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Factors Affecting Shipping and Storage of Ornamental Foliage Plants

J. Ben-Jaacov, C.A. Conover, R.T. Poole, B. Steinitz

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FINAL REPORT

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J. Ben-Jaacov, C. A. Conover, R. T. Poole and B. Steinitz

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ABSTRACT

Research was initiated at the Agricultural Research and Education Center - Apopka, Florida, and the Volcani Institute, Bet Dagan, Israel to determine best methods of storage for tropical indoor foliage plants. Results from this research showed that most of these plants will store satisfactorily at 10-15°C without light and without air exchange for 2-3 weeks. Some species can be stored without light for as long as 4 weeks at certain temperatures without serious deterioration of quality.

Foliage plants are grown and marketed in 3 sequential phases including: (I) Production; (II) Shipping and Storage and; (III) Post Storage Recovery and Interior.

I. Production Phase

Growth conditions during the production phase were found to have a great importance on storability and subsequent indoor performance of foliage plants. Most of our knowledge on these factors is derived from studies performed prior to initiation of this BARD project, and the major findings include the following observations:

Light. Preshipment light levels have a strong effect on postshipment plant quality. Plants grown under high light will not ship as well because they are not properly acclimatized. This results in excessive leaf drop or other loss of quality either in shipment or after placement in an interior environment. Also, plants grown in higher light are not as likely to tolerate lower shipping temperatures without sustaining chilling injury.

Nutrition. Preshipment fertilizer levels also affect acclimatization and, in turn, subsequent interior quality, but this is not often expressed during shipment. Foliage plants grown on higher than recommended nutritional regimes will not be well acclimatized and will ultimately lose more leaves and be of lower quality than those properly acclimatized. However, serious reduction in plant quality during the shipping phase will only be noticeable if the fertilizer level is more than twice the recommended level.

Soil Moisture. Low soil moisture during shipping periods increases desiccation of plant tissues and raises potential for leaf drop or injury. Plants should be thoroughly watered approximately 24 hours prior to shipment and allowed to drain before packing.

Season. Foliage plants grown during high light and high temperature periods are less tolerant of the shipping environment and are more likely to decline in quality during shipment. This may be due to lower levels of acclimatization or inability to tolerate lowered shipping temperatures. It appears that plants grown in summer and shipped then or in early fall will require warmer shipping temperatures than plants grown and shipped in winter or spring.

II. Shipping and Storage Phase

The main environmental conditions determining keeping quality of foliage plants during and following long distances and long term shipping and storage are:

Light. All shipments to date have been made in darkness. Addition of light during the shipping period might be beneficial, but incorporation into reefers would be difficult.

Humidity. Although all plants need to be thoroughly watered prior to shipment, this will not prevent them from desiccating if humidity is too low. We have found that a relative humidity level of around 85 to 90% in the reefer is necessary for maintenance of foliage plants shipped for long durations. This level can be obtained with boxed plants or when reefer air exchange controls are set in the closed position with sleeved or open shipped plants.

Gases. Research on foliage plants has shown that ethylene is probably the only contaminant that may occur in a reefer, unless it receives pollution from an outside source. However, foliage plants require fairly high levels of ethylene (1 to 2 ppm) and relatively high temperatures (15°C or higher) for long durations before any damage will occur. Experience has shown, therefore, that ethylene does not seem to be a major problem when plants are shipped at cooler (15°C or lower) temperatures.

Temperature. Shipping at low temperatures (15°C and below) can be beneficial provided plants are not chill-damaged. In the present project, we focused our work on the long term shipping and dark storage phase. Main objectives of our work were as follows:

- A. In the aim to reach general conclusions with regard to duration and temperature requirements for maintaining quality of foliage plants during dark storage, we extended our test and included new plant species (sections 2.1, 2.2, 2.3).
- B. To test the influence of soil mixes (water holding capacity), and the importance of reduced O₂ concentration in the shipping container, on long term dark storability (sections 2.4, 2.5).
- C. It is well known that cytokinins are potent retardants of leaf senescence. We were interested to test the feasibility of using cytokinins to improve storability of foliage plants, the quality of which was found to be significantly reduced by long term dark storage (section 2.6).

