Temperature and Postharvest Performance of Rose (*Rosa hybrida* L. 'First Red') and Gypsophila (*Gypsophila paniculata* L. 'Bristol Fairy') Flowers

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Abstract

The respiration of cut flowers of rose (*Rosa hybrida* L. 'First Red') and gypsophila (*Gypsophila paniculata* L. 'Bristol Fairy') increased exponentially with increasing respiration, with a Q_{10} value between 0 and 10°C of 3 for both flowers. The vase life of the flowers was negatively affected by simulated transport at higher temperatures whereas dry storage for 5 days at 0°C resulted in a vase life that was not distinguishable from that of the initial controls. When 'First Red' flowers were held in wet storage, the effects of temperature on vase life were quite similar, with slightly longer vase life for wet-stored flowers from 12.5 and 15°C. We found a highly significant linear relationship between respiration during storage and vase life after storage for these important commercial crops, indicating the importance of maintaining temperatures close to the freezing point during commercial handling and transport in contrast to common belief in the industry.

INTRODUCTION

Roses and gypsophila are important standard materials in the florist trade. Although it has long been asserted that flowers should be stored and transported at temperatures close to the freezing point (Maxie et al., 1973; Carow, 1978; Hardenburg et al., 1986; Nowak and Rudnicki, 1990; Jones and Moody, 1993; Sacalis, 1993), it is only recently that the importance of storage temperature in the vase life of stored flowers has clearly been demonstrated (Cevallos and Reid, 2000; Çelikel and Reid, 2002). A common assertion by producers of cut roses is that storage at temperatures near 0°C results in blackening of red cultivars like 'First Red'. This, and the perception that storage temperature is not particularly critical, especially if flowers are transported in water, has led to temperatures that are higher than desirable during long-distance flower shipment and storage in wholesale warehouses.

The objective of the experiments reported here was to examine the hypothesis that postharvest performance of red roses and gypsophila would be optimal when the flowers were stored at temperatures just above the freezing point.

MATERIALS AND METHODS

Plant Material

Roses (*Rosa hybrida* L. 'First Red') were obtained from a commercial grower in Watsonville, transported to Davis, and used in experiments within 24 h. Gypsophila (*Gypsophila paniculata* L. 'Bristol Fairy') were grown in California and obtained from a local wholesale distributor.

Respiration Measurement

The effect of temperature (ranging from 0 to 20°C) on respiration was determined using the 'dynamic' system described by Cevallos and Reid (2000), in which we followed respiration of the flowers over the whole temperature range. A single rose flower, cut just

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below the receptacle, was sealed in a jar ventilated with a stream of CO_2-free air flowing at a rate sufficient to prevent CO_2 concentrations rising above 500 ppm at the highest temperature used (20°C). The jar was submerged in a 30% glycol bath (LAUDA K-4/R, Brinkmann Instruments, Germany) providing precise control of temperature. Respiration of the flower was determined by continuously recording the CO_2 concentration at the outlet of the jar using an infrared gas analyzer (Qubit Systems Inc., Kingston, Ontario, Canada).

The flowers were held overnight at 20°C in the respiration chamber to dissipate any effects of handling on respiration. The CO_2 concentration was recorded, then the temperature of the bath was changed to 15°C. After a stable CO_2 reading was obtained (approximately 1.5 hours), the temperature of the bath was further reduced to 12.5°C, and after similar time intervals to 10, 7.5, 5, 2.5, and 0°C. The effect of temperature on respiration was measured in this manner for at least three replicate flowers. For gypsophila, respiration was measured on a group of panicles comprising buds and open flowers. For rose, we used a single flower cut to 6 cm of the stem.

Wet and Dry Storage

To determine the effect of storage temperature on subsequent vase-life at 20°C, flowers were recut to a length of 30 cm, and six replicate stems were wrapped in newspaper and polyethylene and packed dry in a fiberboard box. Replicate stems of ‘First Red’ roses were also placed in vases containing DI for ‘wet’ storage. The flowers were then stored at temperatures ranging from 0°C to 12.5°C for five days.

