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Effects of Light Intensity and Air Temperature in Simulated Postproduction Environment on *Petunia hybrida* Vilm.[1,2]

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Abstract. **Plants of *Petunia hybrida* 'Coral Sea' were placed in postproduction conditions of low (300 μE m^{-2}s^{-1}), medium (600 μE m^{-2}s^{-1}) or high (900 μE m^{-2}s^{-1}) quantum flux density (QFD) at temperatures of 10, 20, or 30°C after first flower opening. Change in dry weight and number of senesced flowers were determined, and visual quality ratings were given. Plants kept at 20° and 30° had greatest dry weight accumulation and flower number but poorest visual rating at 10 days when kept under high QFD, compared with those kept under medium or low QFD. When plants were kept at 10°, QFD was of little importance to postproduction quality. All plants delined in visual quality by 15 days when kept at 20 or 30° but remained satisfactory when kept at 10°. Plants should be held at either medium or low QFD when placed at 20° or 30° postproduction temperature.**

In the retail sales area, one objective should be to maintain good plant quality over an extended period of time, but it is neither necessary nor desirable to promote growth during the retail sales period. Postharvest studies of floricultural crops have concentrated primarily on cut flowers (3, 4), while little work has been done with intact plants. Postproduction response to cool nights during the production of marigolds and petunias has been evaluated (2), but no evaluation of the effects of light intensity and air temperature in the retail area has been attempted. In the spring of the year when most bedding plants are sold, air temperatures in the retail area may fluctuate widely (10 to 35°C), and plants may be placed in QFD ranging from full sun to heavy shade (1). Most bedding plants are sold in containers which have a very small volume of media, and under conditions of high temperatures, dehydration of media and high transpiration rates can cause severe plant stress. The objective of this study was to determine optimum conditions of light and temperature for enhanced postproduction life of commercially produced petunia plants.

Materials and Methods

Seeds of 'Coral Sea' petunia were sown on June 14, 1981, and germinated at 25°C in the greenhouse. After 5 days, 324 uniform seedlings were transplanted into plastic cell packs containing 110 ml of sphagnum peatmoss:vermiculite (1:1 v/v) Cornell mix. Thirty-six cell packs were placed in a standard bedding plant tray (28 × 53 cm). Plants were grown under natural long-day lengths in a shaded greenhouse equipped with pad and fan evaporative cooling. Night and day air temperatures fluctuated with ambient temperatures but never fell below 17° and 20°C, respectively. Plants were fertilized with 15N–0P–12.5K, providing 200 ppm nitrogen at each irrigation and were leached with tap water every fourth watering. The plants were divided into 3 groups and placed in different growth chambers (10, 20, 30 ± 3°), each with 3 QFD levels (300, 600, 900 ± 20 μE m^{-2}s^{-1}) 35 days after sowing (approximate date of first bloom). These treatment combinations were suggested by previous work by the authors (1). Light was supplied by Super High Output Cool White fluorescent tubes supplemented with incandescent bulbs (80:20) and received a 13-hr photoperiod. Plants were irrigated with tapwater when medium surface was dry to the touch. Watering of plants kept at 10° was done about once very 1.5 days; others were watered about once a day. Eighteen plants were removed from the growth chambers on day 1 (date of placement in postproduction conditions), and 9 plants from each treatment combination were sampled on days 5, 10, and 15. Numbers of open and senesced flowers were determined. The above ground portion of the plant was cut, dried at 80° for 72 hr, and weighed; and the change in dry weight from day 1 was calculated. A visual rating from 1 to 5 (1 = very poor, 3 = marginal, and 5 = excellent) was determined for each plant sampled and was an indication of the overall quality of the plant.

Results

Dry weight. All plants continued to gain dry weight while in postproduction areas, regardless of QFD tested (Fig. 1). Under cool postharvest conditions (10°C), all plants exhibited similar growth trends regardless of QFD. At 20° postproduction temperatures, low QFD plants grew more slowly initially (day 5) than plants under other QFD regimes, but there were no growth differences in medium- and low-light plants at day 10. Plants placed under hot postproduction conditions (30°) and high light continually accumulated more dry weight compared with plants which received low or medium QFD. All plants gained weight initially, but low QFD plants had less dry weight accumulation after 5 and 10 days. However, by day 15 there were no differences between low and medium QFD plants.

