Factors Affecting Postharvest Quality of CUT LILIES

The number of lily bulbs imported by the United States from The Netherlands for both professional forcing and garden usage is up 44 percent. To keep that number moving in the right direction, consumers need exposure to quality lilies. New research from the University of Massachusetts will ensure the quality of your cut lilies.

By Susan S. Han

Production and sales of cut lilies have increased dramatically in recent years. According to the latest published USDA Census in 1998, over 76 million stems of cut lilies were produced in the United States, with a value exceeding $54 million. Many growers find the crop to be very profitable and relatively easy to schedule for year-round production. In addition, many florists prefer or demand locally grown lilies.

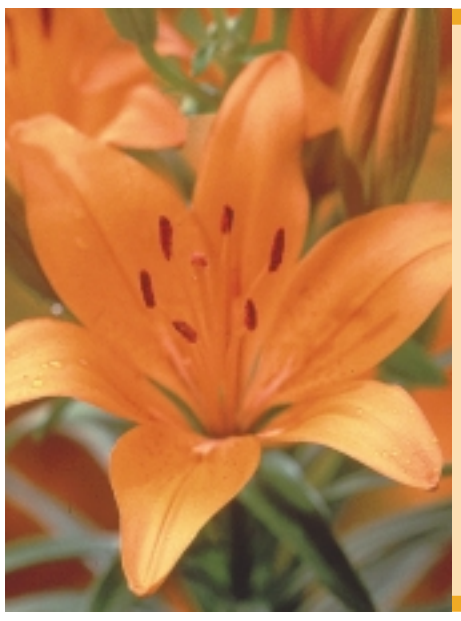
While it is true, in general, that shipping cut flowers long distances reduces quality, it is particularly noticeable in cut lilies. Cold storage of cut lilies, a standard practice to preserve freshness is, however, inevitable, and with the increase in global transportation, the duration and temperature of cold storage can vary greatly. The effects of cold storage on buds are not evident when plants are removed from the cold room, thus giving buyers little indication of cut stem quality.

At the University of Massachusetts, we have been investigating factors that affect postharvest leaf and flower quality of cut Asiatic and Oriental lilies. Unless otherwise stated, most of the experiments were conducted on 'Stargazer' Oriental lily harvested from a local commercial greenhouse. Our studies focused on means to improve overall quality of the cut stems, taking into consideration the quality of both the leaves and the flowers.

SENSITIVITY TO ETHYLENE

It is generally accepted that cut lilies are sensitive to ethylene and that treatment with silverthiosulfacte (STS) increases longevity. In fact, all cut lilies processed through the Dutch and New Zealand auctions have to be pretreated with STS. The benefit of treating cut lilies with STS, however, is debatable.

Van der Meulen-Muisers and van Oeveren studied 16 cultivars of Asiatic lilies and concluded that "the possibilities (of STS) for extending flower longevity are limited." I concur with that conclusion because exposure of



HARVESTING STAGE

The optimal stage for harvesting varies greatly between cultivars. In a study comparing 16 Asiatic lily cultivars, the stage at which the stems were harvested significantly affected the percentage of buds that reached anthesis. In most cultivars, harvesting at a later stage resulted in a higher percentage of open buds (Table 1), but for cultivars 'Apeldoorn' and 'Ladykiller', the harvesting stage is particularly critical. For these cultivars, stems harvested when the most mature flower bud was just starting to color resulted in approximately 30 percent of the buds reaching anthesis. Harvesting when the first bud reached anthesis resulted in nearly all of the buds developing into anthesis. In comparison, harvesting stage did not affect the opening of buds in some cultivars, e.g., 'Bora', 'Gran Sasso', 'Monte Rosa' and 'Napoli'.

Our data on Oriental lily 'Stargazer' also showed a relationship between harvesting stage and opening of buds. To determine the critical stage of harvesting Stargazer lily, we used individual excised buds and monitored their development. All freshly harvested buds that were smaller than 2.4 inches aborted, and all buds that were 2.8 inches or longer developed into anthesis (Figure 1). Therefore, for Stargazer, a bud length between 2.4 and 2.8 inches represents the critical stage for harvesting.

