

# Sensitivity and Growth of Twelve Elatior Begonia Cultivars to Ozone<sup>1</sup>

R. A. Reinert and P. V. Nelson<sup>2,3</sup>

North Carolina State University, Raleigh, NC 27650

Additional index words. air pollutants, Rieger begonia, *Begonia X hiemalis*

**Abstract.** Twelve cultivars of Elatior begonia (*Begonia X hiemalis* Fotsch.) were exposed to O<sub>3</sub> at 25 and 50 pphm. The 'Schwabenland' group, 'Whisper 'O' Pink', and 'Improved Krefeld Orange' were the most sensitive, whereas 'Ballerina', 'Mikkell Limelight', and 'Turo' were the least sensitive. 'Renaissance', 'Heirloom', 'Nixe', and 'Fantasy' were intermediate in sensitivity. The dry weight of foliage (stems plus leaves) of 9 cultivars exposed to O<sub>3</sub> was significantly less than that of control plants. Ozone at 25 and 50 pphm inhibited flower growth (including peduncles) and development in 4 and 8 of the 12 cultivars, respectively. Differences in flower weight ranged from 43 to 105% of the control at 25 pphm and from 25 to 98% of the control at 50 pphm, depending on cultivar.

Begonias are among the more pollutant sensitive floricultural crops (1, 3, 4). Cultivars of the annual bedding begonia (*Begonia semperflorens* Link & Otto) have varying sensitivity to ozone (O<sub>3</sub>) (1). Elatior begonia, 'Schwabenland Red' was exposed, either at an early vegetative (prefloral) stage, or during flower development to SO<sub>2</sub> or O<sub>3</sub> applied separately or together and foliage growth was inhibited (2, 5). The present study was carried out to determine the effect of O<sub>3</sub> on foliar injury, growth and flowering of 12 popular cultivars of the Elatior begonias.

Twenty cuttings each of 12 cultivars obtained from a commercial propagator were planted one to a 15 cm diameter plastic pot. The pots contained a medium of 45% peat, 45% perlite and 10% soil amended with 7 g of dolomitic limestone and 3.5 g of 20% superphosphate per liter of mix. A single application of a trace element mixture (STEM), at the rate of 0.6 g/liter, was applied 2 weeks after potting. A liquid

fertilizer was applied weekly consisting of 3.2 mM KNO<sub>3</sub>, 4.5 mM NH<sub>4</sub>NO<sub>3</sub> and 4.5 mM Ca (NO<sub>3</sub>)<sub>2</sub>. H<sub>2</sub>O (250 ppm N and 125 ppm K; 25% ammoniacal N) was applied weekly. No pesticides were used throughout the study.

Plants were grown at temperatures of 26 ± 3°C (day) and 18 ± 3°C (night). Before exposure to O<sub>3</sub> the plants were grown under long days (interrupted night from 10 PM - 2 AM) for 4 weeks and then natural short days. Growth during the long days was in a greenhouse without charcoal filtered air, whereas growth during the short days and subsequent exposure was in charcoal filtered air. Six weeks after planting, 18 plants of each cultivar were selected, divided into 3 groups (replications), and exposed to charcoal filtered air, 25, or 50 pphm O<sub>3</sub>. Exposure to O<sub>3</sub> began while all cultivars were in the early reproductive stage, about 1 week before flower appearance. To provide the same total O<sub>3</sub> dose, four-4 hr weekly exposures were made at 25

pphm and 2 exposures, 2 weeks apart, were made at 50 pphm. Ozone was generated by a Welsbach O<sub>3</sub> generator and monitored continuously during exposure by a chemiluminescence O<sub>3</sub> analyzer (Monitor Labs, Inc., San Diego, Calif. 92121). Temperatures during exposure were 26-30°C. The experimental design consisted of 12 cultivars, three O<sub>3</sub> treatments, and 2 plants per experimental unit, replicated 3 times (216 total plants).

Foliar injury estimates (0-100%) of the whole plant surface were determined twice, 2 and 4 weeks after the initial exposure. Foliage (leaves plus stems), and flower (flowers including peduncles) dry weights were determined about 2 weeks after the last exposure.

Foliar injury symptoms due to O<sub>3</sub> consisted of red-brown to brown pigmented spots (stipple) rather than fleck giving a bronzed appearance of the upper leaf surface. A chlorotic mottle was the most common O<sub>3</sub>-induced injury in the least sensitive cultivars. Four weeks after the first exposure, foliar injury, expressed as bifacial necrosis, was extensive at both 25 and 50 pphm O<sub>3</sub>. The percentage of foliar injury increased as the O<sub>3</sub> concentration was increased and there were marked differences in the response of cultivars (Table 1). A significant interaction between cultivars and O<sub>3</sub> treatments was found at both the 2- and the 4-week injury evaluation. Injury at 4 weeks was more intense than injury 2 weeks after exposure, both after 4 exposures to O<sub>3</sub> at 25 pphm and after 2 exposures at 50 pphm.

