ADVANCES IN SHIPPING AND HANDLING OF ORNAMENTALS

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Abstract

The over-riding consideration for improving the consumer-level quality of cut flowers and other ornamentals is improved temperature management during shipping and handling. Our research has shown that the proper handling temperature for flowers other than tropicals is close to the freezing point, 0°C (32°F). Techniques for ensuring proper temperatures during marketing include improved precooling, use of surface transportation, disposable time-temperature indicators, and the use of refrigerated air containers. Transporting flowers in water provides only modest protection from the negative effects of marketing at incorrect temperatures.

1. Introduction

The market for cut flowers is increasingly a global market. Flowers are shipped to the major consumers such as the U.S.A., Europe, and Japan from all over the world. This globalization has significantly increased the average time between harvest of a flower and its arrival in the consumer's home. Increased time in the marketing channels has significant implications for the eventual life of the flower, and places increased pressure on careful attention to the factors that affect the postharvest life of the flower. In this brief review, I will discuss some of the research that has been conducted recently in my laboratory and with industry cooperators, in an effort to reduce losses that occur during the marketing chain.

2. Temperature – the over-riding consideration

Professionals in the floral industry have long known that temperature is an important factor affecting the postharvest life of flowers. We ship flowers in refrigerated trucks, florists use cool-rooms to hold their flowers, and we even recommend to consumers that they place their flowers in the refrigerator or a cool place overnight to increase their vase life. However, this appreciation for the importance of temperature has not extended to implementation of an effective cool-handling chain for these highly perishable products. The temperatures that are commonly experienced by cut flowers marketed in North America are well illustrated by the results of monitoring temperatures in a box of roses that were sent from Quito, Ecuador, to Davis, California (Fig. 1).

The flowers were cooled somewhat in Quito, increased in temperature during transport to the airport and in the aircraft, were cooled (relatively slowly) to close to the proper temperature in Miami, and then warmed up and went through several temperature oscillations en route to Davis. Since the industry has known that these sort of temperature variations are common, particularly for imported flowers, we sought to examine the effect of incorrect temperatures on flowers.

In a series of experiments, Juan-Carlos Cevallos (Cevallos, 1999) examined the effects of different transportation temperatures on the life of cut flowers. The experiments were conducted on freshly harvested flowers that were wrapped in newsprint and polyethylene and stored at a range of low temperatures for 4 to 6 days to simulate normal

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transportation times. The flowers were then placed individually in sterile plastic vases containing deionized water (DI) in a vase-life room at UC Davis (20°C, 12 h/day light from cool-white fluorescent lamps, ca. 60% R.H.) for evaluation of quality and vase life. The results of the study showed a clear relationship between storage temperature and vase life – the higher the storage temperature, the shorter the vase life (Figs 2,3). For every flower that we studied, the results were similar. The best storage temperature by far is close to the freezing point, and temperatures commonly experienced during transportation of cut flowers (5-10°C – 40-50°F) reduce the vase life substantially, as much as 50% after

A common postharvest problem for cut flowers is bending of the stems. The bending of the scape of gerbera flowers is clearly very sensitive to the temperature at which the flowers are stored (Fig. 2). Flowers stored at 0°C showed no effect of storage, whereas flowers stored at higher temperatures showed progressively increased negatively geotropic bending.

Narcissus are among the more sensitive cut flowers to handling at improper temperatures. As can be seen in Fig. 3, the vase life of the flowers is reduced 30% by storage for 4 days at 10°C (50°F).

3. Strategies for improving postharvest temperature management

Convinced that improper temperatures during marketing are a major source of loss of quality and reduced vase life for cut flowers, we have been assessing a range of strategies for improving postharvest temperature management, including improved pre-cooling, monitoring truck transportation temperatures during transport of California cut flowers, refrigerated transport of flowers from Central America, use of disposable time-temperature indicators, and educational programs for all participants in the marketing of cut flowers.

3.1. Improved precooling

The forced air precooler that is the standard technique for precooling cut flowers was developed in California in the late 1970's and has been adopted around the world. It relies on movement of cool air through the flowers and the air is sucked or blown from a refrigerated plenum (Fig. 4). Air cannot move through the flowers unless the box is packed correctly. There should be a 6 cm (3 in) air gap at each end of the box, and there should be only sufficient paper to protect flower heads from stems of adjoining bunches.

