*Proc. Fla. State Hort. Soc.* 106:299-302. 1993.

# PRODUCTION FERTILIZER AND POSTHARVEST LIGHT INTENSITY EFFECTS ON BEGONIAS

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*Additional index words. Begonia x semperflorens-cultorum*

*Abstract.* **Plugs of *Begonia* x *semperflorens-cultorum* Hort. varieties 'Prelude Scarlet' and 'Vodka' were transplanted into 10-cm pots containing Fafard 3-B growing medium and placed in a glass greenhouse on 11 Jan. 1993. Pots were top-dressed with 1.0, 1.5, 2.0 or 2.5 g 14N-6.2P-11.6K Osmocote (FR). All plants were watered as needed. Light levels varied because of stripping and repainting the glasshouse during Jan. and Feb., but the average maximum light intensity was about 760 $\mu mol \cdot m^{-2} \cdot s^{-1}$ throughout the production phase. When each plant variety was salable, plant grades, growth measurements (height and width), and number of flower stalks with two or more flowers were recorded. Plants were then moved into interior rooms where all conditions were constant except that plants received 12, 24, 36, or 48 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of light (LT) for 12 hr daily. Begonias remained in the test rooms for 9 weeks, and plant grades were recorded every 3 weeks. Flower stalk number per plant was also recorded at 3 and 6 weeks, but not at termination. Production plant grades decreased as FR increased. Production flower stalks on 'Prelude Scarlet' decreased as FR increased, while on 'Vodka' flower stalk number was lower at the middle fertilizer rates. Interior plant grades and number of flower stalks for both plants generally decreased as FR increased and increased as LT increased.**

Use of blooming plants in interior landscapes is limited by the higher cost of maintaining attractiveness of blooming material compared to using acclimatized foliage plants (Harlass, 1992; Newman, 1992). In order to maintain attractive interiorscapes, blooming plants in commercial settings must be replaced as flowers decline. Therefore, plant choice is restricted to those that remain attractive for the longest time possible to reduce maintenance and replacement costs and further limited to those available from producers.

Since bedding plants in 10-cm pots are usually less expensive than flowering pot crops currently in favor with interiorscapers (U.S.D.A., 1991), the bedding plant market could be considered as a source of plant material for increasing blooming plant variety indoors. However, bedding plants are generally thought to deteriorate rapidly under low light interior conditions.

Research has shown that production regimes, cultivar selection and postproduction handling influence chrysanthemum and poinsettia longevity indoors (Higgins, 1991; Nell, 1991; Nell et al., 1990; Scott et al., 1982 and 1984; Staby and Kofranek, 1979). Experiments with cell packs of *Petunia hybrida* Vilm. showed production practices and holding area environment affected plants' deterioration rate under conditions found in various retail outlets (Armitage and Kowalski, 1983a; 1983b). However, no research focusing on conditioning larger pots of bedding plants to determine their potential for interior environments has been published. If ways can be found to extend bedding plant bloom quality and longevity indoors, especially for shade tolerant species, these plants may provide inexpensive indoor color alternatives for some interiorscapes.

Fibrous rooted begonias, *Begonia* x *semperflorens-cultorum*, were chosen to test indoors with various light levels after different production fertilizer treatments because they are considered to be shade tolerant, have attractive foliage and flower perpetually. If the flowers remain attractive in the low-light interiors, it would contribute significantly to making them low-maintenance plants.

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## Materials and Methods

This experiment was initiated on 11 Jan. 1993, when *Begonia* x *semperflorens-cultorum* 'Prelude Scarlet' and 'Vodka' plugs donated by George J. Ball, Inc. were transplanted into 10-cm diameter pots using Fafard 3-B growing medium. Plants were grown in a glasshouse where average maximum light intensity was approximately 760 $\mu mol \cdot m^{-2} \cdot s^{-1}$. Temperatures ranged from 18 to 32°C and plants were watered as needed to promote healthy growth.