D. Fruit ripening and senescence, and leaf and flower abscission were found in some cases to be genetically controlled. We looked for a possible existence of a genetic variability in ability of Ficus foliage plants to withstand long term dark shipping and storage (section 2.7).

III. Post Storage Recovery and Interior Phase

Based on previous work, we noticed that this phase is of relative little importance, provided only excellent quality plant material is produced for long distance shipping. Therefore, the scope of our work, within this BARD project, covered only the prolonged dark storage phase.

The details concerning the experimental approaches used and the results obtained are presented, in the following sections, in a form of a series of papers part of which were already published while others are in press or in preparation for publication. More general conclusions are discussed in the final part of our report (section 2.8).

DESCRIPTION OF COOPERATION

The BARD project gave a sound basis for a very fruitful cooperation. The mutual publications cited in this report provide the best evidence for this fact. Visits of Dr. J. Ben-Jaacov in Apopka, Florida, and of Dr. R. T. Poole in Bet Dagan, Israel, gave both investigators the opportunity to get acquainted with the research activities in both centers and to learn the problems of the foliage plant industries in both countries. The results of this project can be equally applied in the USA and Israel. We anticipate future collaboration between the two groups within future BARD projects.

BENEFIT TO AGRICULTURE

Prior to initiation of this research project, only limited information was available concerning short and long-term shipping requirements of foliage plants. However, information obtained during the last several years has shown that long-term shipping is a viable system of moving potted foliage plants long distances. Shipping temperatures and duration of shipping has been reported for 26 plant species with a similar number of species to be reported soon. The availability of this information has stimulated shipments of foliage plants to Europe from the U.S. and Israel, as well as to Saudi Arabia. In 1980 less than \$1,000,000 worth of foliage plants were shipped by container to Europe, while in 1983 shipments were about \$5,000,000 with an estimate of \$10,000,000 for 1984. The establishment of a large corporation in the U.S. to specifically utilize the information produced by this research has been a key to the rapid increase in shipments. The potential for shipping foliage plants throughout the world has been shown by this research and commercial experience. This will allow producers access to most free markets and improve communication and market access.

Table 1. Color grade (1 = dead, yellow; 3 = partial yellow but salable; 5 = normal, excellent color) of 7 lower leaves of Dieffenbachia maculata 'Rudolph Roehrs' immediately after removal from 30 days of dark storage and again after 2 weeks.

Tabelle 1. Einstufung der unteren 7 Blätter unmittelbar nach der Entnahme aus der 30 Tage dauernden dunkel Lagerung und dasselbe nach 2 Wochen. (1 = gelb; 3 = schwach chlorotisch, verkauflich; 5 = normal).

BA mg/l	Immediately	Two weeks later
0	3.0 ^z	2.2 ^y
25	4.4	2.9
50	4.3	2.9
100	4.3	3.2
<u>Leaves sprayed</u>		
All	4.2 ^x	3.1 ^x
Lower 4	3.8	2.4

^zCoefficient of determination 0.84. $Y = 3.13 + 0.05X + 3.45 \times 10^{-4}X^2$.

^yCoefficient of determination 0.90. $Y = 2.27 + 0.02X + 1.24 \times 10^{-4}X^2$.

^xLinear separation, 0.05%.

Table 2. Color grade (1 = dead, yellow; 3 = partial yellow but salable; 5 = normal, excellent color) and chlorophyll content of leaves of *Dieffenbachia maculata* 'Rudolph Roehrs' graded immediately after 30 days dark storage at 17°C.

