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Effects of Storage on the Performance of Carnation Cuttings

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Several isolated attempts have been made to show differences in carnation cuttings stored under refrigeration and those rooted and planted directly from stock plants. Comparisons of cuttings stored rooted and unrooted have also been made. Results have invariably been inconclusive as are the results of this experiment. However, certain inferences can be drawn from the data of this experiment.

There are many factors that override storage treatment when performance of cuttings is the criterion used. The major factors affecting this performance are; 1) size of cutting when stored, including fresh and dry weight and number of expanded leaves, and 2) the environmental complex, mainly temperature and light, which produces the cutting. It is not possible to store cuttings for varying lengths of time and have them absolutely comparable. Either they are produced in a different environment or they grow under a different environment following planting.

Sixty uniform cuttings were taken from stock plants on July 12, August 12, and September 12. Half of each lot was rooted and placed in polyethylene lined boxes at 33° F. The other half was stored unrooted at this temperature until October 12. All lots were then removed and rooted along with a lot of unstored cuttings direct from stock plants. On November 5, all rooted cuttings were removed from storage or from the propagative bench and planted at 6" x 8" spacings in a producing bench.

Removal of the apical shoot was delayed until all possible vegetative laterals had developed on the young plants. Yield of the first crop of flowers plus all buds 1/4-inch diameter or larger at the end of the experiment was considered the first crop of flowers. An indication of the effect of treatment on development speed of the first crop was obtained by calculating the time in days from the cutting of the first flower on the earliest treatment to the day when one half the crop was cut from each individual treatment. Table 1 contains the data for the experiment grouped in four ways so that differences due to individual treatment, variety, type of storage, and time in storage can be studied separately.

Results

This experiment in storage time is as comparable as is possible with present facilities. Some small differences can be seen from the data. Unrooted cuttings performed better than rooted. While rooted cuttings were 4 percent heavier and

produced 11 percent more initial breaks, they produced 7 percent less flowers on the first crop averaging significantly lower grade.

The influence of time in storage is more difficult to assess. Fresh cuttings rooted in October performed poorest on the average while cuttings stored either one or two months were best. The initial breaks after pinching and the mean grade of flowers produced were almost the same for fresh cuttings and all storage treatments. The speed of the first crop and yield on the first crop were best for one or two months of storage. The initial fresh weight of the cuttings favored those stored one month (7.3 grams) and was least for those stored three months (5.2 grams). This could cause lower performance for the three-months-storage group which was removed from stock plants in July. Cuttings stored two months were the same size as those rooted fresh. However, performance from the two-months-storage group was significantly improved over fresh cuttings.

A varietal difference is indicated in the data favoring Red Gayety over White Pikes Peak. While average cutting size and initial breaks were similar, Red Gayety produced 16 percent more flowers in the first crop. This difference was due entirely to those cuttings of White Pikes Peak stored three months and those rooted fresh (Table 1), hence cannot be assumed a true varietal difference.

Additional Observations

There was a distinct stretching of the internodes following planting of all cuttings stored rooted. Rooted cuttings stored two and three months were a lighter color than those stored one month or those rooted fresh. This color difference disappeared after a week to 10 days in the producing bench. No color difference was observed in cuttings stored unrooted.

Cuttings stored unrooted performed better than those stored rooted under the conditions of this experiment. While cuttings stored three months did not perform as well as those stored one or two months, the three-months-storage lot was not as good when it went into storage. The quality of the cutting going into storage and the storage environment are most important in determining post storage performance of carnation cuttings.

Table 1. The performance of rooted and unrooted cuttings stored for different time periods.

