Bing 64

CHAPTER 14

STORAGE and HANDLING

ARTHUR BING

One of the best means we have of promoting our product is the product itself. The chrysanthemum that receives such careful attention during growing should also receive the best attention during cutting, grading, bunching, storing, shipping, handling in the wholesale house, in the flower shop and in the consumer's home. Everyone who handles the chrysanthemum should do his best to understand what is involved in getting the best possible use out of the flowers.

Why a Flower Does Not Last

Although a flower is cut from the mother plant, it continues to carry on its respiration, development, and water loss. The shoot continues to use up carbohydrates in respiration, and give off water by transpiration. The carbohydrates were stored in the stem when it was cut. The water must come from an outside water source through the cut end of the stem. The water in the stem will not last long if the leaves and flowers are exposed to dry warm air. If the supply of water or carbohydrates for the shoot runs short, the flower withers and dies. If a flower is cut beyond its peak of maturity, it does not last as long as a flower cut at an earlier stage of development. Warm temperatures hasten maturity and the using up of the carbohydrate reserve by respiration. A flower ages rapidly or "goes to sleep" if exposed to ethylene.

To improve keeping quality of chrysanthemums, they should be conditioned and handled to delay maturity, keep the flower well supplied with carbohydrates and water, and avoid exposure to harmful fumes. To get the best use out of our flowers we must use all the means at our disposal to delay the maturation process of the flower.

Growing Conditions

The conditions most favorable for the production of a chrysanthemum crop do not adversely affect the keeping quality of the flowers after cutting. High light intensity favors good quality in a chrysanthemum crop and also improves keeping quality. Flowers produced during the seasons of highest light intensity stored best. Flowers from plants that were exposed to reduced light two weeks before cutting did not last as long after storage as those kept under high light intensity prior to cutting and storage (18). Mastalerz also found that flowers "grown with normal light and held beyond 30-35 days, kept inversely as the length of the holding period."

Exposing plants to higher than normal temperatures also will reduce the flowers' capacity for storage. For greenhouse grown chrysanthemums, an efficient greenhouse cooling system in bright summer weather should increase carbohydrate content of the plants and improve keeping ability of cut chrysanthemums. Normal growing temperatures have no adverse effect. Flowers from plants grown in soil with an optimum nitrate content keep just as well as those with a lower nitrate content (18). Adequate watering of the soil does not reduce keeping quality. Where low moisture was used the stems were hard. The hard stems when cut and placed in water picked up water with more difficulty than softer stems and required special treatments. Chrysanthemums should be grown under conditions most favorable for growth to produce the longest lasting flowers.

Cutting the Flower

Flowers must be cut at the proper stage of development to get the longest use out of them. Standard chrysanthemums are usually cut just before the green color in the center of the flower has disappeared. For long distance shipping the flowers may be cut a little tighter than if they were being cut for local use. The stage at which pompons are cut may vary depending on the variety. Some of the anemone varieties may need to be further developed than some of the single varieties. Usually the center flower in the pompon spray is well developed and the side flowers are still showing some greenish color before the stem is cut. When the center bud has been removed for better spray formation, the sprays are cut when the first flowers are just losing the greenish color.

If the plants are short such as with a fast crop of standards and the plants are cut near the soil level into the woody portion of the stem, it may be necessary to mash the end of the stem with a hammer or dip in boiling water for 10 seconds to promote water absorption by the stem. Usually this is not required. It is not necessary to leave any great amount of stem on the plant because the plants are discarded after the flowers are cut. Stems are cut to a desired length rather than to a position on the plant. Foliage on the bottom one third of the cut stem is removed. Flowers should be put in water or cold storage immediately after cutting.

Containers and Water

The cut flowers can be put in 31°F dry cold storage for later use or they can be put in water for hardening before delivery to the wholesale or retail florist. The vases or cans should be scrubbed clean, treated with a disinfectant such as chlorox, or steamed to remove bacteria and bacterial spores that can produce growth that flourish as in a vase with stems and dead leaves and then clog up the cut ends of the flower stems. A slant cut of the stem holds most of the stem ends out of the debris that can collect in the bottom of the vase. The bacterial spores can remain alive and ready to go even if a vase is dry for some time. Clean vases and recut stem ends when transferring flowers.