The percentage of foliar injury among all cultivars was greater in plants exposed to 50 pphm than in plants exposed to 25 pphm even though the O<sub>3</sub> dose (concentration × exposure time × number of exposures) was equal.

<sup>1</sup>Received for publication April 27, 1979. Paper No. 6073 of the Journal Series of the North Carolina Agricultural Research Service, Raleigh. Cooperative investigations of the U. S. Department of Agriculture and North Carolina State University. Mention of a trademark, proprietary product, or vendor does not constitute a guarantee or warranty by the U. S. Department of Agriculture or the North Carolina Agricultural Research Service and does not imply approval of it to the exclusion of other products or vendors that also may be suitable.

The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper must therefore be hereby marked *advertisement* solely to indicate this fact.

<sup>2</sup>Plant Pathologist, USDA-SEA-AR and Professor, Department of Plant Pathology, and Professor, Department of Horticulture, respectively.

<sup>3</sup>The authors express gratitude to T. N. Gray and N. C. Mingis for their technical assistance and to Mikkelsens Inc., Astabula, Ohio, for providing the plants used in this study.

Table 1. Effect of ozone on foliage of 12 Elatior begonia cultivars at 2 and 4 weeks following the initial exposure.<sup>2</sup>

Cultivar	Foliar injury (%)			
	2 weeks		4 weeks	
	O <sub>3</sub> concn		O <sub>3</sub> concn	
	25 pphm	50 pphm	25 pphm	50 pphm
Improved Krefeld Orange	41	75	66	89
Improved Schwabenland Pink	38 <sup>y</sup>	74	78	92
Whisper 'O' Pink	24	69	56	82
Schwabenland Red	29	75	74	90
Schwabenland Gold	30	73	68	88
Renaissance	12	66	35	55
Heirloom	3	34	29	69
Fantasy	3	52	21	80
Nixe	6	61	25	75
Mikkell Limelight	7	60	13	56
Ballerina	3	45	13	64
Turo	1	33	5	67
LSD (5%)		5		8

<sup>2</sup>Plants were exposed 4 times to 25 pphm O<sub>3</sub> or twice to 50 pphm O<sub>3</sub> for 4 hr each time over 24 days.

<sup>y</sup>Each injury value is based on 6 plants from 3 replications.

The sensitivity ranking of cultivars for foliar injury due to O<sub>3</sub> at the 2 concentrations differed only slightly; 'Schwabensland' group and 'Improved Krefeld Orange' were among the most sensitive at both 25 and 50 pphm O<sub>3</sub> whereas 'Mikkell Limelight', 'Ballerina', and 'Turo' were among the least sensitive (Table 1).

Foliage growth (g dry weight) of 'Ballerina' exposed to O<sub>3</sub> at 25 pphm was significantly enhanced (Table 2) and foliar injury from that treatment was low (13%). Ozone at 25 pphm significantly inhibited foliage growth of 'Improved Schwabensland Pink' and 'Whisper 'O' Pink'. Ozone at 50 pphm significantly inhibited the foliage growth of 7 additional cultivars. When foliage

growth was inhibited visible injury at 25 or 50 pphm was always greater than 55%. Thus, injury and foliage growth were related, i.e., the growth inhibition was more severe when the foliar injury was high. There was also evidence for tolerance with respect to growth in 'Fantasy', 'Nixe', and 'Turo' which showed 80, 75, and 67% injury at 50 pphm O<sub>3</sub>, but growth was not significantly inhibited.

Gardner and Ormrod (2) exposed 'Schwabensland Red' plants to 15 pphm O<sub>3</sub> daily for 4 hr per day in the early vegetative and prefloral stages. Fresh and dry weights of foliage were significantly less than control plants, if harvested 8 weeks from the last exposure day. There were no significant

changes in weight from the O<sub>3</sub> treatment if harvested 2 weeks from the last exposure day. 'Schwabensland Red' plants exposed to 20 or 30 pphm O<sub>3</sub> for 4 hr daily for 5 days and harvested 2 weeks from the last exposure also had significantly smaller fresh and dry weights compared with the control (2). Thus, the foliage growth inhibition caused by 25 or 50 pphm O<sub>3</sub> in 9 of the 12 cultivars in our study, and especially in 'Schwabensland Red', is similar to that of previous studies concerning 'Schwabensland Red' (2, 5).

Flowers on the more O<sub>3</sub>-sensitive begonia cultivars developed necrotic lesions on the petals. Exposure to O<sub>3</sub> influenced flower dry weight more than foliage weights. Flower weight was significantly less than that of control plants in 4 cultivars after exposure to 25 pphm O<sub>3</sub> and in 8 cultivars after exposure to 50 pphm O<sub>3</sub>. Reductions in the dry weight of flowers appeared to be independent of leaf injury. Relatively tolerant cultivars such as 'Nixe', 'Fantasy', and 'Mikkell Limelight' showed reduced floral growth (52-59% of the control) at the higher O<sub>3</sub> concentration.