Determination of Vase Life

After storage, the roses were re-cut under water to 25 cm and placed in DI containing 50 ppm NaOCl (chlorine bleach), in the controlled-environment vase life evaluation room. A 20 cm panicle was removed from each gypsophila inflorescence and placed in the same solution. The room was kept at 20°C and about 60% relative humidity. Artificial light (15 $\mu mol.m^{-2}.sec^{-1}$ PAR) was provided 12 hours/day from cool white fluorescent tubes (Sylvania Lighting Co., Danvers, Mass.).

The flowers were examined daily, and their vase life was recorded as the time to wilting of the flower (roses), or wilting of half of the open florets (gypsophila).

RESULTS

Effect of Temperature on Respiration

The respiration of both flowers examined increased exponentially with increasing temperature (Fig. 1a and 2a). Q_{10} value between 0 and 10°C was 3 for both flowers.

Effect of Storage Temperature on Vase Life

As the storage temperature increased from 0 to 15°C, the vase life of both tested flowers fell (Fig. 1b, 2b and 3). For gypsophila, storage for 5 days at 0°C resulted in a vase life that was not distinguishable from that of the initial controls. In roses, even storage at 0°C resulted in some loss of vase life, perhaps reflecting an observed increase in the incidence of *Botrytis* in the stored flowers.

Comparison of Wet and Dry Storage

When ‘First Red’ flowers were held in wet storage, the effects of temperature on vase life were quite similar (Fig. 1b), with slightly longer vase life for wet-stored flowers from 12.5 and 15°C. The vase life of the wet-stored flowers was nevertheless reduced by more than 3 days when they were stored at 15°C.

Relationship between Vase Life and Respiration at Different Storage Temperatures

The vase life of flowers after storage for five days at different temperatures was highly linearly correlated with the respiration of the flowers at those different temperatures (Fig. 1c and 2c). The slopes of the regressions were substantially different between the species tested, with a very strong negative correlation for gypsophila (Fig. 2c), and a moderate negative correlation for roses (Fig. 1c). The slope of the regression was less in wet stored rose flowers than in dry stored roses (Fig. 1c).

DISCUSSION

The experiments reported here clearly demonstrate the importance of proper temperature control in the postharvest handling of roses and gypsophila. In contrast to common belief in the industry, the post-storage quality and vase life of these flowers was best when they were stored at 0 or 2.5°C. As shown before (Cevallos and Reid, 2000; Çelikel and Reid, 2002) for other flowers, the benefit of decreasing temperature was largely associated with a reduction in respiration rate as the storage temperature fell. Well over 90% of the variance in the vase life of the flowers after storage could be explained by the effects of storage temperature on flower respiration.

The effect of temperature on respiration was similar in both flowers. They had very high respiration rates at warmer temperatures, and a very high Q_{10} (3) reflecting a pronounced effect of temperature on respiration. In gypsophila, storage at 10°C for five days halved the subsequent vase life of the flowers. Roses suffered less vase life reduction (about 40%). As the storage temperature increased, vase life of flowers after storage was dramatically reduced, principally as a result of accelerated abscission (Fig. 1b and 2b). The decrease in vase life of the flowers was matched by an exponential increase in the respiration of flowers at increasing storage temperatures (Fig. 1a and 2a).

Recently, shippers have been using 'wet' transportation systems like the proprietary 'Procona' system for transporting cut flowers. They claim a significant improvement in out-turn of the flowers, a claim that is substantiated by our data with roses *only* when the flowers are held at warmer temperatures (Fig. 1b). While these data *do* indicate the value of wet storage under non-ideal temperature conditions, it is also important to note that flowers stored at 0°C had the same vase-life (ca. 9 days) whether stored wet or dry, and that this vase life was 50% longer than that of flowers stored wet at 15°C.

