Title Extending cut flower vase life by optimizing carbohydrate status: Preharvest conditions and preservative solution

Author Emma Locke, John M. Dole and John D Williamson

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Abstract

Carbohydrates have numerous roles in plants, serving as photosynthetic precursors required for growth, respirable substrates, osmoregulators, and sometimes, as osmoprotectants. Additionally, carbohydrates can act as cellular signals, controlling gene expression. In experiments with cut *Helianthus*, *Lilium* , and *Rosa* , we explored the effects of endogenous and exogenous carbohydrates on vase life and ethylene sensitivity.

Cut *Rosa* produced in South America are shipped for thousands of miles, frequently stored prior to shipment, and are held dry during shipping and storage. To see if protective carbohydrates would prevent or aid recovery from dehydration stress associated with dry shipping and storage, we conducted a number of pulsing and vase solution experiments with carbohydrates not currently used as pulsing and vase solutions. In cut *Rosa* 'Freedom', treatment with protective carbohydrates such as polyols, trehalose, and raffinose as vase solutions frequently resulted in a vase life similar to that of stems treated with sucrose, which averaged 14.6 and 15.7 days. The longest vase life for stems treated with protective carbohydrates was 13.9 and 15.5 days for one Splenda ® and raffinose concentration, respectively. Vase life of water treated stems for these experiments was 13.2 and 13.9 days. In a subsequent experiment, no increase in vase life above the water control was observed for Splenda® or for either component of Splenda ®, maltodextrin or sucralose, while sucrose yielded an increased vase life. The monosaccharides glucose and fructose yielded vase life as good as, or better than, vase life of stems treated with sucrose. Fructose increased vase life by as much as 4.4 days over sucrose; a commercial preservative solution increased vase life by 4.5 days over sucrose. When sucrose, glucose, and fructose were used as vase solutions, glucose and fructose contents of petals sampled on day 6 were the same in all cases, ranging from 31.83-34.96 and 67.03-69.86 mg g^{-1} dry weight for glucose and fructose, respectively. In contrast, glucose and fructose contents were decreased in water-treated roses (21.52 and 44.19 mg g-1 dry weight, respectively). In two experiments using carbohydrates as pulsing solutions prior to shipping, and in a third experiment using carbohydrates as holding solutions prior to storage, no increase in vase life above the water control was

noted for any carbohydrate solution for *Rosa* 'Freedom', 'Judy', 'Polo', 'Verdi', or 'Versilia', although vase life differed by cultivar. Pulsing with solutions of abscisic acid, ascorbic acid, giberellic acid, indole-acetic acid or quercetin did not yield noticeable changes in vase life in cut *Rosa* 'Charlotte' or 'Freedom'; however, these pulses may have influenced carbohydrate content.

Some reports suggest *Lilium* species are not sensitive to ethylene, while other reports indicate otherwise. A previous report indicated that 'Stargazer' had increased sensitivity to ethylene after cold storage. We hypothesized that differences in sensitivity might be due to carbohydrate status, particularly starch levels, which can change as a result of cold exposure. To test this hypothesis, we pretreated *Lilium* of different genetic backgrounds with 1-methylcyclopropene (1-MCP) or silver thiosulfate (STS) before exposing them to a two-week cold storage period and subsequent treatment with 10 L L^{-1} ethylene. Storage decreased vase life of cut *Lilium* 'Princess Amalia', 'Red Alert', 'Renoir', and 'Stargazer' by 4.1, 5.5, 5.8, and 2.0 days, respectively. Storage decreased tepal starch content and leaf sucrose content, but increased tepal sucrose and fructose content. The magnitude of changes in carbohydrate content was dependent on cultivar. Vase life was positively correlated with starch in tepals and stems plus carpels, and with sucrose in leaves, but was negatively correlated with sucrose in tepals. Ethylene treatment reduced vase life in 'Red Alert' while pretreatment with either 1-MCP or STS increased vase life in both 'Red Alert' and 'Renoir'. Postharvest bud blast during vase life evaluation differed only by cultivar, ranging from 0 to 0.24 buds per stem for 'Red Alert' and 'Renoir', respectively.

Vase life of *Lilium* 'Vermeer' and 'Dazzle' was decreased by high temperature but not by low light during production. Differences between vase life of 'Vermeer' in year 1 and 'Dazzle' in years 2 and 3 between high and low production temperatures were 0.5, 3.0, and 1.2 days, respectively. However, the number of marketable stems (stems with three or more buds) was decreased by both low light and high temperature. Out of 20 stems per crate, low light decreased the number of marketable stems by 4.5 and 5.0 stems in years 2 and 3, respectively, while high temperature decreased marketable stems by 10.2 and 12.4 stems in years 2 and 3, respectively. Vase life of *Helianthus* 'Sunbright' was decreased by high production temperature in year one of the study (2.6 days) and was affected by a light and temperature interaction in year 2, where vase life tended to be decreased at high temperatures and shade promoted vase life at lower temperatures but decreased vase life at higher temperatures. The longest vase life for *Helianthus* grown during year 2 was 15.5 days for stems grown at 10°C night temperature in 30% shade, while the shortest vase life was 10.2 days for stems grown at 20°C in 30% shade. Neither temperature nor light affected vase life of *Helianthus* in year 3. Temperature and light affected carbohydrates sampled during years 2 and 3 in both *Lilium* and *Helianthus* , but carbohydrates had more of an effect on the vase life and quality of *Lilium*

than of *Helianthus* . When buds from a *Lilium* stem were pooled for sampling, vase life did not correlate with tepal carbohydrate content, but was correlated with carbohydrates from leaves, stems, and non-tepal inflorescence tissue. In year 2, changes in vase life of *Helianthus* correlated with changes in different carbohydrates in leaf, stem, ray floret, and non-ray floret inflorescence tissues, but in year 3, vase life was only positively correlated with sucrose in ray florets.