Comparative Effects of Uniconazole Drench and Spray on Shoot Elongation of Hybrid Lilies

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Abstract. Uniconazole was applied as a drench or spray to six hybrid lily (*Lilium* sp.) cultivars. Spray application was generally more effective than drench in reducing shoot elongation rate in the first few weeks, and then the efficacy decreased and was less effective than the drench at later stages of plant development. At flowering, a uniconazole drench at 0.1 mg/pot was ineffective for height reduction in 'Bravo', 'Juliana', and 'Sunray' lilies. At higher rates, uniconazole drench was similar to spray in reducing shoot growth in 'Bravo' and 306-1 but less effective than spray in 'Juliana', 'Star Gazer', and 'Sunray' lilies. Uniconazole spray reduced plant height at flowering in all the lilies compared to control plants. Days to flower was not affected in 'Bravo', 'Juliana', and 'Sunray' but was increased in 'Star Gazer', 306-1, and 306-2 by uniconazole spray treatments. Flowering duration was decreased only in 306-1 by uniconazole spray at 0.2 mg/pot. Chemical name used: (E)-1-(4-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl)-1-penten-3-ol (uniconazole).

Recent studies have shown that uniconazole reduces stem elongation in lilies (Bailey and Miller, 1989a, 1989b). Uniconazole was found more effective when applied as a drench than as a foliar spray (Davis et al., 1988). However, there is little information on the efficacy of uniconazole applied as a soil drench vs. foliar spray on shoot elongation rate in lilies. In addition, little is known about the effect of uniconazole on flower development after anthesis of hybrid lilies. Therefore, the objectives of this study were to 1) compare the effect of a uniconazole soil drench with that of a foliar spray on shoot elongation rate of six hybrid lilies grown as pot plants, and 2) examine flower development before and after anthesis of the lilies as influenced by uniconazole.

Precooled bulbs of 'Bravo', 'Juliana', 'Star Gazer', and 'Sunray' lilies were obtained from Jack Van Klaveren Ltd. (St. Catharines, Ont.). Bulbs of the two hybrid breeding lines 306-1 and 306-2 (from W.D. Evans, Guelph, Ont.) were stored for 8 weeks at 4 ± 1 C for vernalization. All the lilies were asiatic types, except 'Star Gazer', which is an oriental type. All the bulbs (4 to 5 cm in diameter) were planted in 1-liter pots containing PROMIX-BX (Premier Brands, Bramalea, Canada), except 306-2 lilies (8 to 9 cm in diameter), which were planted in 1.7-liter pots. All lilies were placed in a greenhouse with 20 to 25/15 to 18 C day/night cycles. After shoot emergence, plants were fertilized weekly with 200 mg N/liter (20N-8.7P-16.6K). An initial experiment with uniconazole was conducted on 'Star Gazer' to determine the

appropriate concentration range. Based on this experiment, two rates (0.1 and 0.3 mg/

pot) were established for the other lilies. Due to the limited number of 306-1 and 306-2 plants, only one drench and spray rate (0.2 mg/pot) was used for 306-1 and only one spray treatment was applied for 306-2. Uniconazole soil drench (100 ml/pot) and foliar spray (80 ml/eight plants) were applied when the average plant height ranged from 8 ('Sunray') to 15 cm ('Star Gazer'). Since 10 ml/pot spray gave a good coverage of the shoot, the spray concentrations were 10 times higher than those of the comparable drench treatments to give the same active ingredient received per plant. Before spray application, the plants were arranged pot-to-pot to facilitate uniform spray application, and the soil surface of each pot was covered with plastic sheets to keep the chemical off the soil. After treatment, plant height (from the rim of the pot to the top of the plant) was measured weekly until anthesis. Shoot elongation rate was determined as the increase in plant height per week. Visible bud date was counted from planting date to the time when buds were visible from the top. Days to anthesis were recorded from planting date to the date when the first flower of the plant was fully open. Number of flowers, total and senesced leaves, and final plant height were recorded at anthesis. To determine the influence of uni-

Fig. 1. Effect of a uniconazole drench or spray on subsequent plant height. (◆) control, (△) 0.1 mg drench, (○) 0.2 mg drench, (□) 0.3 mg drench, (▽) 0.5 mg drench, (▲) 0.1 mg spray, (■) 0.2 mg spray, (●) 0.3 mg spray, (▼) 0.5 mg spray. Vertical lines indicate two SE of the least-square means.