Tabelle 2. Farbabstufung und Chlorophyll Gehalt von Blättern unmittelbar nach der Entnahme aus 30 tagiger dunkel Lagerung bei 17 C. (1 = gelb; 3 = schwach gelb, verkauflich; 5 = normal).

BA mg/l	Leaves sprayed	Leaf No. from bottom					
		2		5		8	
		Color grade	Chlorophyll mg/cm ²	Color grade	Chlorophyll mg/cm ²	Color grade	Chlorophyll mg/cm ²
100	All	4.4 a ^z	.024 a	4.9 a	.026 a	5.0 a	0.21 a
	4 lower leaves	4.2 a	.019 a	2.3 c	.010 b	5.0 a	.018 a

0	All	1.2 b	.009 b	4.1 b	.019 a	4.9 a	.018 a
Leaves sprayed							
		All		4 lowest			
		BA/mg/l		BA mg/l			
		0		100		100	
Leaf no. from bottom		Color grade	Chlorophyll mg/cm ²	Color grade	Chlorophyll mg/cm ²	Color grade	Chlorophyll mg/cm ²
2		1.2 c ^z	.009 b	4.4 b	.024 a	4.2 b	.19 a
5		4.1 b	.019 a	4.9 a	.026 a	2.3 c	.10 b
8		4.9 a	.018 a	5.0 a	.021 a	5.0 a	.18 a

^zMean separation at 5% level within columns by Duncan's multiple range test.

Figure 1.

(Legend to Figure 1.)

(Fig.1.) *Dieffenbachia maculata* 'Rudolph Roehrs' dark-stored at 17°C for 30 days photographed when taken out of storage.
Left: Control - sprayed with water only.
Middle: Four lowest leaves sprayed with 100 mg/l BA.
Right: Entire plant sprayed with 100 mg/l BA.

(Bild 1.) *Dieffenbachia maculata* 'Rudolph Roehrs' nach der Entnahme aus 30 tägiger dunkel Lagerung bei 17°C.
Links: Kontrolle - mit Wasser besprüht.
Mitte: 4 untersten Blätter mit 100 mg/L BA besprüht.
Rechts: Ganze Pflanze mit 100 mg/L BA besprüht.

Figure 2.

(Fig. 2.) Leaves from bottom to top (left to right) of *Dieffenbachia maculata* 'Rudolph Roehrs' dark-stored at 17°C for 30 days.

Top row: Whole plant sprayed with 100 mg/l BA.

Middle row: Four lower leaves sprayed with 100 mg/l BA.

Bottom row: Control - sprayed with water only.

(Bild 2.) Blätter von *Dieffenbachia maculata* 'Rudolph Roehrs' von unten aufsteigend (Links nach rechts) nach 30 tägiger dunkel Lagerung bei 17°C.

Oben: Ganze Pflanze mit 100 mg/L BA besprüht.

Mitte: Vier unteren Blätter mit 100 mg/L BA besprüht.

Unten: Kontrolle - nur mit Wasser besprüht.

Figure 3.

(Legend to Figure 3.)

(Fig. 3.) Leaves from bottom to top (left to right) of *Dieffenbachia maculata* 'Rudolph Roehrs' dark-stored at 17°C for 30 days.

Top row: Leaves attached to plant - sprayed with water only.

Middle row: Leaves detached from plant - sprayed with water only.

Bottom row: Leaves attached to plant - entire plant sprayed with 100 mg/l BA.

(Bild 3.) Blätter von *Dieffenbachia maculata* 'Rudolph Roehrs' von unten aufsteigend (Links nach rechts) nach 30 tägiger dunkel Lagerung bei 17°C.

Oben: Blätter an der Pflanze nur mit Wasser besprüht.

Mitte: Blätter nach Entnahme von der Pflanze nur mit Wasser besprüht.

Unten: Blätter an der Pflanze, ganze Pflanze mit 100 mg/L BA besprüht.