Based on this information, cut lily cultivars that can be harvested at an early stage without negatively affecting postharvest quality could be grown for long-term storage (assuming that they are not susceptible to cold storage) or for use in long-distance transport. In contrast, cultivars that have to be harvested at anthesis are better-suited for the local market. In addition, data from our laboratory suggest that for cultivars susceptible to cold-storage-induced bud abortion, such as Stargazer, harvesting stems at a more advanced stage will significantly reduce cold storage-induced bud abortion.

freshly cut Stargazer stems, when exposed to 1 ppm and 10 ppm ethylene gas for 24 hours, showed no effect on leaf or flower quality. Pretreatment of those stems with STS induced early development of leaf yellowing, without any beneficial effect on the flowers. Furthermore, treatment with Ethylbloc (1-methylcyclopropene), another ethylene inhibitor, did not improve postharvest quality.

Our results indicate that Stargazer lilies are not sensitive to ethylene. On the other hand, when Stargazer was treated with EthylBloc prior to a 2-week cold storage, we saw a significant drop in cold storage-induced bud abortion, suggesting that pretreatment with an ethylene inhibitor might be necessary for stems that need to be cold-stored.

There are two possible explanations for the differences in ethylene response between lilies that have been cold-stored and those that are freshly harvested. First, it is possible that the sensitivity of the flowers to ethylene increases during cold storage. Second, it is possible that an ethylene receptor protein, which must be present in order for the ethylene to function as a trigger for a senescence process, was not present in freshly cut stems, a fact that has been shown in Arabidopsis. In Arabidopsis, ethylene receptors do not exist in "presenescent" or "late senescent" flowers but are found in "early senescent" flowers, and it is possible that ethylene receptors in lily buds do not exist until they have been stressed from cold storage and are undergoing premature bud senescence.

SUGAR IN VASE SOLUTION AND DEFOLIATION

Leaf yellowing is one of the most serious postharvest problems in cut lilies because it is aesthetically unpleasing. Therefore, to minimize leaf yellowing, the customary practice among florists is to either remove most, if not all, of the leaves or to place the cut stems in a sugarless solution.

Leaves however, are an important part of cut flowers, and in many

Figure 1. Effects of bud size and sugar in the vase solution on bud abortion of Oriental lily 'Stargazer'.