Each cultivar was established as a 4 x 4 factorial with five replications per treatment arranged in randomized block design. Plants were top-dressed with 1.0, 1.5, 2.0 or 2.5 g/10-cm pot 14N-6.2P-11.6K Osmocote (FR) on 15 Jan. 1993. When plants reached salable size on 23 Feb., they were moved into interior rooms where cool white fluorescent lamps provided 12, 24, 36 or 48 $\mu mol \cdot m^{-2} \cdot s^{-1}$ (LT) for 12 hr daily and temperature was maintained at 25 ± 2°C.

Growth [(plant height plus width) ÷ 2] and plant grade (based on a scale of 1 = dead, 2 = poor quality, unsalable/unacceptable, 3 = fair quality, salable/acceptable, 4 = good quality and 5 = excellent quality) were determined for each cultivar after greenhouse production phase was complete. After 3, 6 and 9 weeks in interior environment rooms, plants were graded again using the same scale. Number of flower stalks with at least two blooms was determined after greenhouse production and again after 3 and 6 weeks in interior rooms.

## Results and Discussion

**'Prelude Scarlet'**: Plant grade and number of flower stalks per plant decreased as FR. increased during production (Table 1); however, the plant grade decrease was not commercially significant. Growth was unaffected by fertilizer rate.

*Plant grade and plant grade change.* After 3 weeks in interior rooms, plant grade showed a response to an interaction ($P = 0.05$) between FR and LT (Table 2). Generally, best plant grade in the three lower light levels was for plants produced at lowest FR, while FR did not make a difference at 48 $\mu mol \cdot m^{-2} \cdot s^{-1}$. At this point in the experi-

Table 1. Effects of production fertilizer level on *Begonia* 'Prelude Scarlet' growth, plant grade and number of flower stalks per plant after greenhouse production.

| g 14N-6.2P-11.6K per 10-cm pot | Growth[z] (cm) | Plant grade[y] | Number of flower stalks[x] |
|---|---|---|---|
| 1.0 | 16.5 | 4.9 | 6.6 |
| 1.5 | 16.7 | 4.8 | 5.8 |
| 2.0 | 16.4 | 4.8 | 4.8 |
| 2.5 | 16.2 | 4.8 | 4.8 |
| *Significance* | | | |
| Linear | 0.2695 | 0.0477 | 0.0016 |

[z]Growth was measured as (height + width) ÷ 2.
[y]Plants were graded on a scale of 1 = dead; 2 = poor, unsalable; 3 = fair, salable; 4 = good; and 5 = excellent.
[x]Number of flower stalks with at least two blooms.

Table 2. Interactions of production fertilizer level and indoor light intensity on plant grade of *Begonia* 'Prelude Scarlet' after being in interior rooms for 3 and 6 weeks.

| g 14N-6.2P-11.6K | Interior light intensity (μmol·m$^{-2}$·s$^{-1}$) | | | |
|---|---|---|---|---|
| per 10-cm pot | 12 | 24 | 36 | 48 |
| | Plant grade[z] after 3 weeks in interiors | | | |
| 1.0 | 3.1 | 4.6 | 5.0 | 5.0 |
| 1.5 | 2.7 | 4.6 | 4.5 | 5.0 |
| 2.0 | 2.6 | 3.9 | 4.4 | 4.9 |
| 2.5 | 2.0 | 3.6 | 4.6 | 5.0 |
| *Significance* | | | | |
| *FR x LT* 0.0407 | | | | |
| | Plant grade[z] after 6 weeks in interiors | | | |
| 1.0 | 2.1 | 4.1 | 4.3 | 4.4 |
| 1.5 | 2.5 | 4.6 | 4.4 | 4.9 |
| 2.0 | 2.1 | 4.2 | 4.5 | 4.9 |
| 2.5 | 1.7 | 4.2 | 4.9 | 5.0 |
| *Significance* | | | | |
| *FR x LT* 0.0459 | | | | |

[z]Plants were graded on a scale of 1 = dead; 2 = poor, unacceptable; 3 = fair, acceptable; 4 = good; and 5 = excellent.

ment, all 'Prelude Scarlet' plants remained in good to excellent condition except those under 12 μmol·m$^{-2}$·s$^{-1}$, where only those which had received lowest FR were still of acceptable (3.1) plant grade. Change in plant grade from the production plant grade was not affected by FR; but as LT increased, less plant grade change occurred (Table 3). Plant grade reflected the number of flower stalks more than the condition of the foliage, which held up equally well under all conditions.