Stems pick up warm water much easier than cold water especially if the flowers are wilted. Badly wilted stems may not pick up cold water. Place stems that have been out of water or are wilted in 90-110°F water. Chemical preservatives added to the water prolong life of the cut flowers. Only the cut end of the stem picks up water but the vases are usually filled ⅓ to ½ of the way to serve as ballast and also to make sure all stems are reaching the water and that the water level does not fall below the bottom of the stems.

Chemical Preservatives

There are commercially prepared cut flower preservatives that are added to the water to prolong the life of cut chrysanthemums. The idea of using chemicals to delay or to slow down the rate of metabolism, stop bacterial growth, and furnish carbohydrate to the cut stem is quite old. Some early

work was done by Laurie (15) using such things as ½ tablet of aspirin in 2 qts of water; 1% sugar cane solution; and .1% solution boric acid, potassium permanganate, nitric acid, or potassium nitrate.

More recently it has been found that silver nitrate at 0.003% is an effective bactericide and 4% sucrose is a very effective carbohydrate source (1) (22). Most of the work with flower preservatives has been with flowers other than chrysanthemum because the chrysanthemum normally keeps for quite a long period of time without any preservative. It is best to use flower preservatives in the water from the time the cut flowers are first put in the water up to and including the time the flowers are put in a vase in the consumer's home. The use of a preservative immediately after cutting is the most effective time. Results have shown that preservatives are absorbed more easily when the flowers are fresh cut and also when used in only one stage of handling, used immediately after cutting gives better results. Best results are with the use of a preservative at all stages of handling.

Packing

Chrysanthemum standards may be packed individually in shipping boxes or they may be tied in bunches of 12 and packed in wooden or cardboard boxes (figures 14.1, 14.2, 14.3, 14.4, 14.5, 14.6, 14.7, 14.8). Large local mums are packed 3-4 dozen in a shipping box. After cutting, during grading and packing keep the heads off the bench by supporting the necks. Flowers such as spiders and lace varieties whose petals may get tangled can be individually held in paper collars to prevent bruising. Pompon chrysanthemums are packed in bunches. The size of the bunch has not been standardized. It usually contains approximately 9 ounces of flowers. The flowers are placed in a packing box starting at one end with the heads toward the end and then reverse the process starting at the opposite end coming back. The stems are tied down at the middle with cleats to prevent movement of flowers in the pack. A box of good quality pompons may contain 20 bunches. The individual bunches may be wrapped in cellophane or polyethylene to protect the flowers, make an attractive display and increase shelf life.

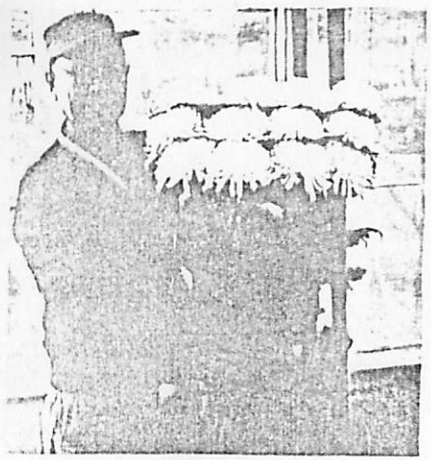

Figure 14.1 A carefully packed and handled bunch of standards by Chuck Myazaki, Babylon, L. I., New York.

Figure 14.2 Stems should be carefully cut and removed from the bench.

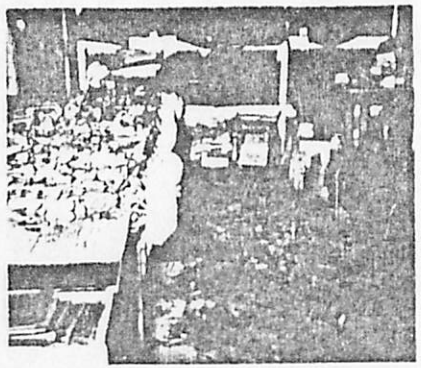

Figure 14.3 Flower stems are placed on the table so the petals are not crushed.