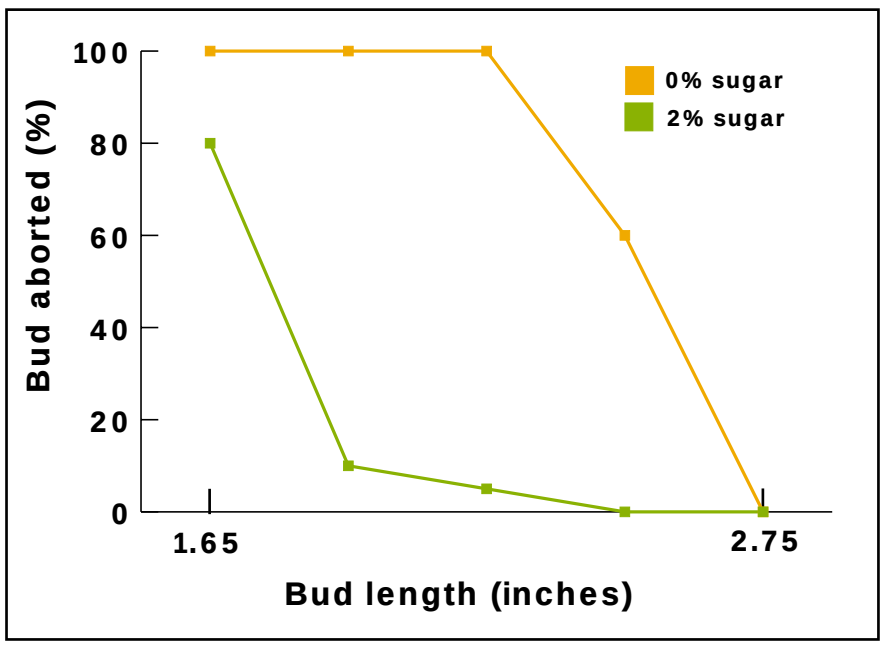
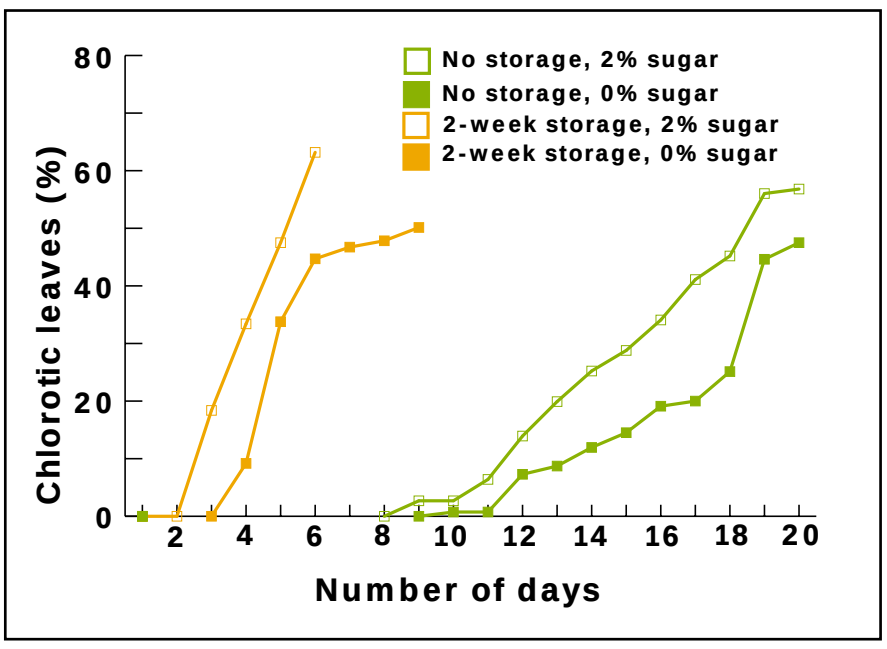


Figure 2. Effects of cold storage on the leaf quality of Oriental lily 'Stargazer'. Cut stems were cold-stored in a 38° F room for up to two weeks and were then placed in a solution containing 0% or 2% sugar plus 200 ppm of 8-hydroxyquinoline citrate for postharvest evaluation.



species, blemish-free foliage is an important factor in determining the quality of the cut stems. In many cut flowers, leaves also serve as a carbohydrate source for the developing buds, and their removal may affect the quality of flowers.

We conducted a series of experiments to determine the role of sugar in the preservative solution and in the leaves on postharvest-quality cut lilies. We found that for Asiatic lily 'Vivaldi' and 'Geneva' and Oriental lily 'Acapulco' and Stargazer, lower leaves began to turn yellow between 1 and 2 weeks on freshly harvested stems, and the yellowing continued to progress upward until the end of the vase life. Addition of 2 percent sugar in the vase solution induced earlier development of leaf yellowing (Figure 2), thus supporting the claims from retail florists that stems should be placed in a solution without sugar. However, we know that spraying the leaves with a solution containing 50-100 ppm each of BA and GA4+7 (currently registered as Fascination) completely prevents leaf yellowing and significantly improves the quality of the buds.

In terms of flower buds, it is known that both sugar in the solution and carbohydrates stored in the leaves play an important role in the quality of the open flowers. Neither the addition of sugar nor defoliation affected the longevity or the size of Stargazer flowers, but addition of sugar and keeping the leaves intact significantly enhanced the intensity of petal color. In defoliated stems, sugar can also be used to counteract the light-color petals, so the addition of sugar to the preservative is even more critical to those stems.

Overall, for best petal coloration and leaf quality, cut stems should be placed in a solution containing 2 percent sugar and the leaves should be left intact and sprayed with a solution containing BA and GA4+7.