Number of flowers. There was an average of 1 flower per plant on day 1. New flower development was fastest in the hot postproduction conditions followed by moderate and then by cool conditions (Fig. 2). Plants placed in cool postproduction conditions had a flush of flowers by day 5 and day 15 regardless of QFD tested. In the moderate postproduction temperature, plants subjected to low QFD produced flowers more slowly through day 5 compared with plants placed under other levels. Plants under high QFD levels continued rapid production of

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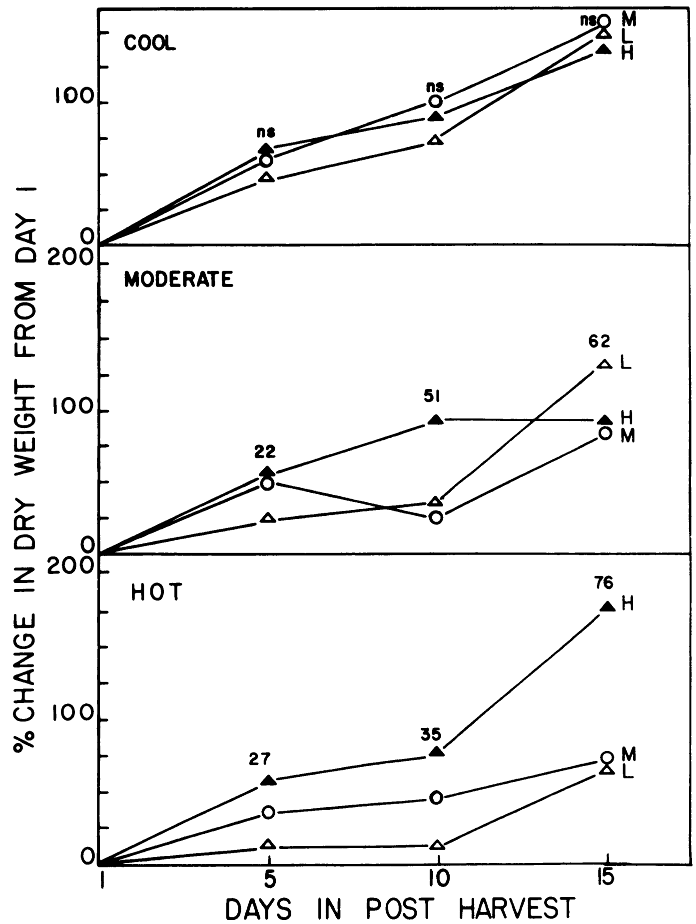

Fig. 1. Percentage of change in dry weight from day 1 of 'Coral Sea' petunia in: (a) cool, 10°C; (b) moderate, 20°; or (c) hot, 30°, postharvest temperatures at 3 quantum flux densities. H = high QFD (900 μE $m^{-2}s^{-1}$), M = medium QFD (600 μE $m^{-2}s^{-1}$), L = low QFD (300 μE $m^{-2}s^{-1}$). Numbers above each day are Tukey's ω test values, 5% level for each date; n.s. = no significance.