Storage time	Rooted or unrooted	Variety	Fresh wt. per cutting in grams	Average no. breaks after pinch	First crop yield[a]	Mean grade flowers	Days to midpoint first crop[b]
1 month	rooted	R.G.*	7.04	7.13	9.52	4.22	36.7
	rooted	W.P.P.**	8.00	6.80	9.20	4.28	36.7
	unrooted	R.G.	6.71	6.27	9.93	4.24	31.7
	unrooted	W.P.P.	7.54	6.73	10.47	4.37	34.0
2 months	rooted	R.G.	6.34	7.00	10.13	4.15	33.7
	rooted	W.P.P.	6.44	7.00	10.00	4.27	33.9
	unrooted	R.G.	5.93	6.33	11.20	4.27	31.0
	unrooted	W.P.P.	6.58	6.67	11.26	4.34	30.0
3 months	rooted	R.G.	6.09	7.20	10.13	4.17	36.7
	rooted	W.P.P.	4.56	7.40	7.66	4.10	43.0
	unrooted	R.G.	5.41	6.13	11.47	4.41	28.3
	unrooted	W.P.P.	4.90	6.33	6.47	4.35	40.4
Fresh cuttings		R.G.	5.99	7.13	9.93	4.17	43.7
		W.P.P.	6.53	7.20	7.54	4.26	44.0
Varieties (105 plants)		R.G.	6.22	6.74	10.39	4.23	34.5
		W.P.P.	6.36	6.88	8.94	4.28	37.4
Storage (90 plants)	rooted		6.41	7.09	9.44	4.20	38.5
	unrooted		6.18	6.41	10.13	4.33	32.6
Time in storage (60 plants)	fresh		6.26	7.08	8.74	4.21	41.9
	1 month		7.32	6.73	9.78	4.28	34.8
	2 months		6.32	6.75	10.65	4.26	32.2
	3 months		5.24	6.77	8.93	4.26	37.1

a. Yield of flowers from April 5 to May 24, 1964, plus buds 1/4-inch diameter or larger on May 25.
b. Time from beginning of flowering of earliest treatment until half flowers were cut for a treatment.
* Red Gayety
** White Pikes Peak

Recent Research

Abstracts of selected papers presented at the American Society for Horticultural Science annual meeting at the University of Colorado, Boulder, August 23 to 26, 1964.

Good, G. L., and Tukey, H. B. Jr., Cornell University, Ithaca, New York. Leaching of metabolites from cuttings under mist. Cuttings of several woody and herbaceous ornamental plants were propagated under intermittent mist. Analyses were made of the nutrient content of the cuttings both before and after rooting. Analyses of the nutrient content of the leachates from the cuttings were also made. Considerable quantities of metabolites were leached from the cuttings during rooting, varying up to 60 percent of some nutrients. Leaching was influenced by the plant species, several environmental factors, and the stage of root development. The nutrient content of the cuttings as modified by leaching had an effect upon rooting.

Brewer, Robert F., Guillemet, F. B. and Sutherland, F. H., University of California, Riverside, California. The effect of atmospheric fluoride on gladiolus growth, flowering, and corm production. The effects on growth, flowering, and corm production associated with varying amounts of visible damage to gladiolus foliage resulting from exposure to HF gas were studied under controlled greenhouse conditions. Plants with leaf injuries amounting to approximately 10, 20, and 30 percent of the total leaf area were compared with control plants grown in fluoride-free air. Flower size and weight were reduced as the fluoride injury severity increased. The number of florets per spike also decreased as the percent of leaf area injured increased. Corm size and weight were reduced in direct proportion to the extent of leaf injury observed. Total top weight (leaves and flowers) was also inversely related to leaf injury but variety Elizabeth the Queen was more severely effected than variety Snow Princess.

Snyder, William E., Rutgers University, New Brunswick, New Jersey. The effect of polyvinyl materials on apparent transpiration of selected horticultural plants. Apparent transpiration of selected horticultural plants was determined by a gravimetric method at biweekly intervals following treatment with several commercial products. Water loss varied significantly with the anti-transpirant material used, with the plant, and with time following treatment. There were no significant differences between method of application (spraying vs. dipping) nor between one and two applications made at the same time.

