the soil line to the uppermost part of the inflorescences), plant diameter, number of leaves, leaf length and width, number of inflorescences per plant, number of flowers in inflorescence, inflorescence diameter, flower diameter were recorded at flowering stage (one flower per plant fully opened).

The relative chlorophyll content in the leaves was measured in dimensionless units, the so-called SPAD readings using a Chlorophyll Meter SPAD-502 (Minolta, Japan). This measurement consists of the determination of the quotient of the light absorption connected with the chlorophyll presence (the wavelength of 650 nm) and absorption through the leaf tissue (the wavelength of 940 nm). The measurements were performed at the flowering stage using three leaves from each plant. Three readings were performed for each leaf and the average value was calculated.

The stomatal conductance was determined using an SC1 porometer (Dekagon Devices, USA). The measurements were performed only on sunny days between 10 to 12 a.m. at the flowering stage on three developed leaves of each plant, three readings per leaf. The experiment was conducted as one-factor experiment with a full randomisation system with four replications of 20 plants each. The results of the measurements were verified using a variance analysis model and the ANALWAR 4.6 software based on Microsoft Excel. The confidence semi-intervals were calculated on the basis of Tukey's test at a significance level of α=0.05.

**RESULTS**

In the conducted experiment, a significant influence of flurprimidol on the height and diameter of the plants and the length and width of *O. saundersiae* leaves was found. The retardant reduced the plant height as a result of foliar spray with the solution at a concentration of 30 mg·dm⁻³. These plants were 52.5% shorter than the untreated control. The plants drenched and sprayed with a retardant solution had the greatest diameter, while plants obtained from the bulbs soaked in the retardant solution at a concentration of 30 mg·dm⁻³ had the smallest plant diameter and the shortest leaves. It was shown that the plants whose bulbs were soaked in flurprimidol, regardless of the solution concentration, formed the widest leaves (Table 1).

Flurprimidol had a significant influence on the days to flowering, the diameter of inflorescences and flowers (Table 2). The plants sprayed with the solution at a concentration of 30 mg·dm⁻³ were delayed of flowering by 25 days. An analysis of the inflorescence diameter revealed that the greater inflorescences were obtained after using the retardant as a soil drench at a concentration of 30 mg·dm⁻³, while the inflorescences of the plants sprayed with the retardant were smaller. As a result of foliar spray with flurprimidol, the plants had smaller flower diameter, regardless of the retardant concentration (Table 2).

The relative chlorophyll content in the leaves of the plants treated with the retardant was significantly higher, on average by 10.1 SPAD units, as compared to control plants. The form of retardant application and the solution concentration did not influence the relative chlorophyll content in the leaves (Table 3). The flurprimidol treatment influenced the stomatal conductance of the leaves. The plants sprayed with the retardant, regardless of the concentration, were characterised by a higher stomatal conductance of the leaves, on average by 7.60 mmol H₂O m⁻² s⁻¹ than the untreated control (Table 3).

**DISCUSSION**

A lot of ornamental plants are too high, so methods are searched to limit their height by the use of retardants. On the basis of the results obtained in the experiment, it was shown that flurprimidol effectively inhibited the growth of *O. saundersiae*. The results are consistent with the data presented by other authors, who obtained lower plants by using flurprimidol in the cultivation of tulips (Fair et al., 2012; Sprzaczka and Laskowska, 2013) and lilies (Currey et al., 2012). In this research, it was shown that flurprimidol applied as a foliar spray at a concentration of 30 mg·dm⁻³ inhibited plant growth most effectively. Similar results were obtained by Pobudkiewicz and Treder (2006), who reported that *Lilium* 'Mona Lisa' plants sprayed with flurprimidol were significantly lower than plants drenched with the retardant.

According to Whipker et al. (2004), plants treated with growth retardants are more compact, owing to which a larger number of plants can be placed per square metre, thus increasing the profitability of production. In the conducted experiment, stocky plants with a significantly
smaller diameter and length of leaves were obtained as a result of soaking the bulbs in the retardant.

In this study, the foliar spray of the plants with flurprimidol delayed the flowering. A larger number of days to anthesis as a result of flurprimidol treatment was also observed in the cultivation of oriental lily ‘Mona Lisa’ (Pobudkiewicz and Treder, 2006) and Dahlia variabilis ‘Purple Gem’ (Whipker et al., 2011). In the experiment conducted, flurprimidol did not influence the number of inflorescences obtained per plant or the number of flowers in an inflorescence. The research by Currey et al. (2012) on the use of flurprimidol in pot cultivation of Lilium longiflorum ‘Nellie White’ also showed that the number of flowers did not depend on the treatment of plants with the retardant. In this research, the O. saundersiae plants had smaller flowers as a result of foliar spray the leaves with flurprimidol. Similarly, Pobudkiewicz and Treder

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**Table 1.** Effect of flurprimidol on plant height, plant diameter, no. of leaves, leaf length and leaf width of Ornithogalum saundersiae.