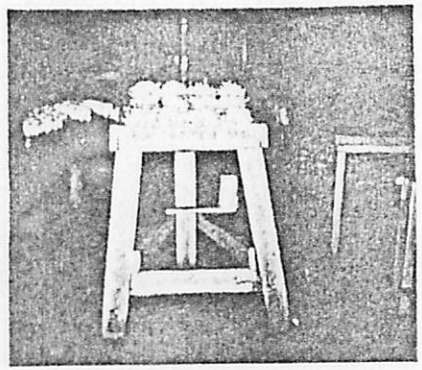

Figure 14.4 Bunching table—note no weight on the flowers and the layers are separated by tissue.

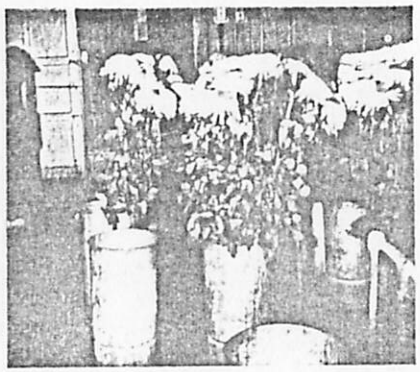

Figure 14.5 Just 2 bunches per vase and these are separated by tissue.

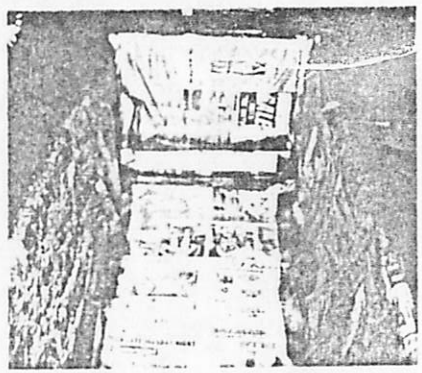

Figure 14.6 A roll of paper in the packing box to keep the flower heads from being crushed.

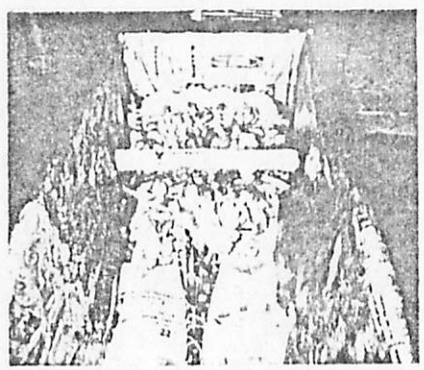

Figure 14.7 A roll of paper over the first bunch is used to hold the second bunch.

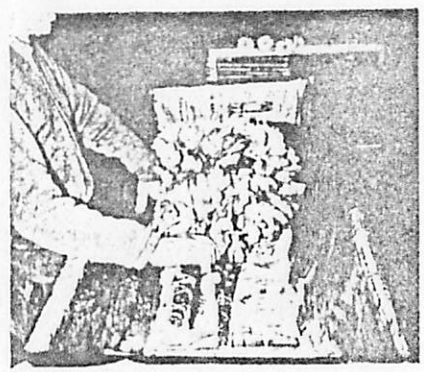

Figure 14.8 The second bunch placed in the box. Two more bunches will be put in from the other side.

Insulation

When the outside temperature drops below freezing, it is usually necessary to insulate the boxes. Standard practice is to use up to 10 layers of dry newspaper. Furuta (7) reports that layers of dry newspaper are one of the most efficient means of insulating flower boxes. Wet newspaper is a poor insulator compared to dry newspaper. The bottom of the box and the ends tend to cool off first so be sure and insulate the bottom and ends most of all.

The larger the box and the more flowers in the box the more difficult to handle but the slower the rate of temperature change in the box as there is more material that has to change temperature. Also in cold weather wrapping the box with manila paper and sealing the package considerably reduces the rate of temperature change.