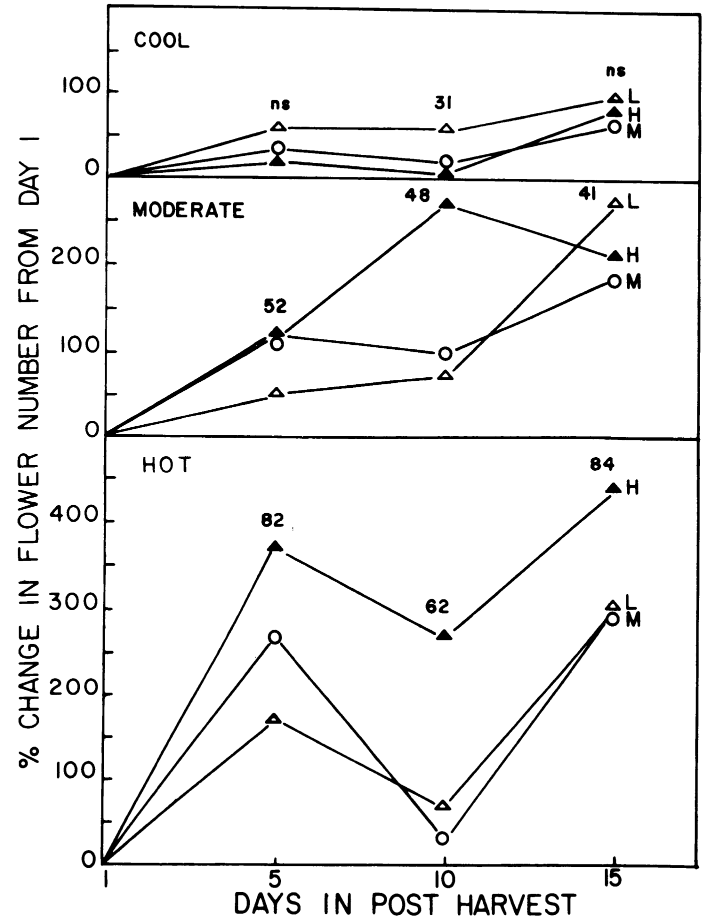

Fig. 2. Percentage of change in number of flowers from day 1 of 'Coral Sea' petunia in: (a) cool, 10°C; (b) moderate, 20°; or (c) hot, 30°, postproduction temperatures at 3 quantum flux densities. H = high QFD (900 μE $m^{-2}s^{-1}$), M = medium QFD (600 μE $m^{-2}s^{-1}$), L = low QFD (300 μE $m^{-2}s^{-1}$). Numbers above each day are Tukey's ω test values, 5% level for each date; n.s. = no significance.

flowers to day 10, but then number of flowers decreased. Plants kept under medium light flushed early, slowed in flower production, and then had high flowering by day 15. Plants in the hot postproduction conditions (30°C) flowered rapidly regardless of QFD tested, but plants under low QFD were the slowest to open. By day 10, a decline occurred in the number of flowers opening for all QFD levels, followed by another flush of flowers. Plants under high QFD and hot temperatures produced flowers at a faster rate for all sampling times.

Number of flowers senesced. Plants placed in 30°C temperatures had more flower senescence than those placed in moderate or cool chambers at all sample dates (Fig. 3). In the cool and moderate postproduction environment, little senescence occurred regardless of QFD up to day 10. By day 15, plants kept under moderate conditions and high QFD exhibited more senescence compared with medium or low QFD conditions. In the hot environment, the most rapid flower senescence occurred in plants placed under high QFD; there were no differences in plants under medium or low QFD at day 5. Senescence was slowest in plants under low QFD at day 10 compared with other QFD levels.

Visual rating. Plants in the cool postproduction environment were never rated below 4 regardless of light level, while those in hot conditions and high light were ≤ 3 by day 5 (Fig. 4). Those in the cool chamber under high QFD increased in quality rating and were of higher quality on day 5 compared with plants under other light regimes (Fig. 4). By day 15, all plants had declined but were still of satisfactory (> 3.0) quality. Plants placed under hot postproduction conditions initially declined faster than those in the cool or moderate environments. In moderate postproduction conditions, the plants placed under low light were of better quality at day 5, but after 10 days, there was no difference in quality rating between plants under low and medium QFD. In the hot postproduction chamber, all plants declined initially, but plants placed under low light were of better quality at day 10 compared to other light levels. High QFD plants in warm conditions declined rapidly but then stablilized by day 10–15.

The interaction of the effect of light level and postharvest temperatures on visual rating at day 10 (Fig. 5) indicates that light is most important at high temperatures but has little effect at low temperatures.