Many of the early precoolers were constructed using the 'humifresh' system that employs an ice bank and ice-water to cool the air. These precoolers cannot provide air that is cooler than about 1° C (34°F) at best, and modern precooling facilities use direct expansion coils to provide air at 0°C (32°F). Improved packing and improved precooler design and construction is an important component to ensuring proper temperature management during the rest of the marketing chain.

3.2. Monitoring transportation temperatures for California cut flowers

Over the past two years we have been continually monitoring temperatures during the transportation of California cut flowers. Miniature dataloggers have been placed among bunches of flowers in boxes during packing, and recovered by a cooperating wholesaler on the East Coast for downloading temperature profiles. Results have been variable but very commonly show a pattern like the example illustrated in Fig. 5. In this shipment, flowers were precooled to a relatively satisfactory temperature after packing, and then warmed up substantially during transport to a dock where they were transferred to a long-distance truck. In the truck the flowers cooled down slowly, with a mid-transport peak probably reflecting a period when the doors were opened to drop product off at an intermediate destination. The flowers cooled to around 2.5°C (37°F) after about two days of transportation.

3.3. Deployment of inexpensive time-temperature indicators

As part of the 'California Fresh' program described below, we contracted with a Swedish Company, Vitsab (http://www.vitsab.com/default.htm) to supply us with disposable time/temperature indicators. These enzyme-based stick-on tags provide a visual indication of the temperature history of the flowers (Fig. 6). The three-dot strips that we used in our trials were designed to change color after 1, 2, or 4 days' exposure to temperatures above 4°C, and cost 35 cents each. The tabs were placed in flower boxes with miniature dataloggers (as part of the 'California Fresh' program), and we were able to demonstrate a good correlation between the color of the dots and the temperature history of the flowers as indicated by the datalogger record. For commercial use, it is anticipated that a single dot that changes color once flowers have been exposed to temperatures above 4°C (40°F) for two days might be sufficient to give an indication of product freshness, and would be inexpensive enough to include on every flower sleeve.

3.4. Refrigerated transportation of flowers from Central America

The adverse temperatures experienced by Central American flowers that are exported to the U.S. (and to Europe) are a major factor affecting their quality and postharvest life (Fig.1). In recent months, there has been increasing interest in the potential for transporting these flowers under refrigeration. Two possible technologies have been tested on an experimental basis: refrigerated marine shipping, and use of individually refrigerated air containers. The major trade in bananas from Central America is now conducted largely with refrigerated containers and fast container ships that make it possible to land products in North America within 1 week of harvest. In pilot trials with flowers from Ecuador, we have seen excellent temperature control during transport, and good out-turns for many of the cut flower species tested. Refrigerated air containers are available for lease, and although expensive, provide an immediate opportunity for growers to test the benefits of an unbroken cold chain from the packing shed to the consumer. Given the high value of cut flowers, and the rapid deterioration that we have demonstrated for flowers held at improper temperatures, this is certainly a technology worth exploring for the future.

3.5. 'California Fresh': a pilot temperature management program

As part of our effort to improve temperature management of California cut flowers during transportation, and in cooperation with industry leaders and the California Cut Flower Commission, we conducted a pilot trial of a program we call 'California Fresh'. The Goal of the program is that the flowers will be cooled after packing to 1.5°C (35°F) and maintained at that temperature or below until arrival at destination. In the pilot trial, selected shippers supplying a major East-coast wholesale florist with fresh cut flowers agreed to pack their flowers so that they could be pre-cooled easily, to include dataloggers and time-temperature indicators, to precool the boxes to the target temperature, and to probe and record flower temperatures as the flowers leave their dock. The trucking company that picks up the flowers and loads the long-haul truck agreed to probe the boxes on arrival at their dock, to pre-cool any that arrived at temperatures above 4°C (40° F), and to check temperatures as boxes were loaded into the truck. On arrival on the East coast, the boxes were again probed and their arrival temperature was recorded. The state of the time-temperature indicators and the condition of the flowers on arrival were also recorded, and the dataloggers were returned to our laboratory for decoding.

The results of the California Fresh pilot were mixed. We gained a valuable database of information on the temperatures commonly experienced by flowers during transport. We also determined that problems continue to be in provision of adequate

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precooling, proper packing, proper operation of precoolers, and inadequate temperature control during pick up of boxes from individual farms. However, the trial was a very significant opportunity to sensitize the industry to the temperature issue, and we observed a general lowering of cooler and truck temperatures during the summer.