<table>
<thead>
<tr>
<th>Flurprimidol treatment</th>
<th>Application method</th>
<th>Concentration (mg·dm⁻³)</th>
<th>Plant height (cm)</th>
<th>Plant diameter (cm)</th>
<th>No. of leaves</th>
<th>Leaf length (cm)</th>
<th>Leaf width (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td>0</td>
<td>133ᵃ</td>
<td>47.5ᵇ</td>
<td>6.25ᵃ</td>
<td>55.2ᵃ</td>
<td>5.68ᵇ</td>
</tr>
<tr>
<td>Bulb soak</td>
<td>15</td>
<td>89.7ᵇ</td>
<td>43.2ᵇ</td>
<td>7.25ᵃ</td>
<td>36.0ᶜ</td>
<td>7.38ᵃ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>85.7ᵇ</td>
<td>39.5ᶜ</td>
<td>7.50ᵃ</td>
<td>29.3ᶜ</td>
<td>7.50ᵃ</td>
<td></td>
</tr>
<tr>
<td>Soil drench</td>
<td>15</td>
<td>88.5ᵇ</td>
<td>55.2ᵃ</td>
<td>6.75ᵃ</td>
<td>46.0ᵇ</td>
<td>6.13ᵇ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>79.2ᵇ</td>
<td>61.0ᵃ</td>
<td>7.00ᵃ</td>
<td>45.5ᵇ</td>
<td>6.38ᵇ</td>
<td></td>
</tr>
<tr>
<td>Foliar spray</td>
<td>15</td>
<td>86.5ᵇ</td>
<td>57.0ᵃ</td>
<td>6.25ᵃ</td>
<td>47.2ᵇ</td>
<td>7.50ᵃ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>63.2ᶜ</td>
<td>59.2ᵃ</td>
<td>7.00ᵃ</td>
<td>49.7ᵇ</td>
<td>6.50ᵇ</td>
<td></td>
</tr>
</tbody>
</table>

Values are means of 4 replicates. Means followed by the same letter are not statistically different (P < 0.05) by Tukey’s test.

**Table 2.** Effect of flurprimidol on number of days to flowering, number of inflorescence per plant, number of flowers in inflorescence, inflorescence diameter and flower diameter of Ornithogalum saundersiae.

<table>
<thead>
<tr>
<th>Flurprimidol treatment</th>
<th>Application method</th>
<th>Concentration (mg·dm⁻³)</th>
<th>No. of days to flowering</th>
<th>No. of inflorescence per plant</th>
<th>No. of flowers in inflorescence</th>
<th>Inflorescence diameter (cm)</th>
<th>Flower diameter (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td>0</td>
<td>115ᶜ</td>
<td>1.00ᵃ</td>
<td>73.0ᵃ</td>
<td>12.7ᵇ</td>
<td>3.52ᵃ</td>
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<tr>
<td>Bulb soak</td>
<td>15</td>
<td>123ᵇᶜ</td>
<td>1.00ᵃ</td>
<td>70.3ᵇ</td>
<td>13.0ᵇ</td>
<td>3.50ᵃ</td>
<td>3.53ᵃ</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>126ᵇ</td>
<td>1.00ᵃ</td>
<td>68.7ᵃ</td>
<td>15.5ᵃ</td>
<td>3.50ᵃ</td>
<td>3.53ᵃ</td>
</tr>
<tr>
<td>Soil drench</td>
<td>15</td>
<td>117ᶜ</td>
<td>1.00ᵃ</td>
<td>75.8ᵃ</td>
<td>13.5ᵇ</td>
<td>3.70ᵃ</td>
<td>3.55ᵃ</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>112ᶜ</td>
<td>1.00ᵃ</td>
<td>75.3ᵃ</td>
<td>12.5ᵇᶜ</td>
<td>3.70ᵃ</td>
<td>3.55ᵃ</td>
</tr>
<tr>
<td>Foliar spray</td>
<td>15</td>
<td>123ᵇᶜ</td>
<td>1.00ᵃ</td>
<td>76.7ᵃ</td>
<td>10.2ᵇᶜ</td>
<td>2.97ᵇ</td>
<td>2.76ᵇ</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>140ᵃ</td>
<td>1.00ᵃ</td>
<td>72.0ᵃ</td>
<td>9.38ᶜ</td>
<td>2.76ᵇ</td>
<td></td>
</tr>
</tbody>
</table>

Values are means of 4 replicates. Means followed by the same letter are not statistically different (P < 0.05) by Tukey’s test.
In summary, it can be concluded that *O. saundersiae* can be cultivated as an attractive pot plant. The use of flurprimidol, depending on the application form and concentration of the solution, does not only reduce the growth and modifies the appearance of *O. saundersiae*, but it also influences the flowering time, the relative chlorophyll content and the stomatal conductance of the leaves.

REFERENCES


