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Scientia Horticulturae 107 (2006) 187–193
SCIENTIA HORTICULTURAE
www.elsevier.com/locate/scihorti

Growth and flowering of black iris (*Iris nigricans* Dinsm.) following treatment with plant growth regulators

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Received 22 March 2005; received in revised form 4 October 2005; accepted 26 October 2005

Abstract

The effects of application method and concentration of gibberellic acid (GA_3), paclobutrazol and chlormequat on black iris performance were assessed. Plants (10 cm high, 4 ± 1 leaves) were sprayed with 125, 250, 375 or 500 mg L^{-1} or drenched with 0.25, 0.5, 1 or 2 mg L^{-1} GA_3. In a second experiment, the plants were sprayed with 100, 250, 500 or 1000 mg L^{-1} or drenched with 0.25, 0.5, 1 or 2 mg L^{-1} paclobutrazol. Other plants were sprayed with 250, 500, 1000 or 1500 mg L^{-1} or drenched with 100, 250, 375 or 550 mg L^{-1} chlormequat. In each experiment, the control treatment consisted of untreated plants. Results indicated that the tallest plants (37.3 cm) in the GA_3 experiment were those sprayed with 250 mg L^{-1}. The most rapid flowering (160 days after planting) occurred when a 375 mg L^{-1} GA_3 spray was used, whereas flowering was delayed to 200 days using 1 mg L^{-1} GA_3 drench. Drenching with 1 mg L^{-1} GA_3 increased height of the flower stalk by 7 cm compared to the control. Though relatively slow to flower, plants drenched with 1 mg L^{-1} GA_3 had long and rigid stalks, which were suitable as cut flowers. Number and characteristics of the sprouts were not affected by GA_3. All paclobutrazol sprays resulted in leaf falcation. A 500 or 1000 mg L^{-1} paclobutrazol spray resulted in severe and undesirable control of plant height, drastic reduction in stalk height and weight, and delayed flowering. Plants drenched with 0.25 or 1 mg L^{-1} paclobutrazol were suitable as pot plants. Chlormequat reduced plant height only at the highest drench concentration, which also reduced flowering to 70%. No leaf falcation was observed with GA_3 or chlormequat. Chemical names: (±)-(*R**,*R**)-beta-((4-chlorophenyl)methyl)-alpha-(1,1,-dimethylethyl)-1H-1,2,4,-triazol-1-ethanol (paclobutrazol); (2-chloroethyl) trimethylammonium chloride (chlormequat).

Keywords: Iridaceae; GA_3; Paclobutrazol; Chlormequat

1. Introduction

Regulation of growth and flowering is of particular concern for plants grown for cut flower production. Gibberellins are involved in several plant development processes and promote a number of desirable effects including stem elongation, uniform flowering, reduced time to flowering, and increased flower number and size (Hopkins, 1995). However, certain concentrations of GA_3 may cause excessive stem elongation and result in poor-quality plants (Neumaier et al., 1987). Production of high quality, compact pot plants may be achieved through the use of plant growth retardants including paclobutrazol (Cramer and Bridgen, 1998; Deneke and Keever, 1992; Ecker et al., 1992; Reiser and Langhans, 1993) and chlormequat (Gowda et al., 1991). Effectiveness of growth retardants depends on concentration and method of application among other factors. Excessive and undesirable reductions in growth may be caused by certain application rates of growth retardants (Cox and Keever, 1988; Latimer et al., 2001).

The most common methods of application of growth regulators are foliar sprays and media drenches. Foliar sprays are used more often than drenches, presumably due to the higher labor costs involved in applying drenches in large scale production areas (Latimer et al., 2001). However, drenches have a longer period of activity than spray applications (Barrett, 1994). Moreover, drenches provide more uniform control of plant height and use less active material and lower concentrations of the growth regulator.

Black iris is an endemic herb of Jordan, 20–30 cm tall in its native habitat (Al-Eisawi, 1998). The leaves are flattened, 10–15 cm long and much shorter than the flower stalk. The plant has one green flower stalk arising from a rhizome and bearing a

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0304-4238/$ – see front matter
doi:10.1016/j.scienta.2005.10.003

single flower. The flowers are 12–15 cm in diameter, glossy black-dark lilac. Successful introduction of black iris as a specialty cut flower or flowering pot plant depends on performance of the plant in cultivation. For production of this plant as a cut flower, increased length and firmness of the flower stalk should be considered. However, if the plant is to be produced as a flowering pot plant, height of the plant and flower stalk should be controlled without drastic reduction in flower size or change in plant shape. Such characteristics may be achieved using plant growth regulators. Since there is no reported literature on the effect of growth regulators on black iris, this study was carried out to determine the optimal concentration and method of application of GA_3, paclobutrazol, and chlormequat on growth and flowering of this species.