Discussion

Our results indicate that air temperature in the retail area is a more important environmental factor in the postproduction life of intact plants than QFD within the ranges tested. Although temperature appears to be the major environmental input in keep-

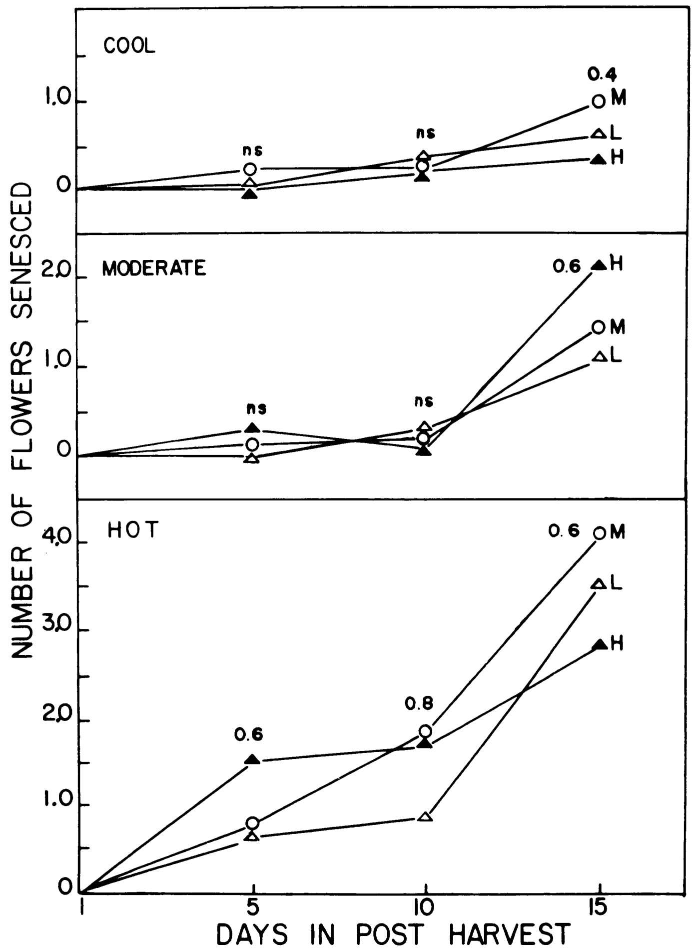

Fig. 3. Number of flowers senesced in 'Coral Sea' petunia in: (a) cool, 10°C; (b) moderate, 20°; or (c) hot, 30°, postproduction temperatures at 3 quantum flux densities. H = high QFD (900 $\mu E\ m^{-2}s^{-1}$), M = medium QFD (600 $\mu E\ m^{-2}s^{-1}$), L = low QFD (300 $\mu E\ m^{-2}s^{-1}$). Numbers above each day are Tukey's ω test values, 5% level for each date; n.s. = no significance.