Although dry newspapers and insulation materials are more effective than wet materials in retarding the movement of heat, a container containing more water changes temperature slower and once cooled to the point where tissue or water starts to freeze, that temperature raises to the freezing temperature and holds that temperature until all the water is frozen regardless of lower external air temperature.

Shipping

Fortunately chrysanthemums ship as easily as any flower and this is why cut chrysanthemums are easily shipped considerable distances. Studies have been made on continuous shipments of chrysanthemums and other flowers (3) (4) (9) (10). The flowers can be shipped at temperatures of 32-55° for 2 days with low perishibility. In long distance shipping of standard mums, it has been found advantageous to ship the flowers in tight condition and to recut the stems and put the stems in warm flower preservative when they arrived at the destination (3). Shipping in the bud stage saves shipping space, results in less damage to blooms and takes less space in the wholesale house and they can be held for 4-5 days while opening (3). Temperatures in a shipping container follow outside air temperatures. There have been several studies on the change of temperature in containers during long distance shipping (4) (9) (10).

CONDITIONING OR STORAGE

Temperature

Of the many factors affecting the useful life of the cut flower, temperature is by far the most important. Low temperature reduces respiration and development of plants and cut flowers. The lower the storage temperature the greater the reduction in respiration. The effect of temperature on chrysanthemum is similar to that shown by Claypool and Morris (4) on spinach in Table 14.1.

Table 14.1 Effect of temperature on rate of deterioration (spinach).[1]

Temperature °F	Storage life days	Rate of deterioration relative to that at 32°F
32	66	1
41	12	1½
50	13	5
59	7	9
68	4	16
77	3	21
86	2	31

[1]Unpublished data—University of California.

The lower limit of the storage temperature would be the freezing point as shown in Table 14.2 or that temperature which adversely affects the flowers so that they are not as good as fresh flowers when taken from storage. The following freezing temperatures were taken from Whiteman (22).

Table 14.2 Freezing temperature of chrysanthemums.

Tissue	Freezing Point Degrees Fahrenheit		
	Average	Low	High
Chrysanthemum foliage	29.6	28.7	30.5
Chrysanthemum petals	28.4	28.0	28.7

From these data and actual trials with cut chrysanthemums, 31°F has been found to be the best for storing chrysanthemums dry the longest period of time or 40°F for keeping them in water in the best condition for several days. At 31°, close control of temperature is essential or there could be freezing in one part of the refrigerator and too high temperatures in another spot.

Flowers cool off very rapidly if put in the refrigerator in small bundles especially if not enclosed in a container. Large sealed containers of flowers take several hours to cool down to lower outside temperature. When packing flowers in large drums or boxes it may be advisable to precool the open bunches in the cold room for 15-20 minutes before packing.

Wet vs Dry Storage

Chrysanthemums stored at 40-50° for a short period of time do best if held with their stems in water. At 31-35°F, cut chrysanthemums do better if stored without water in closed containers. Water supplied to the stem hastens maturity so withholding water helps prolong the life of the flower. The flowers must be kept in a humid atmosphere so they are stored in large polyethylene bags or sleeves, in moisture proof lever pack drums, or more commonly now in polyethylene lined shipping boxes. Pure water in containers at 31°F would freeze, but cell sap or flower preservative solution would freeze at lower temperatures. Packing flowers dry in containers allows for much greater economy in storage space. Flowers should be put in storage with dry leaf and flower surfaces. Surface moisture such as caused by syringing before packing encourages *Botrytis*.

Duration of Storage

In the original storage information by Wright, Rose and Whiteman (26) it was suggested that chrysanthemums could be held at 35° for 2 weeks very effectively. However, more recent work by Fischer and Masterlerz (5) (18) (19) shows that pompons stored better at 31° than at high temperatures and there was no freezing or bad effects on the flowers when held at 30-32°. They could be stored for 6 weeks at 31° and be as good as and dependable as fresh after storage (20). The maximum period of storage at which the flowers would still look as fresh and usually keep quite well would be 8 weeks (20). Only the best flowers should be used for extended storage periods.