Clonal Variability in Responsiveness to Light Intensity During Growth and to Subsequent Dark Storage as Reflected in Morphology and Leaf Abscission of Ficus benjamina and Ficus retusa foliage plants.

J. Ben-Jaacov, B. Steinitz, D. Ziv

ABSTRACT

Three clones of Ficus benjamina and one clone of Ficus retusa foliage pot plants were raised at three different light intensities. The variation in the morphological development of the clones in response to light intensity was recorded. Leaf abscission from these plants was followed at the end of 2 weeks of dark storage and during subsequent stay for one month in a simulated home environment. In non-stored plants only low levels of leaf drop were observed. Leaf abscission was strongly stimulated during dark storage and in subsequent indoor environment. The degree of dark storage promoted leaf abscission and the response pattern to light intensity during the production phase, with regard to leaf drop during simulated home conditions, showed a clear clone-dependent specificity. It is concluded that the genetic background is the main factor affecting storability and later performance under simulated home conditions.

INTRODUCTION

Ficus benjamina L. is a popular foliage plant which was frequently used in the last decade to study the impact of various environmental factors on its growth and development. Photosynthetic photon flux density (PPFD) (3,4,6,7), fertilization levels (2,3,7) and irrigation frequency (6) during the production phase influence net CO₂ exchange rates, leaf

anatomy and pigment content and the entire morphology and structure of the plant. The same environmental factors largely influence also keeping quality of the plants during dark storage, shipment and subsequent performance in an indoor environment (9,10). The most conspicuous deleterious effects environmental growth conditions might impose on the following interior decorative value of the ornamental pot plant is reflected in leaf drop which occurs during shipping and in the first phase of adaptation to the new indoor environment.

The great potential of using genetic variability as a tool for improving and extending longevity and keeping quality of fruits has been recognized already years ago (5,11). We are unaware of any similar approach undertaken with ornamental foliage plants. It is not known to what extent, if at all, the degree of modulations in physiological, anatomical and morphological traits of *Ficus* plants - as induced by different environmental factors - are genetically determined; likewise it is unknown if, in *Ficus*, a genotypic variation exists in withstanding transfer from outdoor to indoor conditions via a period of dark storage (simulated shipment). The present work focuses on the variability in response to light intensity during the growth and production phase, found among three clones of *F. benjamina* and one clone of *F. retusa*. The variability in response to light intensity during the production phase is examined with regard to the morphological development of the plants and their subsequent storability and keeping quality in an indoor environment.

MATERIALS AND METHODS

Plant Material

The four clones of *Ficus* used in these experiments were: a and b,

commonly grown clones of F. benjamina, originating and propagated from two different seedlings, were collected of two different commercial nurseries. Both had similar morphology but their physiological performance was intended to be evaluated. c. A type of Ficus, grown commercially as an indoor foliage plant in some nurseries in Israel. Morphologically this clone looks similar to the "weeping Ficus" recently introduced to the trade by "Golf stream" nursery in Texas (12). d. Ficus retusa, a type of Ficus commonly grown in Israel as a street tree and known in other countries as an indoor foliage pot plant.

Growth Storage and Indoor Conditions

Uniform, 15 cm tall rooted cuttings were potted into 15 cm plastic pots with volcanic ashes:peat:styrofoam (1:2:2) medium. Pots were placed in a polyethylene covered house with a min.-max. temperature range of 10°C-37°C. Watering was done with 2 liter/hr. drippers twice a day in quantities allowing 20% to drain out. Liquid fertilization was applied in each irrigation with 1/2 g/liter of 20:20:20 "Deshen-kol" fertilizer (Haifa Chemicals product) providing 100 ppm N, 45 ppm P, 82.5 ppm K and micronutrients. Plants were grown at 3 light intensities provided by shading with saran netting. PPFDs were 75%, 50% and 25% of the natural outdoor light ($17 \mu\text{mol s}^{-1}\text{m}^{-2}$ measured on June 17th, 1983 at 12:00 A.M. on a clear day).