After 6 weeks indoors, plant grade again showed an interaction between FR and LT ($P = 0.05$) (Table 2). Best plants at this time were those receiving highest light at any fertilizer level above 1.0 g/10-cm pot and those plants that had received 2.5 g/10-cm pot that were placed under 36 μmol·m$^{-2}$·s$^{-1}$. These plant grades were different from those of 3 weeks in that at 3 weeks the best plant grade, except at the highest light level when there was no difference, was at the 1 g/pot (lowest FR), but at 6 weeks the 1 g/pot FR plants had the worst plant grades for each light level except for the lowest level (12 μmol·m$^{-2}$·s$^{-1}$) where all plants were unacceptable, but the worst grade was at the highest FR. Plant grade change (from that at initiation of the interior portion of the experiment) was not different due to FR, but decreased dramatically under 12 μmol·m$^{-2}$·s$^{-1}$ (Table 3).

Table 3. Effects of indoor light intensity on plant grade of *Begonia* 'Prelude Scarlet' after 9 weeks in interiors and on plant grade change from greenhouse production after being in interior rooms for 3, 6, and 9 weeks.

| Light intensity (μmol·m$^{-2}$·s$^{-1}$) | Plant grade[z] after 9 wk in interiors | PG change[y] after 3 wk in interiors | PG change[y] after 6 wk in interiors | PG change[y] after 9 wk in interiors |
|---|---|---|---|---|
| 12 | 2.2 | -2.1 | -2.6 | -2.4 |
| 24 | 3.8 | -0.7 | -0.6 | -1.0 |
| 36 | 3.8 | -0.2 | -0.3 | -1.0 |
| 48 | 4.1 | 0.1 | -0.1 | -0.8 |
| *Significance* | | | | |
| Linear | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| Quadratic | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| Cubic | 0.0001 | 0.2458 | 0.0021 | 0.0013 |

[z]Plants were graded 9 weeks indoors based on a scale of 1 = dead, 2 = poor quality, unacceptable, 3 = fair quality, acceptable, 4 = good quality and 5 = excellent quality.
[y]PG change = plant grade after greenhouse production minus plant grade after period in interiors.

Neither plant grade after 9 weeks in interiors nor the change in plant grade compared to that at end of production was different due to FR. Change in plant quality was still much greater for plants under 12 μmol·m$^{-2}$·s$^{-1}$ compared to plants maintained under the higher light levels (Table 3) and only those plants under 12 μmol·m$^{-2}$·s$^{-1}$ were unsatisfactory.

*Number of flower stalks with two or more flowers/plant.* More flower stalks were present after 3 weeks indoors than after production except for those plants at the lowest light level but the number of flower stalks decreased as FR increased and increased as LT increased (Table 4). The increase in the number of flower stalks compared to those at the end

Table 4. Effects of production fertilizer level and indoor light intensity on number of flower stalks per plant on *Begonia* 'Prelude Scarlet' and the change from the number of flower stalks at termination of greenhouse production after being in interior rooms for 3 and 6 weeks.