Hardening

After flowers come out of low temperature dry storage or if flowers have wilted or been out of water for any period of time, the stems should be recut and put in warm 90-110° water then held at 40-50° for 12 hours before packing. During this period they should be held out of drafts or bright light. If it is not possible to keep them out of a drafty location, the flowers should be covered with bags or sheets of polyethylene to reduce water losses at the top. It is also advisable to use flower preservative in the water.

The Cold Storage Room

The refrigerator should be capable of maintaining a 31°F temperature with a variation of less than 1 degree. Adequate insulation with a proper vapor barrier helps relieve the strain on the refrigeration unit. A cube shaped box gives the greatest volume with the least wall space for heat transmission. Constant vigorous air circulation is necessary to maintain even temperatures.

Duck boards on the floor and slatted shelves allow for good air drainage. Do not stack containers too close together or up against the wall. Do not open and close the door any more than necessary. Consult a refrigeration engineer for details on construction and size of refrigeration unit. There are also extension bulletins on the construction of refrigerated storage rooms (8)—see your agricultural extension agent.

Defrosting

To keep from overloading the unit have a good defrosting system for the cooling coils in the box and periodically clean the condensor coils especially if water cooled.

Atmospheric Conditions and Diseases

Chrysanthemum flowers are adversely affected by ethylene gas and should never be stored with fruit and vegetables (6, 13, 17). Also chrysanthemums should not be stored where there is decaying or diseased plant tissue. Williamson (24, 25) has shown that ethylene is produced by the activity of several diseases on foliage and flowers. The following excerpt from this table 14.3 (24, 25) shows how several chrysanthemum diseases produce ethylene which causes damage to the flowers.

Table 14.3. Relative ethylene production by different diseases.

Pathogen	Host	Common name of disease	Response rating (a) to tissue	
			Diseased	Healthy
Puccinia chrysanthemi	chrysanthemum	rust	2	1
Septoria obesa	chrysanthemum	*Septoria* leaf spot	2	1
Ascochyta chrysanthemi	chrysanthemum flower	ray blight	5	1
Botrytis cinerea	chrysanthemum flower	*Botrytis* rot	4	1

(a) Ethylene production rated from 0 (none) through 5 (the maximum response of pea seedlings).

Fischer and Keller (6) showed that *Ascochyta* infected flowers gave off ethylene which promoted break down of flowers unless the ethylene were absorbed by brominated activated charcoal. Ethylene damage can occur in greenhouses, storage rooms, or shipping containers so do not place flowers where they are exposed to ethylene from illuminating gas, fumes from stoves, incomplete combustion of hydrocarbons, or from some fruits and vegetables. Ethylene production by plant materials is less at lower temperatures.

Smog can also produce harmful effects on chrysanthemums as well as other flowers. The damage is primarily from hydrocarbons of oxidized gasoline from automobiles and refineries. It will be necessary to promote more complete combustion of fuels with the help of special devices which are now being developed. Weather conditions and topography can intensify smog conditions (11).

Disease itself can reduce the useful life of flowers by its development on flower petals, leaves or stems in moist storage or in shipping containers and make the flowers useless to the retailer or consumer (figure 14.9). Vascular diseases can cause production of toxins or plugging of the stems thereby reducing the ability of the stem to transport water to the flower. Diseases are most effectively controlled when growing the plants by proper sanitation, keeping foliage and flowers dry and protective sprays.

Give the flowers the best possible care and they will give most satisfaction to all concerned.