There were no significant changes in flower weights of 'Renaissance', 'Heirloom', 'Ballerina', and 'Turo' (Table 2). The influence of O<sub>3</sub> on flowering in elatior begonia has not been reported. However, the flowering of several cultivars of *Begonia semperflorens* was inhibited by 40 and 80 pphm O<sub>3</sub> for 2 weeks (1).

Our data suggest that many cultivars of Elatior begonia are sensitive to O<sub>3</sub>. The Schwabensland cultivars, 'Improved Krefeld Orange' and 'Whisper 'O' Pink' are among the most sensitive. Sensitivity is based not only on inhibition of foliage growth and foliar injury but also on inhibition of flower development. In some cases cultivars were stressed enough that flower weights were reduced in the absence of high levels of foliar injury.

#### Literature Cited

- Adedipe, N. O., R. E. Barrett, and D. P. Ormrod. 1972. Phytotoxicity and growth responses of ornamental bedding plants to ozone and sulfur dioxide. *J. Amer. Soc. Hort. Sci.* 97:341-345.
- Gardner, J. O. and D. P. Ormrod. 1976. Response of the Rieger begonia to ozone and sulfur dioxide. *Scientia Hort.* 5:171-181.
- Leone, I. A. and E. Brennan. 1969. Sensitivity of begonias to air pollution. *Hort. Res.* 9:112-116.
- \_\_\_\_\_ and \_\_\_\_\_. 1969. The importance of moisture in ozone phytotoxicity. *Atmos. Environ.* 3:399-406.
- Weber, D. E., R. A. Reinert, and K. R. Barker. 1978. Influence of ozone and sulfur dioxide on the reproduction of selected plant-parasitic nematodes. *Phytopathology* 69:624-628.

Table 2. The effect of ozone on the growth of 12 Elatior begonia cultivars.

Cultivar	O <sub>3</sub> concn <sup>z</sup> (pphm)	Dry weight (g) <sup>y</sup>		
		Foliage	Flower	Plant
<i>Improved Krefeld Orange</i>	0	2.34	0.37	2.71
	25	1.94	0.16	2.10
	50	1.30	0.11	1.41
	LSD (5%)	.41	.13	.39
<i>Improved Schwabensland Pink</i>	0	4.62	1.47	6.09
	25	3.87	0.93	4.80
	50	3.09	0.55	3.64
	LSD (5%)	.73	.32	.98
<i>Whisper 'O' Pink</i>	0	4.19	1.15	5.34
	25	3.37	0.82	4.19
	50	2.45	0.29	2.74
	LSD (5%)	.64	.24	.71
<i>Schwabensland Red</i>	0	4.41	1.59	6.00
	25	3.87	1.12	4.99
	50	3.64	0.65	3.88
	LSD (5%)	.67	.33	.88
<i>Schwabensland Gold</i>	0	4.06	1.20	5.27
	25	3.55	0.94	4.50
	50	2.63	0.44	3.06
	LSD (5%)	.61	.29	.74
<i>Renaissance</i>	0	3.16	0.62	3.78
	25	2.49	0.60	3.09
	50	2.18	0.43	2.61
	LSD (5%)	.71	.41	.65
<i>Heirloom</i>	0	1.87	0.35	2.23
	25	1.66	0.33	1.99
	50	1.29	0.21	1.51
	LSD (5%)	.50	.21	.50
<i>Fantasy</i>	0	2.98	1.02	3.99
	25	2.96	0.92	3.88
	50	2.82	0.55	3.36
	LSD (5%)	.59	.27	.55
<i>Nixe</i>	0	2.47	0.56	3.03
	25	2.62	0.59	3.21
	50	2.21	0.29	2.50
	LSD (5%)	.83	.16	.93
<i>Mikkell Limelight</i>	0	5.16	0.86	6.02
	25	5.22	0.83	6.05
	50	4.17	0.50	4.68
	LSD (5%)	.96	.21	1.07
<i>Ballerina</i>	0	1.99	0.31	2.30
	25	2.11	0.43	2.53
	50	1.52	0.13	1.65
	LSD (5%)	.09	.24	.26
<i>Turo</i>	0	2.46	0.47	2.93
	25	2.33	0.50	2.82
	50	2.37	0.46	2.83
	LSD (5%)	.53	.17	.46

<sup>z</sup>Plants were exposed 4 times to 25 pphm O<sub>3</sub> or twice to 50 pphm O<sub>3</sub> for 4 hours each time over 24 days.

<sup>y</sup>Each value is the mean for 6 plants from 3 replications.