3.6. Educational programs

Although the basics of temperature management for cut flowers have been known for years, turnover in industry personnel as well as the advent of new technologies places a high priority on continuing education. In recent years we have published a special issue of Perishables Handling (Reid *et al*.,1998), and developed a training video (in Spanish and English, available from the California Flower Growers and Shippers Association).

4. Transportation in water – do Proconas and Aquapacs have some value?

In recent years, the industry has increasingly utilized the 'Procona' and 'Aquapac' systems for transportation of cut flowers. Flowers are transported in boxes with water or a flower preservative in the bottom. It has widely been suggested that this transportation method reduces the need for proper temperature control and that flowers have a longer vaselife after transport in water. We have tested this suggestion on a wide range of crops, and find the benefits of shipping in water to be much over-stated. Typical results are shown in Fig. 7 for *Narcissus* flowers stored dry or in water. The vase life after both dry and wet storage decreased with increasing storage temperatures (Fig. 4). There were no significant differences between dry and wet storage except for flowers stored at 12.5°C (55°F). At that temperature wet stored flowers had 0.5 d longer vase life, but the vase life of the wet-stored flowers was 2 days shorter than that of dry or wet-stored flowers stored at the proper storage temperature (0°C, 32°F). Apart from the obvious disadvantages of increased expense and weight, these systems typically are much more difficult to cool in the standard precooling systems presently available in the industry.

5. Conclusions

The world over-supply of cut flowers puts tremendous pressure on our industry to increase consumption. This will only be achieved by providing consumers with products that give a high degree of satisfaction; they MUST have an an adequate vase life. Our research has shown the importance of proper temperature control in the maintenance of vase life, but has also shown the difficulties of changing the distribution system to ensure proper temperature control. It seems likely that the most important tools to address this dilemma will be techniques that the intermediate marketers – wholesalers and florists – will be able to use to determine the freshness of flowers. The time-temperature indicators tested in our studies may be an important example of such techniques.