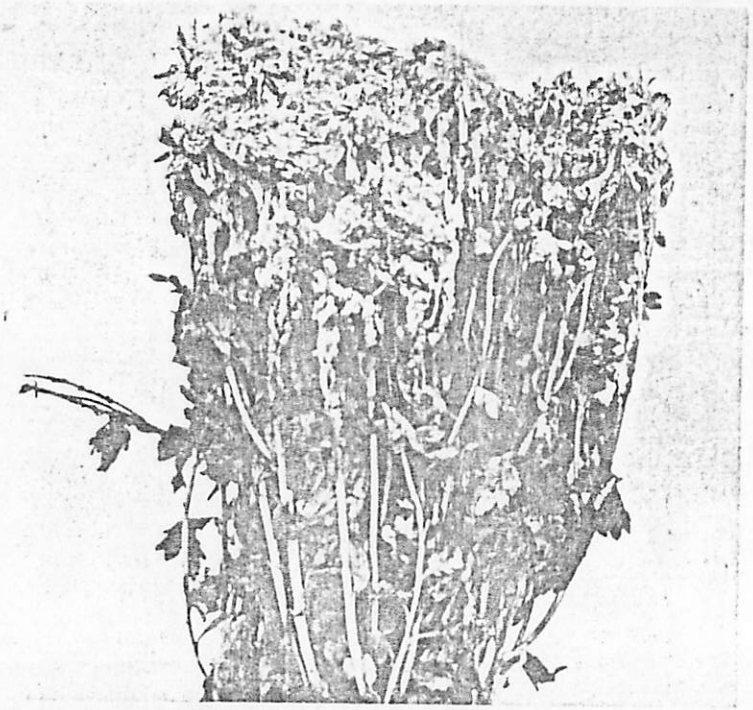

Figure 14.9 Improper storage can result in diseased and rotted flowers.

HOLDING POT MUMS

A pot mum developed to a saleable stage will rapidly pass beyond usefulness if left in a warm, sunny greenhouse. The useful life of the plant can be extended by placing the plant in a cool, shady location.

Plants approaching maturity or already saleable can be held in a cool, dark garage or shed for 3-7 days where they will develop much slower than in a greenhouse. If the storage is dry, the plants will need watering every 2 or 3 days. In a cool shed, flower and foliage color keep much better for this short period of time compared to plants left in the greenhouse.

Where controlled storage is available, longer periods of storage are possible. Plants can be put in paper sleeves or polyethylene bags with the top end open and held at 32-34°F for 1-2 weeks with ease. Plants stored in paper sleeves or plastic bags with the tops open stored as well as those with tops closed for the 2 week period. Tightly closing the tops may increase the occurrence of petal rot. Plants stored in sleeves for 1 week did not need water

before delivery. Plants stored for 2 weeks may require water before delivery: punch a hole in the sleeve just above the pot rim and pour some water into the pot. Flower and leaf color were not adversely affected by up to 2 weeks of storage at 32-34°F. Plants stored for 2 weeks at 32-34° were as beautiful and useful as plants just taken from the greenhouse and much better than plants of the same flowering period which were left in the greenhouse.

Varieties held successfully in this test on Long Island were Mermaid, Golden Princess Ann and Starburst. Storage of pot mums has been done successfully by commercial growers. The lower the storage temperature (above freezing of course) the better will be the color in foliage and flowers.

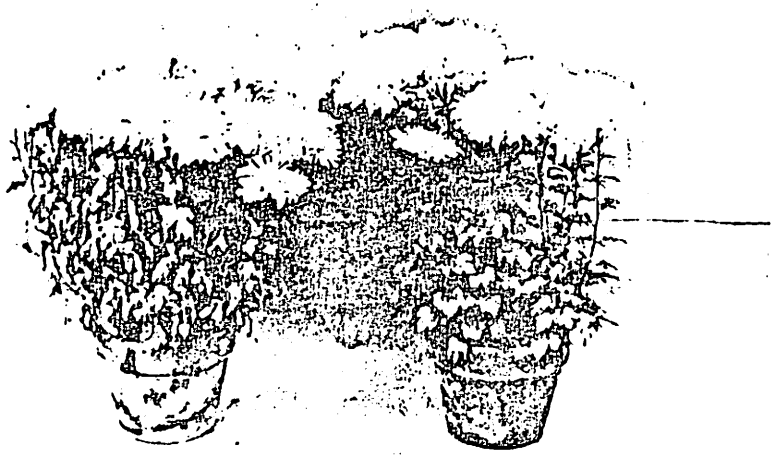

Figure 14.10 Pot mum on right stored for 2 weeks at 32-34°F. Left, remained in greenhouse.