| g 14N-6.2P-11.6K per 10-cm pot | Number flower stalks[z] after 3 wk in interiors | Change in number stalks[y] | Number flower stalks[z] after 6 wk in interiors | Change in number stalks[y] |
|---|---|---|---|---|
| 1.0 | 13.5 | 6.8 | 4.0 | -2.6 |
| 1.5 | 11.6 | 5.8 | 5.0 | -0.8 |
| 2.0 | 9.2 | 4.4 | 4.4 | -0.4 |
| 2.5 | 8.3 | 3.5 | 4.8 | 0.0 |
| *Significance* | | | | |
| Linear | 0.0006 | 0.0361 | 0.5763 | 0.0178 |
| Light intensity (μmol·m$^{-2}$·s$^{-1}$) | | | | |
| 12 | 3.9 | -1.6 | 0.2 | -5.2 |
| 24 | 11.5 | 6.4 | 4.8 | -0.2 |
| 36 | 11.9 | 6.5 | 5.8 | 0.4 |
| 48 | 15.2 | 9.2 | 7.2 | 1.2 |
| *Significance* | | | | |
| Linear | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| Quadratic | 0.0063 | 0.0021 | 0.0001 | 0.0004 |
| Cubic | 0.0042 | 0.0058 | 0.0281 | 0.0874 |

[z]Number of flower stalks per plant with two or more flowers.
[y]Number of flower stalks per plant after greenhouse production minus number of flower stalks per plant after indoor period.

of production was less as FR increased, indicating that the low fertilizer rate may be best if this plant is to be placed indoors. Number of flower stalks per plant was dramatically increased as interior LT increased above the 12 $\mu mol \cdot m^{-2} \cdot s^{-1}$ rate, indicating that the lowest light level may not give enough light to maintain this plant indoors.

After 6 weeks in interiors, change in number of flower stalks continued to decrease as FR increased (Table 4), and the change in flower stalk number was more than three times greater for plants fertilized at 1.0 g/pot than for plants at any other fertilizer rate. Plants in 48, 36 or 24 $\mu mol \cdot m^{-2} \cdot s^{-1}$ had nearly the same number of flower stalks after 6 weeks indoors when compared to flower stalk count after greenhouse production, so the surge in number of flowers after 3 weeks indoors was not maintained under any light level.

**'Vodka'**: At the end of greenhouse production, plant grades were higher at the low fertilizer rate (1.0 g/10-cm pot) and plants had more flower stalks at the lowest and highest fertilizer rates, but growth was not affected by FR (Table 5).

Table 5. Effects of production fertilizer level on *Begonia* 'Vodka' growth, plant grade and number of flower stalks per plant after greenhouse production.

| g 14N-6.2P-11.6K per 10-cm pot | Growth[z] (cm) | Plant grade[y] | Number of flower stalks[x] |
|---|---|---|---|
| 1.0 | 15.4 | 4.9 | 16.0 |
| 1.5 | 15.9 | 4.8 | 14.4 |
| 2.0 | 15.8 | 4.6 | 14.2 |
| 2.5 | 15.7 | 4.6 | 15.8 |
| *Significance* | | | |
| Linear | 0.2847 | 0.0010 | 0.8499 |
| Quadratic | 0.1891 | 0.2768 | 0.0370 |

[z]Growth was measured as (height + width) ÷ 2.
[y]Plants were graded on a scale of 1 = dead; 2 = poor, unsalable; 3 = fair, salable; 4 = good; and 5 = excellent.
[x]Number of flower stalks with at least two blooms.

*Plant grade and plant grade change*. After 3 weeks indoors, plant grade decreased as FR increased (Table 6), but plant grade change from the production plant grade was not significant due to FR, nor were plant grade and plant grade change significant due to FR at 6 or 9 weeks. Though plant grades declined between 3 and 6 weeks, no change in quality occurred between 6 and 9 weeks due to fertilizer and all plants at all FRs were of satisfactory quality.

Plant grade decreased as LT decreased, with plants under 48 $\mu mol \cdot m^{-2} \cdot s^{-1}$ maintaining the best indoor quality. However, grades for plants under 48, 36 or 24 $\mu mol \cdot m^{-2} \cdot s^{-1}$ at 3, 6 and 9 weeks were acceptable and had less deterioration (plant grade change) than plants in 12 $\mu mol \cdot m^{-2} \cdot s^{-1}$. Plants under 12 $\mu mol \cdot m^{-2} \cdot s^{-1}$ were unacceptable even at 3 weeks and continued to decline, indicating that the lowest light level is unsatisfactory for maintaining 'Vodka' as well as 'Prelude Scarlet' indoors.