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Figures

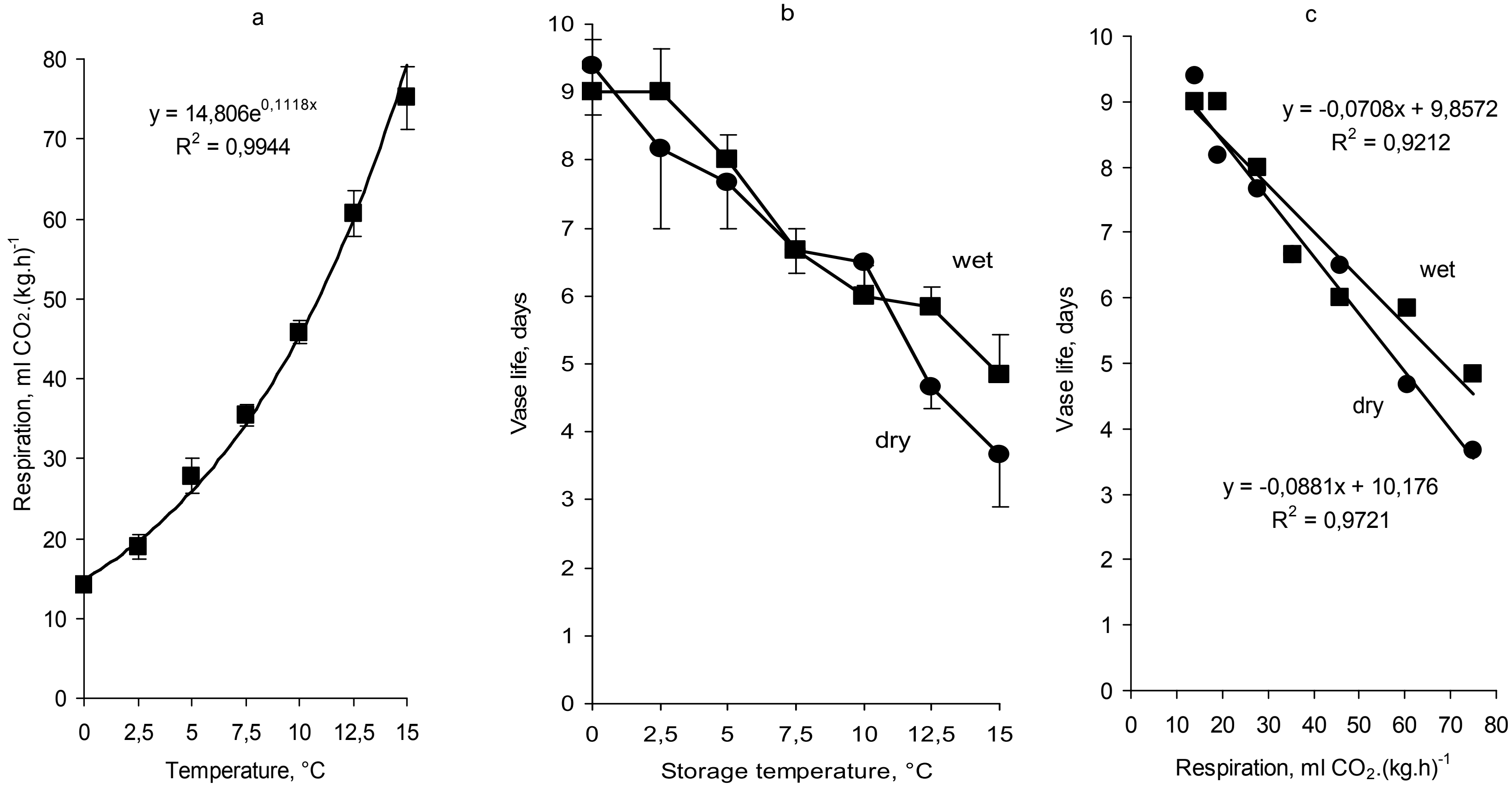

Fig. 1. Respiration rates at different temperatures (a), vase life at 20°C after 5 days of dry or wet storage at different temperatures (b) and relationship between vase life and respiration (c) of dry and wet-stored rose (*Rosa hybrida* L. 'First Red') flowers. Vertical bars in Fig. 'a' and 'b' show standard errors of three and six replicate flowers, respectively, for each temperature. The vase life of the non-stored flowers was 10.5 ± 0.5 (mean ± SD) days.