Acknowledgments

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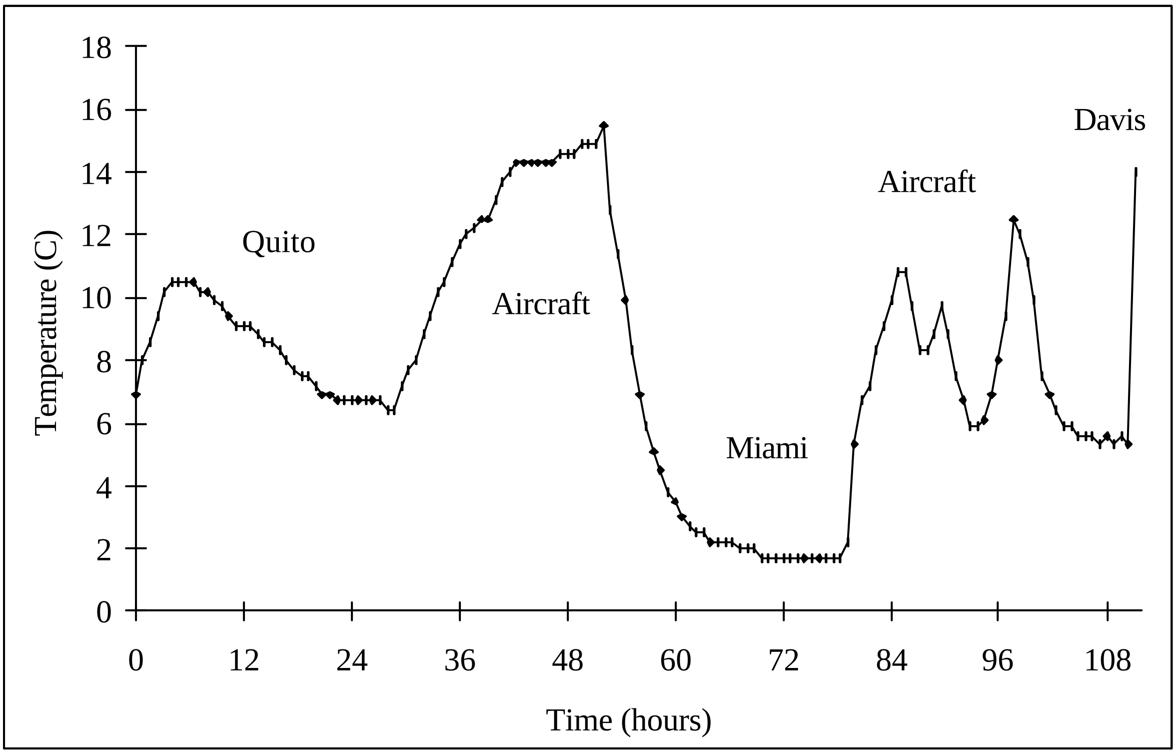
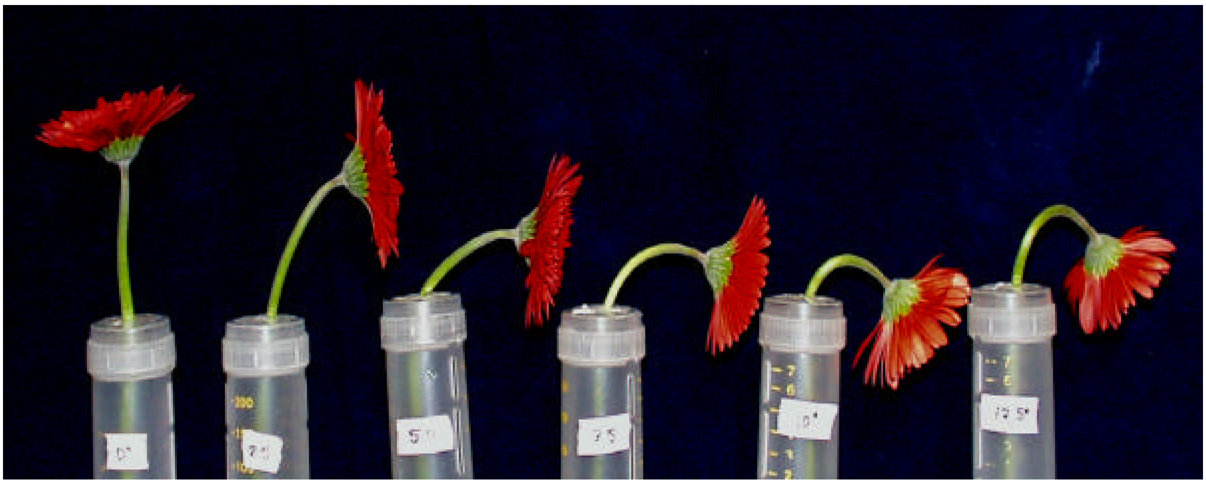
Cevallos, J-C, and M.S. Reid, 1999. Effect of Temperature on the Respiration and Vase Life of *Narcissus* Flowers. Acta Horticulturae (in press).
Reid,M.S.,1997. Ornamentals. Issue 92, Perishables Handling, U.C. Postharvest Research and Information Center, 40 pp. http://postharvest.ucdavis.edu/Pubs/phn92.html

Figures

1. Temperatures in a box of roses transported from Quito, Ecuador, to Davis, California.





2. Effect of storage temperature on quality of gerbera after storage. Gerberas stored at different temperatures for 4 days were placed in the vaselife room and photographed after one day. From left to right, storage temperatures were 0, 2.5, 5, 7.5, 10 and 12.5°C (32, 37, 41, 46, 50, 55°F).