COLD STORAGE

The quality of leaves and flowers of cut lilies suffers after cold storage. Two cultivars of cut Asiatic lily, Geneve and Vivaldi, and two cultivars of Oriental lily, Stargazer and Acapulco, were used in our study. The study indicates that storage in a 38˚ F cold room for more than one week significantly increased bud abortion, reduced longevity of flowers and reduced the vase life of cut stems in all cultivars. There are, however, differences in the susceptibility of cultivars to cold storage-induced bud abortion.

TOP TEN LILY VARIETIES*

The lily is number five on the "Top 10 List" of flowers sold at the famous cut flower auctions in Holland. It follows roses, chrysanthemums, carnations and tulips, in that order.

Variety	Acres	Color	Type
Star Gazer	966	red/white	Oriental
Snow Queen	291	white	Longiflorum
Pollyanna	197	yellow	Asiatic
Vivaldi	170	pink	Asiatic
Casa Blanca	165	white	Oriental
Elite	158	orange	Asiatic
Acapulco	150	white	Oriental
Marco Polo	133	white/pink	Oriental
Le Reve	116	pink	Oriental
Montreux	35	pink	Asiatic

*Based on acres under cultivation in Holland. Information courtesy of The Netherlands Flower Bulb Information Center.

In addition, we conducted an in-depth study on the effects of cold storage on Stargazer lilies, the cultivar most susceptible to cold storage-induced disorders. We found that after cold storage, buds often do not fully develop into open flowers (they were either opened partially or aborted), are much smaller in size and are paler in color. Overall, the quality of the open flowers of Stargazer lilies cold-stored for two weeks is such that they would not be considered acceptable by the industry. However, we found that the harvesting stage of the stems is a critical factor, as there was a dramatic increase in cold storage-induced bud disorders for stems harvested at a slightly earlier stage. In addition, we found that placing the cut stems in a sugarless solution during cold storage significantly reduces cold storage-induced bud disorders when compared to those sleeved and stored dry.

Furthermore, studies conducted on potted Stargazer showed that storage temperature is another important factor to consider. Storage at 33˚ F for two weeks resulted in 100 percent bud abortion in potted Stargazer, whereas storage temperatures of 39˚ F or higher reduced bud abortion to approximately 30 percent. Adding light or spraying leaves with a solution containing 100 ppm each of BA and GA4+7 further reduced bud abortion. While providing sufficient light to leaves during cold storage might not be a viable option for cut lilies, since they are typically bundled and sleeved prior to that point, this study suggests that lilies should be stored in a cooler with a somewhat higher than usual temperature.

Conventionally, cut flowers intended for long-term storage or long-distance transportation are harvested at a tighter bud stage than those intended for the local market, and are stored dry in a 33˚ F cooler. Based on our information, handling of cut lilies, specifically Stargazer, should be different. For cut lilies, stems should be harvested at a more mature stage and stored wet in a cooler set at approximately 40˚ F to minimize the damage caused by cold storage. The major drawback of handling lilies this way is that buds will continue to develop during the cold storage and some might even open while in the cooler.

*Table 1. Effects of harvesting stage on percentage of bud opening in 16 cultivars of Asiatic lilies**

	HARVESTING STAGE Largest bud:		
Cultivar	**Starting to color**	**Fully colored**	**At anthesis**
Adelina	61	90	100
Apeldoorn	30	46	85
Bora	100	100	100
Dreamland	64	89	99
Enchantment	87	96	96
Eurovision	70	92	99
Figaro	72	97	97
Gran Sasso	98	98	100
Ladykiller	28	72	99
Lavender Dream	56	91	100
Monte Blanc	96	86	100
Monte Negro	58	78	94
Monte Rosa	100	100	100
Napoli	96	99	100
Orange Mountain	93	100	100
Sahara	54	83	76

*Data are adapted from van der Meulen-Muisers and van Oeveren, 1997.

In addition to the effects of cold storage on flower quality, cold storage also worsened leaf disorders (Figure 2). The longer the duration of cold storage,

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