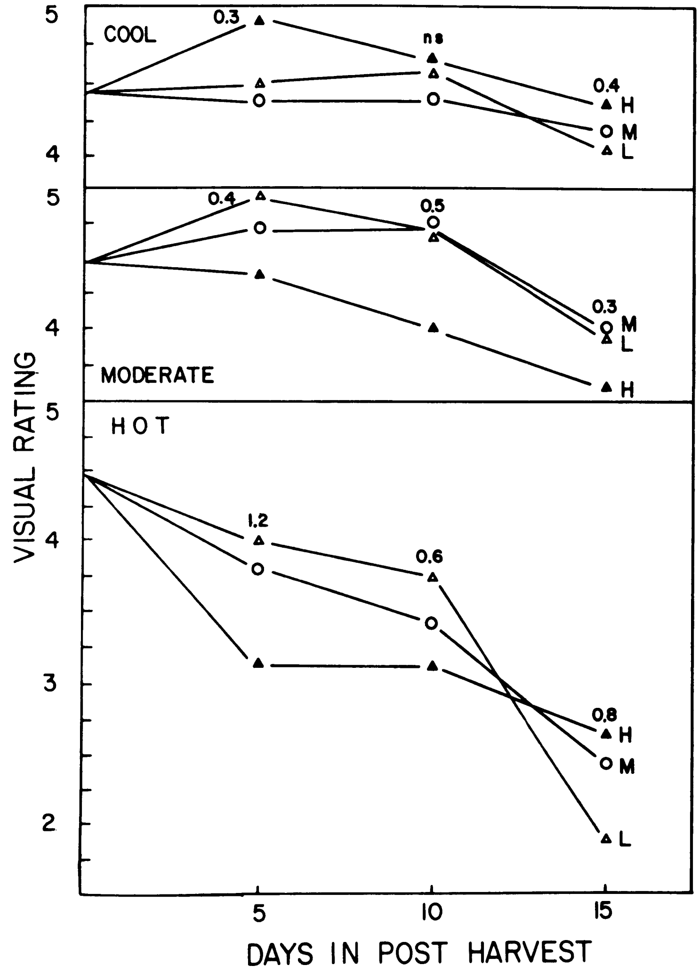

Fig. 4. Visual rating (5 = excellent, 1 = very poor) of 'Coral Sea' petunia in: (a) cool, 10°C; (b) moderate, 20°; or (c) hot, 30°, postproduction temperatures at 3 quantum flux densities. H = high QFD (900 $\mu E\ m^{-2}s^{-1}$), M = medium QFD (600 $\mu E\ m^{-2}s^{-}$), L = low QFD (300 $\mu E\ m^{-2}s^{-1}$). Numbers above each day are Tukey's ω test values, 5% level for each date; n.s. = no significance.

ing quality, it is influenced by QFD. The reduced rate of dry weight change (i.e., growth) through day 10 in plants placed in conditions of low light and 10°C is perhaps a result of decreased photosynthesis or other photoresponses inhibited at low QFD and temperatures. A main objective in the postproduction bedding plant area is maintenance and not growth, thus a slow rate of growth is beneficial if visual ratings do not deteriorate. In general, QFD levels tested are of little significance if plants are kept under cool postproduction conditions. At 20° temperature, however, plants visually declined more rapidly in high light even by day 5, reflecting a rapid rise in dry weight production and flower senescence. The rapid rate of flower production was the reason they were not rated below 3. The low visual rating of low QFD plants at day 5 is due to their slower rate of flowering. Plants subjected to high temperatures and high QFD declined most rapidly by day 5, suggesting that QFD was too intense when high rates of metabolism were occurring. High temperature and high QFD combination also caused rapid flower opening and senescence and rapid overall deterioration. A satisfactory visual rating for all QFD treatments in the hot chamber on day 10 suggests that some adaptation is taking place, but by day 15, plants subjected to low QFD levels declined rapidly. The QFD temperature interaction in visual rating at day 10 shows that

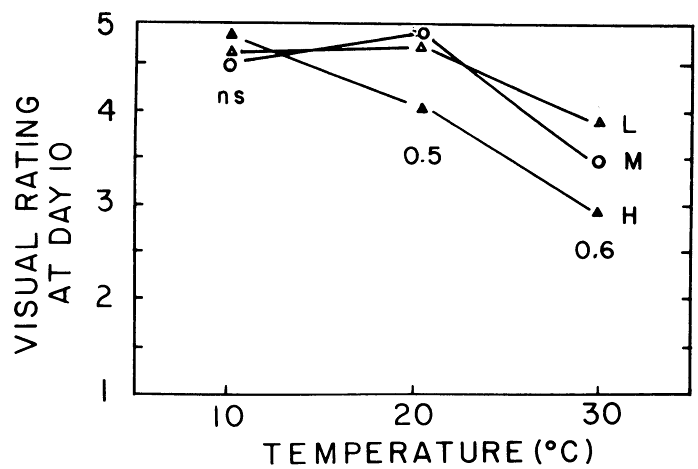

Fig. 5. Visual rating (5 = excellent, 1 = very poor) at day 10 of 'Coral Sea' petunia at 3 different postproduction temperatures at 3 quantum flux densities. H = high QFD (900 $\mu E\ m^{-2}s^{-1}$), M = medium QFD (600 $\mu E\ m^{-2}s^{-1}$), L = low QFD (300 $\mu E\ m^{-2}s^{-1}$). Numbers above each temperature are Tukey's ω test values, 5% level for each date; n.s. = no significance.

when plant metabolism is high at 20° and 30°, QFD responses are likely saturated at low intensities, and high QFD levels are detrimental to overall plant quality at these temperatures. Photoresponses appear to be less important in maintaining intact plant quality when plants are kept at 10°.