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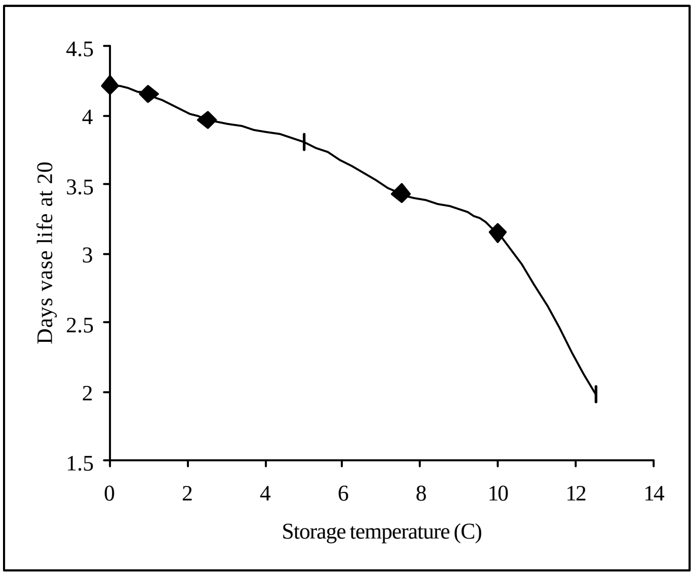
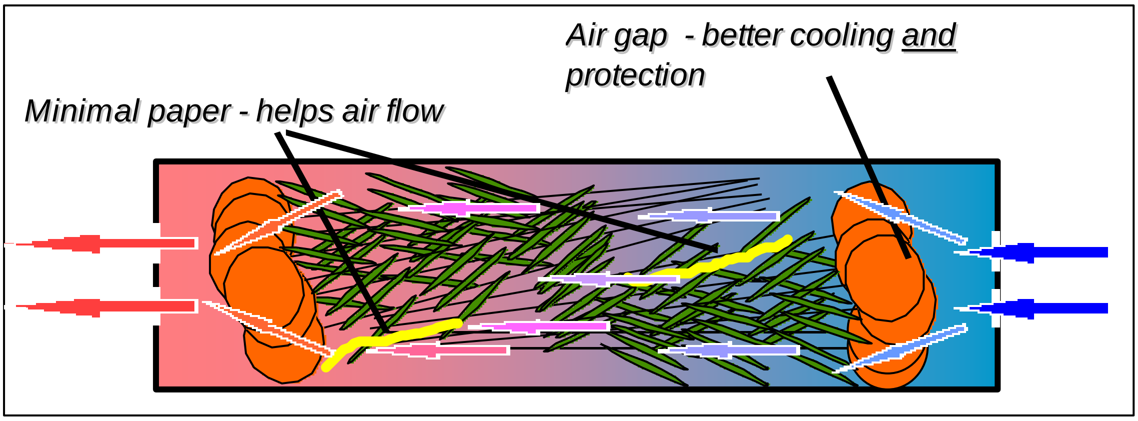
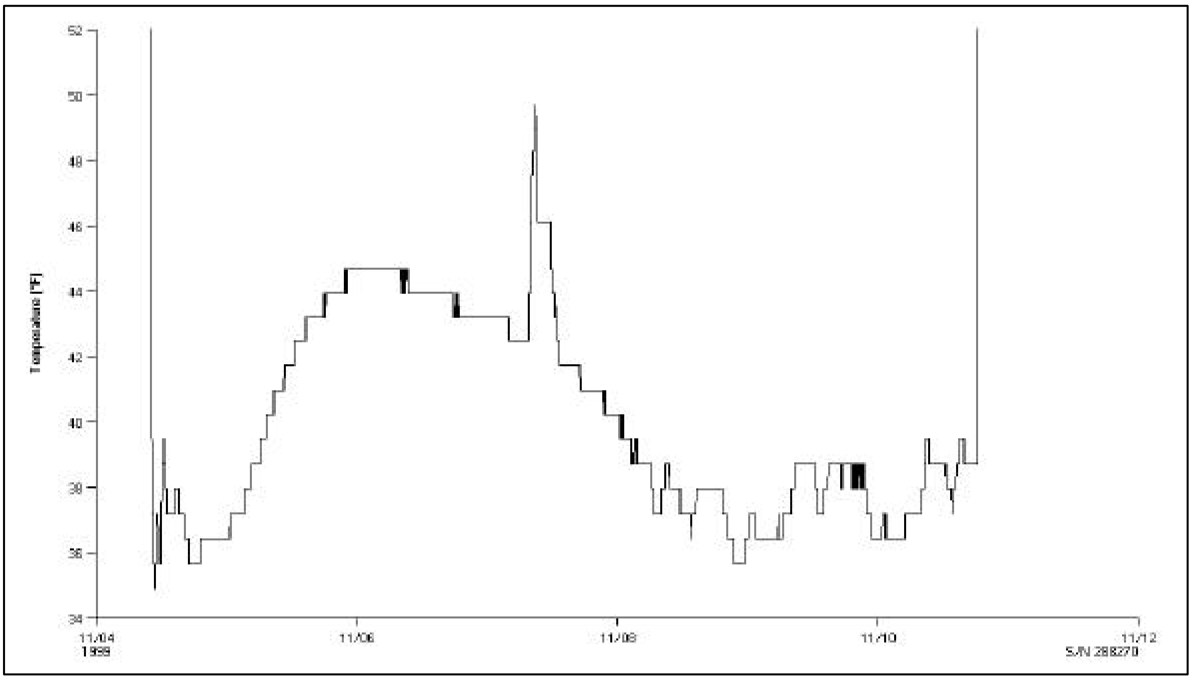