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Table 1. Effects of uniconazole drench or spray on plant height and flower development of six hybrid lily cultivars.

Uniconazole treatment (mg/pot)	Final ht		Flowering characteristic ^z			
	Cm ^y	Reduction (%)	Interval to visible buds (days)	Days to anthesis	Flower counts (no.)	Flowering period (days)
<i>Bravo</i>						
0.0	51.8 a	0	40.8 a	78.4 a	3.9 ab	17.5 a
0.1 drench	49.1 a	5	41.5 a	79.0 a	3.5 b	17.1 a
0.3	36.4 b	30	41.0 a	79.3 a	4.3 ab	17.6 a
0.1 spray	40.7 b	21	41.6 a	78.9 a	4.1 ab	17.8 a
0.3	40.7 b	21	40.5 a	80.4 a	4.4 a	19.1 a
<i>Juliana</i>						
0.0	52.9 a	0	36.9 a	71.5 a	4.5 a	15.8 a
0.1 drench	49.4 ab	7	36.8 a	72.4 a	5.4 a	17.3 a
0.3	45.8 b	13	34.9 a	69.9 a	4.8 a	17.3 a
0.1 spray	39.9 c	25	36.0 a	72.5 a	4.3 a	15.1 a
0.3	38.6 c	27	36.3 a	71.5 a	3.9 a	16.5 a
<i>Star Gazer</i>						
0.0	53.2 a	0	---	119 b	2.0 a	12.4 ab
0.2 drench	45.6 b	14	---	123 b	2.5 a	12.9 a
0.5	44.3 b	17	---	123 b	2.2 a	12.0 ab
0.2 spray	37.9 c	29	---	133 a	2.2 a	10.3 b
0.5	38.4 c	28	---	134 a	2.3 a	10.6 b
<i>Sunray</i>						
0.0	40.8 a	0	41.5 a	76.4 a	3.8 a	12.5 ab
0.1 drench	38.6 a	5	41.1 a	76.8 a	4.8 a	13.9 a
0.3	34.1 b	16	40.8 a	77.0 a	4.1 a	12.9 ab
0.1 spray	29.2 c	28	41.5 a	77.0 a	3.8 a	11.6 b
0.3	26.5 d	35	40.6 a	78.3 a	4.8 a	13.7 a
<i>306-1</i>						
0.0	85.9 a	0	57.8 b	97.9 b	6.1 a	17.8 a
0.2 drench	48.8 b	43	58.6 ab	99.8 b	6.4 a	18.0 a
0.2 spray	56.4 b	34	60.0 a	104.9 a	5.3 a	13.3 b
<i>306-2</i>						
0.0	104.9 a	0	63.7 b	97.7 b	14.9 a	26.9 a
0.2 spray	55.6 b	47	67.8 a	104.1 a	15.5 a	28.3 a

^yMeans separation in a column within cultivars by Duncan's multiple range test, $P = 0.05$.

^zLeast squares means in the column within cultivars followed by the same letter are not significantly different at $P = 0.05$.

^xData not available.

conazole on flower development after anthesis, flowering period of each plant under the same greenhouse environment was recorded from anthesis to the wilting of the last flower.

Completely randomized design was used for each cultivar with 8 one-plant replicates, and all data were subjected to one-way analysis. As plant height at the time of treatment tends to influence subsequent height change, shoot length of each plant was measured on the dates of treatment and used as a covariate for the analysis of weekly and final height. Height analysis with covariate increased relative efficiency up to 10 times compared to that without covariate. Therefore least squares means are presented for all height measurements except for the values before treatment where normal means were used.