The influence of light intensity on plant development was recorded prior to storage. Leaf area and chlorophyll content were determined on fully expanded leaves. Chlorophyll was extracted in N, N-dimethyl(formamide) and determined spectrophotometrically according to Moran, 1982 (8).

For stored plants were thoroughly watered individually sleeved with net sleeved and placed horizontally in non-waxed cardboard boxes with holes in

their walls and moved into dark storage (see also). Temperature in the boxes was maintained at $15^{\circ}\pm 1^{\circ}$ with relative humidity of $85\pm 10\%$. After 2 weeks plants from the dark storage and the control unstored plants from the greenhouse were moved into the simulated home room and kept there for one month at light intensity of $12\ \mu\text{mol s}^{-1}\text{m}^{-2}$ provided by cool white fluorescent lamps, with a daily photoperiod of 12 h light, and a temperature of $22\pm 2^{\circ}\text{C}$. Light intensity in the greenhouse and in the simulated home environment was measured with a.....

Number of leaves was counted at 3 stages; before placing plants into storage, when plants were placed into simulated home conditions (end of storage) and at termination of the experiment, i.e., at the end of one month in the simulated home conditions. Percent of leaves dropped was calculated, using number of leaves prior to storage as 100%.

Storage experiments were repeated three times, each experiment initiated on a different date. Since, however, cuttings for all experiments were prepared and rooted in the same time, pot plants were placed in storage at respectively different stages of development. Consequently the values obtained for a treatment were quantitatively different at each storage experiment, yet qualitatively the comparative results between the four clones were similar in all three experiments. For the sake of conciseness we bring representative data obtained in one of the three storage experiments. Each treatment in an experiment consisted of 6 plants with one plant per pot.

RESULTS AND DISCUSSION

1. The effect of light intensity during production on growth and development.

The response of each of the Ficus clones was measured after growth for 6 months at three levels of PPFDs. The data collected are summarized

in Table 1A-E. In general terms, all clones displayed in all tested traits a response to light intensity. Plant height, leaf area and chlorophyll content increased with decreasing light intensity; stem capilar diameter, and leaf number per plant increased with increasing light intensity. No real significant difference in morphological response to light could be detected between F. benjamina a and b. However, some clone-specificity in responsiveness to light intensity was observed in a few cases. Leaf area and chlorophyll content were strongly influenced in F. benjamina a and b, and moderately influenced in the weeping Ficus clone (c). Both these traits were nearly indifferent to light intensity in F. retusa.

2. Influence of light intensity during growth on storability and keeping quality in an interior environment.

The main damage caused to Ficus plants, intended to serve as foliage pot plants, by their transfer from the production site to the indoor environment is leaf abscission. Therefore, the evaluation of any potential influence of light intensity or genetic variability on the indoor performance of the plants, is concerned with the phenomenon of leaf drop occurring following production.

After 6 months of growth at different light intensities plants were transferred to the interior environment either directly or after 2 weeks of dark storage (simulating long distance transport). Thus, observations include stored and non-stored plants. Leaf counts were performed on each individual plant: Number of leaves found on a plant, when removed from the greenhouse, was regarded as the 100% value; leaf counts were repeated at the end of storage (for stored plants) and finally at the end of one month stay in the indoor environment. These counts provided the basis for

expression % leaf drop at the end of storage and the end of experiment, respectively. The % leaf abscission, as a function of light intensity during the production phase, is presented for each clone of stored or non-stored plants in Fig. 1.

Among the non-stored plants, weeping Ficus (c) had the lowest extent of leaf drop. Clone b of F. benjamina was the only one to show a minor, but significant, increase in leaf drop when removed from the two higher growth light intensities. In general, regardless of light intensity present during the production phase, all clones retained excellent quality throughout the duration of the experiment.