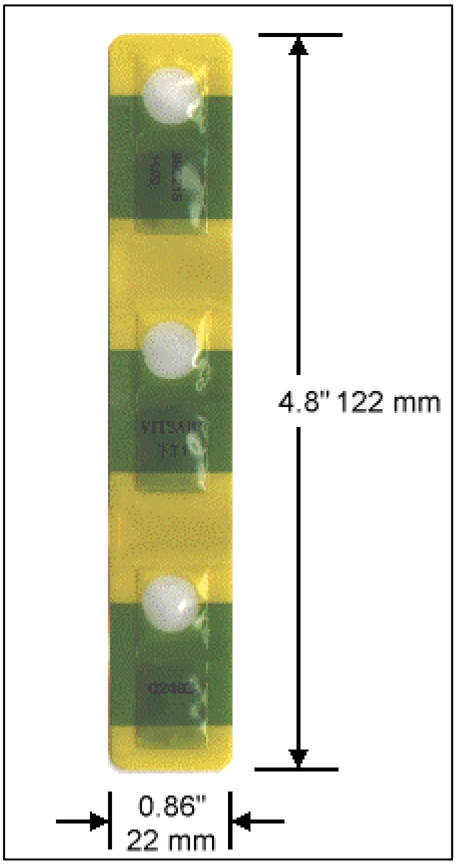
3. Effect of storage temperature on vaselife of Narcissus flowers. Flowers were stored for 4 days at different temperatures, then placed in the vaselife room. Vaselife was determined as days to wilting of half the flowers in an inflorescence.



4. The forced-air cooling system for cut flowers depends on flow of air through the flower box.



5. Temperature of flowers transported from Southern California to New Jersey by refrigerated truck.



6. Vitsab® time-temperature tags used for determining the temperature history of cut flowers.

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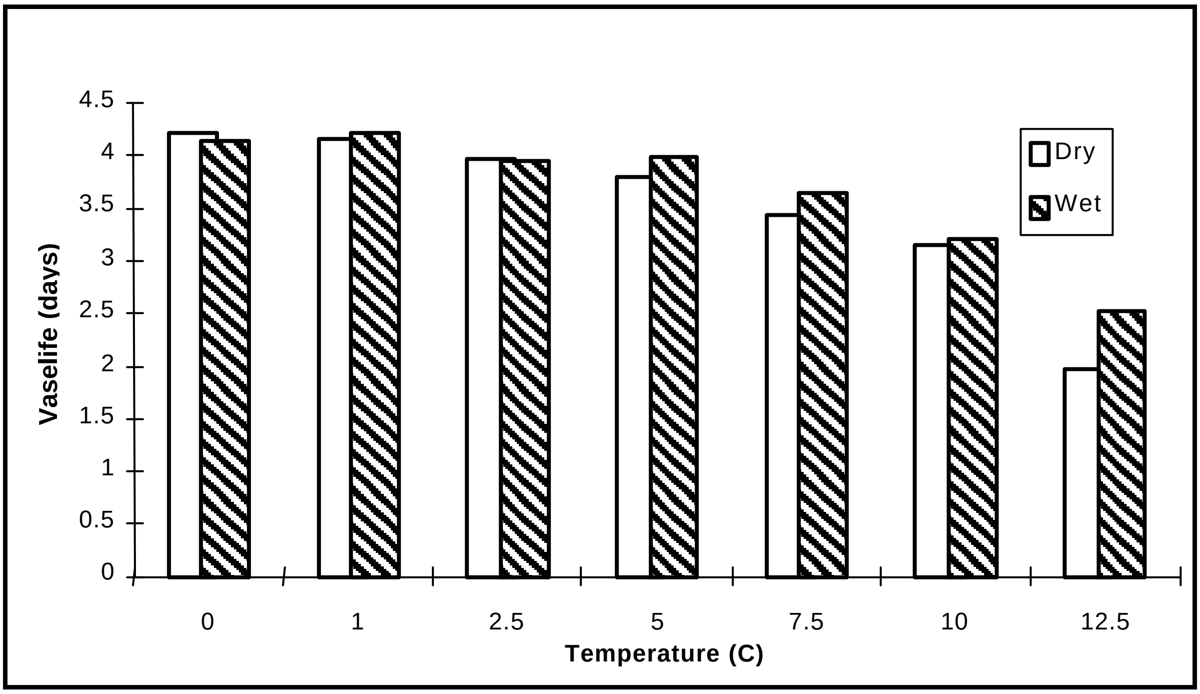

7. Vase life of Narcisuss flowers after storage for 5 days at different temperatures wrapped in newsprint and polyethylene (dry), or in DI water (wet).