White, John W., Pennsylvania State University, University Park, Pennsylvania. The concept of "container capacity". There is a point at which drainage of superfluous water from soil mixtures placed in a container essentially ceases; this point was defined in the study as "container capacity". Container capacity, therefore, is the total percent of water, by volume, held by a sample of soil, organic matter, coarse aggregate, or soil mixture, when in a container of a given depth (17.2 cm. in this study) with zero hydraulic head (saturation) at its lower surface and in the absence of any evapotranspiration. There appears to be no specific matric suction value with which container capacity can be determined for soil mixtures and their components, where a relatively wide range of physical characteristics exists. This study also demonstrated that the 1/3 atmosphere value, which is often taken as the upper limit of available water for field conditions, represents a point at which approximately 50 percent of the available moisture remains in the soil when placed in a container. For 36 mixtures studies, the matric suction at container capacity ranged between .007 and .03 bar.

White, John W., Pennsylvania State University, University Park, Pennsylvania. The application of "container capacity". Different, definable, and reproducable water regimes were maintained by daily weighing and observation to determine the relative dryness of the soil. The objective was to study the effects of various water regimes on the growth of pot chrysanthemums, utilizing the container capacity concept. Regardless of whether fertilizer was supplied in a liquid form at each watering or as an ion exchange resin (Tydex C), different moisture regimes had more effect on both height and fresh weight than they did when no fertilizer was used. It was suggested that maximum growth could be produced with 100 ppm each of nitrogen and potassium in the irrigation water if the soil was irrigated before 2/3 container capacity was reached. This point occurred when 67 percent of the water by volume remained in the soil mixture or at a matric suction of 0.048 bar.

Hanan, Joe J., and Langhans, R. W., Cornell University, Ithaca, New York. Utilization of water by plants. Effect of three irrigation regimes on growth and flowering. Five crops of snapdragons were grown in succession and subjected to three irrigation regimes. These treatments consisted of watering when suction was 30 cm water, 300 cm water, and 600 cm water or higher, between 8 and 9 a.m. It was found that reducing the frequency of irrigation by allowing the soil to become dryer

between irrigations reduced mean grade, stem length, spike length, number of florets per spike, and fresh and dry weight. Percent dry weight of cut flowers increased. The magnitude of differences between treatments from one crop to the next was not consistent. Usually, the higher the solar radiation during initial stages of growth, the greater the reduction in growth of those plots watered at 300 and 600 cm water suction. The efficacy of a given irrigation regime in reducing growth was largely dependent upon solar radiation during initial stages of seedling establishment in the greenhouse bench.

Hanan, Joe J., and Langhans, R. W., Cornell University, Ithaca, New York. Utilization of water by plants. Efficiency of three irrigation regimes. Water loss from five consecutive crops of snapdragons, subjected to three irrigation regimes in floating lysimeters was studied. Treatments were watering soil plots when soil suction reached 30 cm water, 300 cm water, and 600 cm water between 8 and 9 a.m. Irrigation at the lowest suction level resulted in highest mean grade, but the increase was not sufficient to justify the water required. Mean daily solar radiation did not significantly affect the total amount required to produce a cut flower. At higher radiation levels, time in bench was reduced and the plants were smaller. Irrigation regime did affect quantity of water required to produce a cut flower. The amount of fresh weight produced per liter of water was not affected by irrigation regime, but was directly related to mean daily solar energy level; the lower the intensity, the more fresh weight produced per liter of water. The weight of water required to produce 1 g dry weight of plant material decreased with higher suctions at the time of irrigation and with increasing solar radiation.

Carpenter, W. J., and Wittsell, Lawrence E., Kansas State University, Manhattan, Kansas. Comparison of snapdragon and chrysanthemum growth and flowering at various levels of soil compaction. Chrysanthemum cultivars, Cloudburst and Skyline and snapdragon cultivar Brokers Tip were grown in especially prepared soil treatments in a greenhouse bench with bulk densities ranging from .93 to 1.71. Decreases in plant height, number of flowers, and fresh and dry weights occurred as bulk densities increased. A delay in snapdragon flowering occurred in the severely compacted soil plots. Second plantings in the same plots showed a decrease in the bulk densities had occurred in the compacted treatments and increased compaction in the noncompacted treatment. Plant response was closely correlated with bulk densities of the soil throughout the studies. Carbon dioxide and oxygen measurements were made at regular intervals during the study. Oxygen contents decreased with increased soil compaction and carbon dioxide levels increased slightly as bulk densities increased from .93 to 1.35 and increased rapidly from 1.35 to 1.71.