*Number of flower stalks with two or more flowers/plant.* Number of flower stalks decreased as FR increased after 3 weeks indoors (Table 7); but by 6 weeks indoors, FR was not a factor. After 3 weeks indoors, the smallest decline in the number of flower stalks was at the lowest FR (1.0 g/10-cm pot), while at 6 weeks the smallest change was at 1.5 g/10-cm pot. Number of flower stalks per plant at 3 and 6 weeks increased as LT increased, but flower stalk production dropped steadily in interiors with plants under 12 $\mu mol \cdot m^{-2} \cdot s^{-1}$ showing the largest difference in number of stalks per plant at both 3 and 6 weeks.

## Conclusions

Production plant grades were best at the low fertilizer rates when number of blooms was considered when determining overall plant quality. Additionally, lower fertilizer levels were also beneficial in maintaining interior plant quality, especially during the first 3 weeks. Both varieties tested deteriorated much more rapidly under 12 $\mu mol \cdot m^{-2} \cdot s^{-1}$ than under higher light levels indicating that light intensity

Table 6. Effects of production fertilizer level and indoor light intensity on plant grade of *Begonia* 'Vodka' after 3, 6 and 9 weeks in interior and on plant grade change from greenhouse production after being in interior rooms for 3, 6 and 9 weeks.

| g 14N-6.2P-11.6K per 10-cm pot | Plant grade[z] after 3 wk in interiors | PG change[y] after 3 wk in interiors | Plant grade[z] after 6 wk in interiors | PG change[y] after 6 wk in interiors | Plant grade[z] after 9 wk in interiors | PG change[y] after 9 wk in interiors |
|---|---|---|---|---|---|---|
| 1.0 | 4.6 | -0.4 | 3.2 | -1.7 | 3.2 | -1.7 |
| 1.5 | 4.3 | -0.5 | 3.6 | -1.2 | 3.6 | -1.2 |
| 2.0 | 4.0 | -0.5 | 3.4 | -1.2 | 3.4 | -1.2 |
| 2.5 | 3.9 | -0.8 | 3.5 | -1.2 | 3.4 | -1.2 |
| *Significance* | | | | | | |
| Linear | 0.0135 | 0.1775 | 0.4846 | 0.0690 | 0.6392 | 0.1345 |
| Light intensity ($\mu mol \cdot m^{-2} \cdot s^{-1}$) | | | | | | |
| 12 | 2.8 | -1.9 | 2.3 | -2.4 | 2.2 | -2.6 |
| 24 | 4.5 | -0.2 | 3.4 | -1.2 | 3.6 | -1.0 |
| 36 | 4.7 | -0.2 | 3.8 | -1.0 | 3.6 | -1.2 |
| 48 | 4.9 | 0.1 | 4.2 | -0.6 | 4.3 | -0.5 |
| *Significance* | | | | | | |
| Linear | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| Quadratic | 0.0001 | 0.0001 | 0.0008 | 0.0036 | 0.0018 | 0.0077 |
| Cubic | 0.0015 | 0.0001 | 0.2388 | 0.0997 | 0.0001 | 0.0001 |

[z]Plants were graded after each indoor period based on a scale of 1 = dead, 2 = poor qualilty, unacceptable, 3 = fair quality, acceptable, 4 = good quallity and 5 = excellent quality.
[y]PG change = plant grade after greenhouse production minus plant grade after period in interiors.