In all cultivars, uniconazole spray treatments reduced plant height (Fig. 1) by reducing shoot elongation rate (Fig. 2) in the 1st week. The effectiveness of the spray on shoot elongation rate in 'Bravo' decreased with time and was ineffective 5 weeks after application (Fig. 2). Soil drench at 0.1 mg/pot did not reduce plant height or shoot elon-

gation rate in 'Bravo' during 5 weeks following treatment (Figs. 1 and 2). At 0.3 mg/pot, uniconazole drench slowed shoot growth rate in the 1st week and was more effective than spray at the same rate 4 weeks after application (Fig. 2). In 'Juliana', 'Star Gazer', and 'Sunray' lilies, uniconazole drench was ineffective or less effective than spray in controlling plant height (Fig. 1) or rate of shoot elongation (Fig. 2) during the first few weeks after application. In all 'Star Gazer' plants, little shoot growth occurred after 7 weeks (Figs. 1 and 2). In 306-1, uniconazole drench was less effective than spray in reducing shoot growth in the first 3 weeks, but became more effective between 5 and 8 weeks (Fig. 2). Spray was ineffective in controlling shoot elongation in 306-1 by 8 weeks. In 306-2, uniconazole spray inhibited stem elongation for 9 weeks, but was more effective in the first 4 weeks after application (Fig. 2). At flowering, uniconazole drench at 0.1 mg/pot was ineffective in height reduction in 'Bravo', 'Juliana', and 'Sunray' lilies (Table 1). At higher concentrations, uniconazole drench was similar to spray in plant height reduction in 'Bravo' and 306-1, but less effective than spray in 'Juliana', 'Star Gazer'

and 'Sunray' lilies.

The efficacy of growth retardants applied as a soil drench on reducing shoot growth could be affected by the growing medium (Larson et al., 1987) and root development. Uniconazole is expected to be gradually taken up by roots over a long period of plant growth. As the root development is relatively slow in hybrid lilies (Bailey and Miller, 1989a), it is possible that more uniconazole was taken up by the plants at later stages of growth when the root system was well-developed. This relationship could explain why uniconazole drench treatments were less effective in reducing shoot growth in the first few weeks but more effective at later stages (Fig. 2). When applied as a spray, uniconazole is expected to be taken up more readily at application time and metabolized gradually, which may account for the fast response in retarding shoot elongation in the first few weeks and the decrease in efficacy at later stages. In 'Nellie White' Easter lily, ancymidol spray was similar to drench in reducing plant height for 6 weeks after application, but plants sprayed with ancymidol were taller at flowering than those that received a drench application (Jiao, 1985).

In 'Bravo', 'Juliana', and 'Sunray', uniconazole treatments did not affect the time required for visible buds to develop or the time to flowering (Table 1). Uniconazole spray, however, delayed flowering in 'Star Gazer'. Visible bud development was delayed by 2 and 4 days in 306-1 and 306-2, respectively, by a uniconazole spray at 0.2 mg/pot. Uniconazole spray delayed anthesis in 306-1 and 306-2 by 1 week, indicating that the flower bud development after appearance of visible buds was also slowed with the spray treatments. The influence of uniconazole on the time to flowering appears to be species and cultivar dependent (Bailey and Miller, 1989a, 1989b; Wang et al., 1989). Flower number was not affected by the growth retardant, but was much higher in 306-2 than in any other cultivar (Table 1), which is consistent with previous studies (Bailey and Miller, 1989a; Wang et al., 1989). Uniconazole did not affect total leaf number but slightly increased lower leaf yellowing in some treatments (data not shown).

In a previous study with the asiatic hybrid lily 'Connecticut King', we found that uniconazole spray at 15 and 30 μ l/liter reduced the flowering period by 3 and 5 days, respectively (Wang et al., 1989). In the present study, the flowering period was generally not affected by uniconazole except in 306-1 lilies where it was reduced by 4 to 5 days with the uniconazole spray (Table 1).

We showed uniconazole to be a very effective growth retardant for height control of hybrid lilies. The effective dosage of uniconazole is similar to that of ancymidol, but 10 times less than that of paclobutrazol for lilies (Jiao et al., 1986). In addition, uniconazole spray can be as effective as or even more effective than drench treatments in some hybrid lilies, which allows optional application methods according to cultivars and growing medium.

Fig. 2. Effect of a uniconazole drench or spray on subsequent stem elongation rate. (◆) control, (△) 0.1 mg drench, (□) 0.2 mg drench, (○) 0.3 mg drench, (▽) 0.5 mg drench, (▲) 0.1 mg spray, (■) 0.2 mg spray, (●) 0.3 mg spray, (▼) 0.5 mg spray. Vertical lines indicate two SE of the least-square means.

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