Chan, A. P., Plant Research Institute, Ottawa, Canada. Induction and recovery of chrysanthemum and rose mutants caused by X-rays. Rooted cuttings of ten cultivars of Chrysanthemum morifolium and four rose cultivars were given single acute treatments of X-rays ranging from 1200r to 8000r. The effective range of radiation and the potentiality to mutate was found to vary greatly in all samples. Chrysanthemum cultivars responded best to treatments within the range of 1200 to 3000r, whereas rose cultivars needed at least 7500r for any effect to be produced. As a result of these radiations, some cultivars of both chrysanthemum and rose mutated freely but others were very stable. The degree of sensitivity to radiation appeared soon after treatment, when growth was inhibited in varying amounts. More than 284 chrysanthemum and 76 rose mutants were successfully recovered and evaluated. In most of the desirable mutants there were changes in the color, form, and size of flowers, and in time of flowering, but in others there were also improved color of leaf and habit of growth. Not all mutants were genetically stable. Some reverted to their original form while many others developed sectorial chimeral patterns.

Kohl, Harry C., Jr., and Nelson, R. L., University of California, Davis, California. Selection of improved gerberas for cut flowers. Gerberas proved to be highly variable with respect to night closing and keeping quality as well as the more obvious physical characteristics and production. Night closing is highly negatively correlated with receptacle size and degree of doubleness. Useful life was found to vary from less than one day to fourteen days under standard room conditions dependent upon variety. The size of the flower and stem length were found to be highly responsive to the environment and, more particularly, those factors in the environment affecting water relations.

Ewart, L. C., and Walker, D. E.,* Pennsylvania State University, University Park, Pennsylvania. The inheritance of flower size in Grandiflora and Multiflora petunias. The hypothesis that the large flower size of grandiflora petunias is inherited as a single dominant gene was accepted for investigation in this study. F_1, F_2 and testcross generations as well as pollen studies, seed germination studies, and cytological analysis were utilized in obtaining the necessary information. Ratio of 3:1, 2:1, 9:7 and 1:1 were found for segregating lines; however, the testcross results for these entries were nonsignificant for a 1:1 ratio. The results, along with the homozygous large-flowered plants

having been found to be very weak in this and in past studies, would seem to point out that lethal and sublethal genes are closely linked with the dominant gene causing the dominant class to be a weak group. This makes the ratio of 2:1 more important than the expected 3:1 ratio. The results also suggest that vigor alleles are interacting with the large-flower-viability gene linkage, and genetic models have been proposed to illustrate the possible breeding behavior of such a system.

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Watson, Donald P., and Shirakawa, Takumi, University of Hawaii, Honolulu, Hawaii. Gross morphology and shelf-life of flowers of Anthurium Andreanum. Evidence was presented to indicate that the shelf-life of the Anthurium inflorescence is influenced by the stage of maturity of the flowers at the time of harvest. Because of the size and nature of the flowers in the spadix, a series of photographs of stages of development of individual flowers was provided as a criterion for stage of maturity and uniformity at the time of harvest.

Link, Conrad B., Marousky, Francis J., and Shanks, James B., University of Maryland, College Park, Maryland. The influence of a senescence inhibitor on the keeping quality of Poinsettias. A senescence inhibitor, N^6 benzyladenine (Verdan), has been used as a material to retard the loss of leaves and bracts on poinsettias. Sprays ranging from 10 to 100 ppm have been used and with one or two applications. Sprays have been applied either at the time of putting the plants under home conditions or a week before while still in the greenhouse. Plants of the variety Indianapolis Red lasted approximately eight days longer when plants were sprayed with Verdan at the rate of 100 ppm just previous to placing under home conditions. Plants sprayed twice, seven days and one day before putting under home conditions, increased the lasting qualities of three varieties, 10 to 20 days. No injury to the leaves or bracts was observed.