References

1. Aarts, J. F. Th. 1957. Concerning the keeping quality of cut flowers. (In Dutch, English translation available), Hort. Lab. at Wageningen. Pub. 174.
2. Aarts, J. F. Th. 1957. The development and keeping qualities of flowers after picking. (In Dutch, English summary). Overdruk uit Mededelingen Directeur van de Tuinbouw 20: 690-701.
3. Besemer, Seward T. 1961. Trial of shipping blooms transcontinental. Florists Exchange. April 29: 12-13.
4. Claypool, L. L., L. L. Morris, W. T. Pentzer, and W. R. Barger. 1958. Air transport of fruits, vegetables, and cut flowers: temperature and humidity requirements and perishable nature. U.S. Dept. Agr. AMS 280: 1-27.
5. Fischer, Charles W. Jr. 1950. Long-term cut flower storage now possible. New York State Flower Growers Bul. 62: 6-8.
6. Fischer, C. W. Jr. and J. R. Keller. 1951. Stop the rot in flower shipments. New York State Flower Growers Bul. 65: 2-3, 8.
7. Furuta, T. 1959. Effects of insulation in flower boxes. Florists Review. April 30: 19.
8. Gray, Harold E. 1950. Farm refrigerated apple storages. Cornell Ag. Ext. Bul. 786. 18 p.
9. Harvey, J. M., M. Uota, Ralph H. Segal, J. M. Lutz, M. U. Ceponis, and H. B. Johnson. 1962. Transit temperatures in cut flowers shipped from California. U.S. Dept. Agr., AMS 459. 11 p.
10. Harvey, J. M., M. Uota, Ralph H. Segal, and M. J. Ceponis. 1963. Transit times and temperatures of transcontinental cut-flower shipments. U.S. Dept. Agr. MRR 592: 1-16.
11. Havens, A. V. 1963. Weather—an increasingly significant factor in air pollution occurrence and control. News and Views (College of Agri., Rutgers—The State University) No. 4.
12. Hitchcock, A. E. and P. W. Zimmerman. 1929. Effect of chemicals, temperature and humidity on the lasting qualities of cut flowers. Amer. Jour. Bul. XVI: 433-440.
13. Holley, W. D. 1960. Plant injury from flue gasses. Colo. Flr. Grws. Bul. *120*: 1-2.
14. Hukill, M. V. and R. L. Wright. 1930. Preventing the freezing of cut flowers in transit. U.S. Dept. Agr. Bur. Pl. Ind. 1-6. Dec. L.A.
15. Laurie, A. 1928. Use of cut flowers. Mich. Agri. Expt. Stat. Spec. Bul. *176*: 19-20.
16. Link, Conrad B. 1960. The care of cut flowers. The Maryland Florist. *74*: 1-5.
17. Lumsden, D. V., R. C. Wright, T. A. Whiteman, and J. W. Byrnes. 1940. Fruit and flowers should not be stored together. Florists Rev. *86* (2223): 22-23. July 4.
18. Mastalerz, John. 1952. Nitrate levels, light intensity, growing temperatures and keeping qualities of flowers held at 31°F. New York State Flower Growers Bul. *88*: 2.
19. Mastalerz, J. W. 1961. The latest on the keeping qualities of cut flowers. Florists Exchange 12-13, 53-55. Dec. 23.
20. Post, Kenneth. 1951. Cut flower storage. New York State Flower Growers Bul. *71*: 7.
21. Post, Kenneth and C. W. Fischer Jr. 1952. Commercial storage of cut flowers. N. Y. (Cornell) Ext. Bul. 853: 1-14.
22. Ryan, Wayne L. 1957. Flower preservatives. Florist Review. Nov. 14: 59-60.
23. Whiteman, T. M. 1957. Freezing point of fruits, vegetables and florist stocks. U.S. Dept. Agri., MSR NO. 196: 30 p.
24. Williamson, C. E. 1950. Ethylene, a metabolic product of diseased or injured plants. Phytopath. XL (2): 205-208.
25. Williamson, C. E. Plant disease affects keeping quality. "Living Flowers That Last." Chap. 3: 19-34.
26. Wright, R. L., Dean H. Rose, and T. M. Whiteman. 1954. The commercial storage of fruits, vegetables, and florist and nursery stocks. U.S. Dept. Agri. Ag Handbook 66. 77 p.