The results of this work provide several practical ramifications for people involved in retail sales of bedding plants. An obvious goal is to hold plants in the retail area for as short a time as possible. If plants are sold within 2 or 3 days, the postproduction environment within ranges we tested is of little importance. If plants are held between 3 and 10 days, low light (about 70–85% shade) in the postproduction environment will aid in maintaining better quality plants when temperatures are 20 to 30°C. Petunias must be shaded if they are to be maintained for any length of time.

Shading of the plants may be accomplished in many ways, and previous work by the authors indicates that 80% shade reduction on bright days is not unreasonable (1). At the highest QFD level provided in this work (about 50% shade), plants declined rapidly; plants under full sun would be expected to decline even faster. By 15 days, petunias would likely be unsalable if not held at cool temperatures. Until retail operators provide artificially cooled and lighted retail areas for bedding plants, shade and air movement are the best means to aid in temperature reduction.

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Effect of Irrigation Frequency during Greenhouse Production on the Postproduction Quality of *Petunia hybrida* Vilm.[1,2]

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Additional index words. chlorophyll, flower senescence, water

Abstract. **'Coral Sea' petunia plants were irrigated at "low" frequency (surface media dry, soil moisture = −4 to −10 bars), "normal" frequency (surface media moist, soil moisture = −0.8 to −3 bars) or "high" frequency (surface media wet, soil moisture > −0.6 bars) during production. Postproduction quality was evaluated under cool (10°C day, 10° night), moderate (20° day, 20° night), or hot (30° day, 20° night) temperature postproduction environments. Frequency of irrigation was not significant when plants were placed in cool postproduction environments. In moderate or hot postproduction conditions, plants irrigated with high frequency declined in quality most rapidly. Low moisture-treated plants had slower flower development and senescence, greater dry weight, and better overall visual quality than plants with other moisture treatments.**

Successful bedding plant production involves the integration of proper fertilizer, light, temperature and irrigation regimes. Frequency of irrigation is related to moisture stress, and many bedding plant growers will allow the media to become very dry and the plant to wilt before additional water is applied. Growing plants under conditions of moisture stress results in shorter plants and reduced plant growth (9). Others will irrigate crops to maintain constant high soil moisture, resulting in more rapid and succulent growth and taller plants. Several studies (4, 5, 6) have delineated the effects of irrigation frequency on production parameters such as flower yield, height, and leaf area of floriculture crops, but they have included little on its effect on postproduction life. Although studies of whole plant keeping quality of floriculture crops have received attention recently (9, 10, 11, 12), most postproduction research has dealt with cut flowers. Water is generally reduced in foliage plants for acclimatization (3, 8), and although many growers reduce water at the end of the crop cycle for hardening-off, little documentation of the benefits of this practice exists.

The objective of this study was to determine the effects of irrigation practices during the production phase on the postproduction quality of petunias under various simulated retail environments.

Materials and Methods

Seeds of 'Coral Sea' petunia were sown under intermittent mist on May 7, and 320 seedlings selected for uniformity were transplanted into a 1 sphagnum peatmoss:1 vermiculite (v/v) "Cornell" medium (1) on May 25. Seedlings were planted in plastic cell packs containing about 110 cc of medium, and 36 plants were placed in a standard bedding plant tray (28 × 53 cm). Plants were produced in a shaded greenhouse (about 50% shade) equipped with adiabatic fan and pad cooling. They were grown under a natural long photoperiod at 17 ± 3°C (night) and 22 to 34° (day) temperature.

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