Coorts, Gerald D., Gartner, J. B., and McCollum, J. P., University of Illinois, Urbana, Illinois. Respiratory measurements of the senescing "Velvet Times" rose. Under controlled environmental conditions, CO_2 measurements of Velvet Times roses were recorded by infrared gas analysis over a period of seven days. These roses were placed in treatments of either tap water or flower preservative. It was found that by placing the rose stems in a flower preservative, a much greater respiration rate was obtained than when stems were placed in tap water. In both treatments the respiratory drift decreased until the third day, when it began to rise and reached its climax on the sixth day. Measurements were also taken to correlate water uptake and change in flower weight with the respiratory changes.

Kuc, Ruth, Workman, Milton, and Durkin, Dominic, Purdue University, Lafayette, Indiana. Nitrogen and organic acid metabolism of aging Better Times roses. Changes in total ammonia, amide, and organic acid content were measured throughout the cut life of Better Times roses and for every stage of development in roses allowed to age on the plant. Data were obtained showing the bluing of cut Better Times roses was due to the increase of ammonia in petal tissues. A direct method for determining both ammonia and amide in fresh tissue slices was devised. In aging cut flowers, ammonia levels increased rapidly after three days. On the plant, ammonia accumulation was more gradual and never reached the levels of the cut flower. R.Q. measurements pointed to increased amino acid oxidation as the source of the increased ammonia content in aging cut flowers. Amide synthesis is suggested to be at least partially effective in ammonia detoxification. In aging cut flowers, amide synthesis increases for two days. Amide synthesis continues into senescence in flowers aged on the plant. The bulk of excess ammonia detoxification is suggested to be neutralization by organic acids. Malic and quinic acid content of aging cut flowers and flowers aged on the plant were measured. Malic acid rises significantly during senescence in both types of aging flowers. These data confirm the hypothesis that color change in aging cut roses is directly related to ammonia nitrogen levels in excess of the acid equivalence. This excess ammonia level is reached four to five days after cutting. In flowers aged on the plant, the ammonia level never surpasses the acid equivalence and the rose does not blue.

Shaw, Richard, J., and Rogers, Marlin N. University of Missouri, Columbia, Missouri. The effects of elevated temperatures and additional carbon dioxide on various greenhouse crops. Three varieties of carnations were grown under four different temperature combinations - 50^oN - 60^oD, 60^oN - 70^oD, 50^oN - 70^oD, and 60^oN - 60^oD - with and without additional CO_2. There were no great differences in production; however, flower quality was greatly impaired at 60^o - 70^o without additional CO_2. Several snapdragon varieties were grown at 50^oN - 60^oD and 60^oN - 70^oD. Flowering was accelerated by about 10 days at the higher temperature and also at the lower temperature with the addition of CO_2. There was little difference in stem length, weight, or flower spike length. Numerous chrysanthemum varieties, roses (var.

Redbird), and geraniums (var. Irene) were studied under different temperatures - 60°N - 70°D, 70°N - 70°D, and 60°N - 80°D - and different CO_2 levels. The higher day and night temperatures delayed the flowering of certain varieties of chrysanthemums. The additional CO_2 increased the stem length and stem weight particularly at 60° - 70°. Increased rose production was obtained at the higher temperatures with additional CO_2. The high night temperature showed a marked production increase during January and February, but reduced flower quality. Elevated temperatures and additional CO_2 improved the rooting, flowering, height, and branching of geraniums.

Koths, Jay S., University of Connecticut, Storrs, Connecticut. Snapdragon production as influenced by CO_2 enriched atmospheres. Snapdragons were grown at controlled atmospheric concentrations of 500 - 550 ppm CO_2 injected in proportion to solar radiation as controlled by a light operated interval switch (LOIS). The CO_2 was injected from Sept. 1 to May 1 when vents were closed or not open more than five inches. Harvest dates of crops were February, 1963, November, 1963, January, February, March, and April, 1964. The growth response during the Fall season was primarily a weight gain. As the maturity dates occurred later in the Winter, the crops matured in less time while weight differences tended to be less significant. The January, 1964 crop showed a 56 percent increase in weight per stem while the average flowering date was advanced one day. The February, 1964 crop had an 11 percent weight increase and flowering was advanced six days. The March, 1964 crop was 10 percent heavier while flowering two weeks earlier. The balance of the crops substantiated this trend.

Your editor,

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