Table 7. Effects of production fertilizer level and indoor light intensity on number of flower stalks per plant on *Begonia* 'Vodka' and the change from the number of flower stalks at termination of greenhouse production after being in interior rooms for 3 and 6 weeks.

| g 14N-6.2P-11.6K per 10-cm pot | Number flower stalks[z] after 3 wk in interiors | Change in number stalks[y] | Number flower stalks[z] after 6 wk in interiors | Change in number stalks[y] |
|---|---|---|---|---|
| 1.0 | 8.2 | -7.8 | 2.0 | -14.0 |
| 1.5 | 6.0 | -8.4 | 2.9 | -11.5 |
| 2.0 | 4.5 | -9.7 | 2.3 | -11.9 |
| 2.5 | 4.3 | -11.6 | 2.4 | -13.4 |
| *Significance* | | | | |
| Linear | 0.0001 | 0.0068 | 0.7558 | 0.7326 |
| Quadratic | 0.1054 | 0.5734 | 0.3550 | 0.0152 |
| Light intensity ($\mu mol \cdot m^{-2} \cdot s^{-1}$) | | | | |
| 12 | 2.6 | -12.2 | 0.1 | -14.6 |
| 24 | 6.0 | -8.8 | 2.5 | -12.4 |
| 36 | 6.2 | -8.6 | 3.3 | -11.5 |
| 48 | 8.3 | -7.8 | 3.7 | -12.4 |
| *Significance* | | | | |
| Linear | 0.0001 | 0.0041 | 0.0001 | 0.0425 |
| Quadratic | 0.2528 | 0.2242 | 0.0012 | 0.0548 |
| Cubic | 0.0390 | 0.4042 | 0.3676 | 0.9230 |

[z]Number of flower stalks per plant with two or more flowers after indoor period.
[y]Number of flower stalks per plant after greenhouse production minus number of flower stalks per plant after indoor period.

is more important indoors than production fertilizer for these plants. This experiment did show that there is potential for using these begonia varieties in interior landscaping without having to replace the plants too frequently provided sufficient light (24 $\mu mol \cdot m^{-2} \cdot s^{-1}$ or higher) is available. Begonias with the ability to remain attractive indoors for 6 to 9 weeks at 24 $\mu mol \cdot m^{-2} \cdot s^{-1}$ or higher could compete favorably with many potted flowering plants presently utilized in interiors.

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*Proc. Fla. State Hort. Soc.* 106:302-305. 1993.

# EVALUATION OF A YARD WASTE COMPOST AS A POTTING MEDIUM AMENDMENT FOR PRODUCTION OF POTTED *AGERATUM*


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*Additional index words.* organic matter, recycling, soil amendment.


*Abstract.* **Verlite Nursery Mix A, a commercially-prepared, peat-based potting medium for greenhouse crops was blended with an Orange County yard-waste compost in 25% increments by volume from 100% peat-based medium to 100% compost. Fertilizer was added at the rate of 0, 2, 4, and 6 g of Osmocote™ 14N-6P-11.6K (14-14-14) per 12-cm pot containing one *Ageratum* 'Blue Puff' plug (2 seedlings/plug). Plants were started in a shadehouse (50% shade) for 2 weeks then moved to full sun for 7 weeks until finished. Plants grown in all media combinations without fertilizer were not salable. Potting medium formulation had no significant influence on plant height, plant width, foliage color grade, root grade and plant grade. Verlite mix (100%) without Osmocote produced the poorest quality plants of all treatment combinations. Plants which ranked best for specific measurements or ratings were grown with the following rates of Osmocote (g/pot): plant height (2, 4, and 6 g), plant width (4 and 6 g), foliage color grade (6 g), flower number (2, 4, and 6 g), root grade (2, 4, and 6 g), and plant grade (6 g). The pH range of extract from 100% Verlite mix and 100% compost, before planting, were within a good range for plant growth. The conductivity of the extract from nonleached compost was high, but with dilution with other potting amendments and leached by overhead irrigation practice resulted in normal growth of ageratum. Results of this study indicate that the Orange County yard-waste compost is a suitable amendment to supplement peat-based media for use on at least one short term potted ornamental crop.**


Florida Agricultural Experiment Station Journal Series No. N-00867.