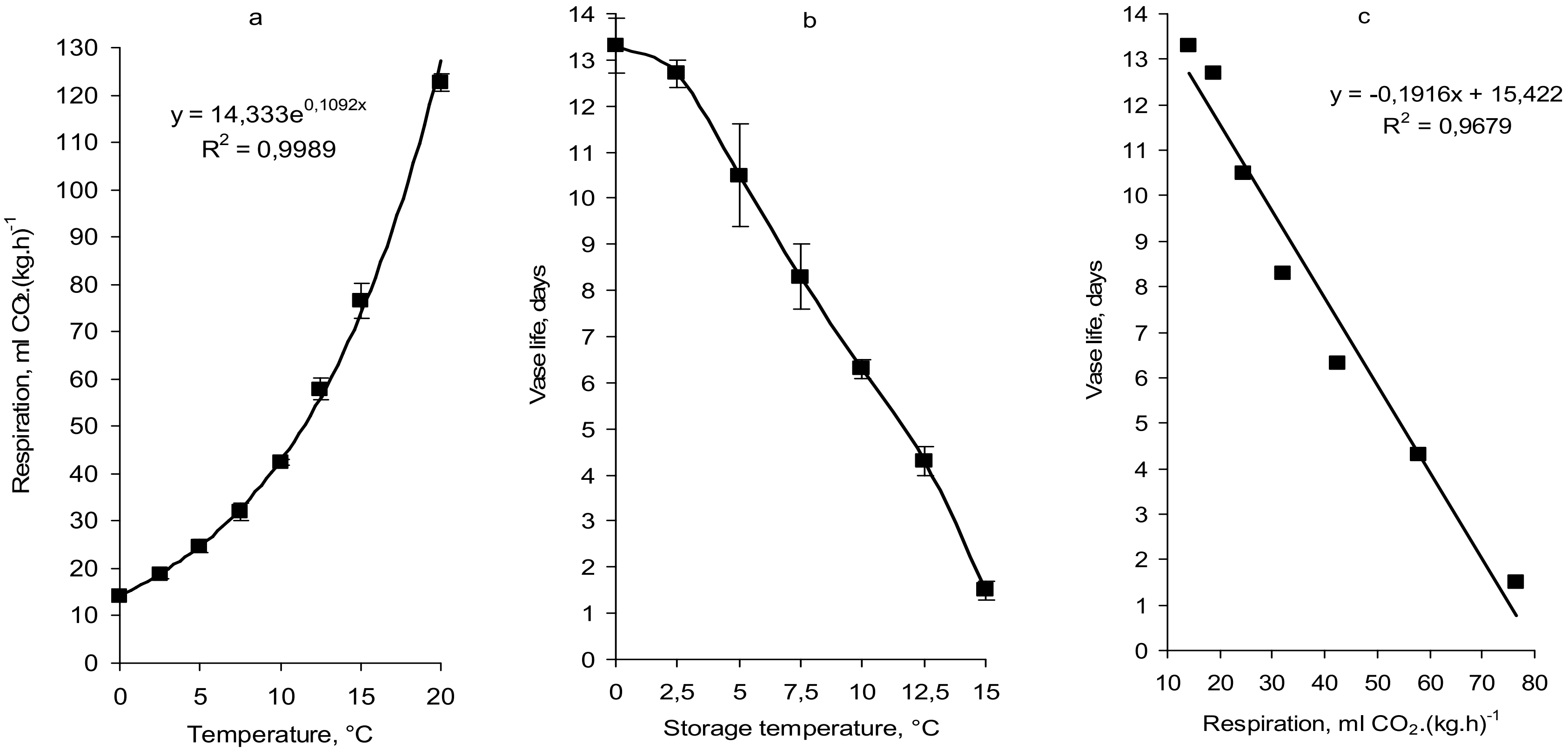

Fig. 2. Respiration rates at different temperatures (a), vase life at 20°C after 5 days of dry storage at different temperatures (b) and relationship between vase life and respiration (c) of gypsophila (*Gypsophila paniculata* L. 'Bristol Fairy') flowers. Vertical bars in Fig. 'a' and 'b' show standard errors of three and six replicate flowers, respectively, for each temperature. The vase life of the non-stored flowers was 14.2 ± 3.0 (mean ± SD) days.

Fig. 3. Effect of 5 days dry storage at six different temperatures (0, 2.5, 5, 7.5, 10 and 12.5°C) on rose (*Rosa hybrida* L. 'First Red') flowers after 8 days in the vase.