2. Materials and methods

Rhizomes were collected from a single locale in north Jordan (32°09′N latitude, 35°52′E longitude, 762 m altitude) in summer 2002 and established in the field. Rhizomes were harvested from the field in June 2003. Uniform rhizomes (18 ± 2 g, 10 ± 2 buds each, and free of infections) were selected, dry brushed from soil particles and dry plant parts, and the roots cut to 7 cm length. Three-liter plastic pots (18 cm top diameter, 14.5 cm depth) were filled with 500 g/pot of 1 Scandinavian peatmoss (Pindstrup Moseburg, Denmark): 1 per liter (v/v) mixture that was amended with 3 kg m^{-3} dolomitic limestone. The rhizomes were placed horizontally to a 2 cm depth in the medium, which was then drenched with 0.07 g/pot methyl benzimdazole-2-carbamate (Carbendazim 80% DF, Sulphur Mills Ltd., India).

The pots were placed on a raised bench in a greenhouse and maintained at 26 ± 2 °C (day)/15 ± 2 °C (night), 50 ± 2% RH, and average of 250 μmol m^{-2} s^{-1} (winter)/450 μmol m^{-2} s^{-1} (spring) midday. The plants were shaded as needed using muslin mesh, irrigated weekly with 300 ml/pot tap water, and fertilized every two months with 2 g/pot of 14N-6.11P-11.62K fertilizer (Osmocote, Scotts-Sierra Horticultural Products, Marysville, OH).

Growth regulator treatments were applied when the plants were approximately 10 cm high with 4 ± 1 fully expanded leaves. Treatments were applied in the morning (17 °C, 50 ± 2% RH, and no air current). Before spraying, each pot was covered with foil paper to prevent any run-off from the foliage to enter the media. Drenches were applied carefully to avoid splashing onto foliage. The growth regulators tested were GA_3 (ProGibb T&O®, Valent BioSciences Corporation, Libertyville, IL), paclobutrazol (Bonzi®, Uniroyal Chemical Company, Middlebury, CT) and chlormequat (Cycocel®, Olympic Horticultural Products Company, Mainland, PA), which were applied at 50 ml/pot.

Ten plants each were sprayed with 125, 250, 375 or 500 mg a.i. L^{-1} GA_3 or drenched with 0.25, 0.5, 1 or 2 mg a.i. L^{-1}. In a second experiment, the plants were sprayed with 100, 250, 500 or 1000 mg a.i. L^{-1} paclobutrazol or drenched with 0.25, 0.5, 1 or 2 mg a.i. L^{-1}. In a third experiment, the plants were sprayed with 250, 500, 1000 or 1500 mg a.i. L^{-1} chlormequat or drenched with 100, 250, 375 or 550 mg a.i. L^{-1}. In each experiment, a control treatment was included in which the plants were not treated with the growth regulator.

Data were collected up to harvest (218 days after planting rhizomes) for plant height (from the media surface to the tip of the uppermost leaf), leaf number and weight, flowering percentage, number of days to flower, flower stalk height and weight, flower number, size, and weight, and characteristics of post-treatment sprouts.

2.1. Experimental design and statistical analysis

In each experiment, spray and drench treatments were arranged in a completely randomized design with 10 replicate pots per treatment and one rhizome per pot. Data for each experiment were subjected to analysis of variance (ANOVA) by the general linear models procedure using SAS (Statistical Analysis System) (SAS Institute Inc., 1996). Mean values were separated using the least significance difference (LSD) method, $P \leq 0.05$. Percentage data were arcsine transformed before performing ANOVA.

3. Results

3.1. Effect of GA_3 on growth and flowering

There was no effect of GA_3 on leaf number (12–16), fresh weight (10–16 g), or dry weight (1.6–2.3 g). Flowering percentage (90–100) or flower number (average of 1.3–2.9 per pot), length (8–10 cm), width (10–12.5 cm), fresh weight (6.1–8.2 g), or dry weight (0.57–0.79 g) was not affected by GA_3. However, plants sprayed with 250 mg L^{-1} GA_3 were the tallest (37.3 cm), whereas control plants were the shortest (31.8 cm) (Table 1). Furthermore, a 375 mg L^{-1} GA_3 spray resulted in the most rapid flowering (160 days after planting), whereas a 1 mg L^{-1} drench delayed flowering to 200 days. Application of GA_3 had a significant effect on characteristics of the flower stalk, which was the tallest (30.7 cm) and heaviest (10.36 and 1.15 g fresh and dry weight, respectively) for plants drenched with 1 mg L^{-1} GA_3. On the other hand, plants sprayed with 375 or 500 mg L^{-1} GA_3 produced the shortest flower stalks (18–19 cm) coupled with significant reduction in fresh (4.8 g) and dry (0.5–0.6 g) weight. Number (average of 1.9–3.9 per pot), growth, or flowering of the sprouts, which developed after treating the mother plants with GA_3, was not affected by GA_3. No leaf falcation (Zohary and Feinbrun-Dothan, 1986), whereby leaves curve out of the plant body, was observed on the plants or the sprouts, irrespective of the treatment.

3.2. Effect of paclobutrazol on growth and flowering

All parameters related to growth were affected by paclobutrazol (Table 2). The tallest plants (35–36 cm) were those drenched with 0.25 or 1 mg L^{-1} paclobutrazol. Maximum number of leaves (average of 12.2–13.6) was obtained