Two weeks of dark storage had a dramatic consequence on all plants causing strong leaf loss during storage as well in the indoor stay thereafter. However, there is a very clear clone-dependent specificity in the promotion of leaf abscission by dark storage: During storage Ficus retusa (d) lost most of its foliage, common-type F. benjamina clones a and b dropped an intermediate percentage of leaves whereas weeping F. benjamina (c) lost only 10-15% of its foliage; within the following one month of indoor stay the process of leaf abscission continued mainly in clones a and b. Likewise we found a clone-dependent specificity in the pattern of response to light intensity during the production phase; only clones a and b showed consistently throughout all the experiments a significant accumulative (storage plus indoor) increasing extent of leaf drop with the increase in light intensity. Interestingly, weeping F. benjamina (c) showed least sensitivity to both light intensity during production phase as well as to dark storage- promoted leaf abscission.

Since weeping type F. benjamina does show in other traits responsitivity to light intensity during the production phase (Table 1), the low sensitivity to light intensity with regard to leaf abscission (Fig.1) indicates that there is an internal mechanism which controls the response-specificity in sensitivity to light. This observation, taken together with the finding that there is a great clonal variability in response to light intensity and to dark storage, clearly point to a genetic determination of those traits we regard to be part of the keeping quality during the post production phase of foliage plants. Such genetic variability should be seriously considered in future attempts to improve performance of interior foliage plants and it seems that the feasibility for a success in such an attempt is highly positive.

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Table 1. Morphological characteristics of 4 different clones of Ficus pot plants grown for 6 months at 3 light intensities. Values represent means $\pm$ S.E.

A. Plant height (cm), measured from pot rim to end of fully stretched plant.

Light intensity (% of outdoor)	Type of Ficus			
	benj. (a)	benj. (b)	benj. weeping (c)	retusa (d)
75	65 $\pm$ 7	63 $\pm$ 7	97 $\pm$ 5	75 $\pm$ 5
50	77 $\pm$ 3	84 $\pm$ 5	113 $\pm$ 3	77 $\pm$ 5
25	80 $\pm$ 2	81 $\pm$ 6	113 $\pm$ 8	81 $\pm$ 2

B. Stem caliper diameter (mm), measured 3 cm above pot rim level.

Light intensity (% of outdoor)	Type of Ficus			
	benj. (a)	benj. (b)	benj. weeping (c)	retusa (d)
75	10 $\pm$ 0	10 $\pm$ 0	10 $\pm$ 0	7 $\pm$ 0
50	8 $\pm$ 0	7 $\pm$ 0	9 $\pm$ 0	6 $\pm$ 0
25	8 $\pm$ 0	8 $\pm$ 0	8 $\pm$ 0	5 $\pm$ 0

C. Leaf number per plant.

Light intensity (% of outdoor)	Type of Ficus			
	benj. (a)	benj. (b)	benj. weeping (c)	retusa (d)
75	395	446	224	654
50	202	226	127	357
25	174	200	127	266

D. Leaf area (cm²).

Light intensity (% of outdoor)	Type of Ficus			
	benj. (a)	benj. (b)	benj. weeping (c)	retusa (d)
75	10.3±2.5	13.5±0.5	26.5±1.0	13.5±0.5
50	18.3±0.8	21.6±0.7	27.5±1.2	13.0±0.5
25	21.2±0.8	25.0±1.0	32.0±1.5	15.3±1.2

E. Chlorophyll content (µg Chl/cm²)

Light intensity (% of outdoor)	Type of Ficus			
	benj. (a)	benj. (b)	benj. weeping (c)	retusa (d)
75	12.5±0.5	15.8±0.7	21.2±0.8	20.6±0.5
50	21.5±1.0	25.3±0.8	26.0±1.5	26.0±0.8
25	33.7±1.0	33.6±1.0	19.5±1.5	26.2±0.7

Fig.1: Leaf abscission in 4 clones of Ficus foliage pot plants, during dark storage and subsequent stay under simulated home conditions, as influenced by light intensity during production.

2.8 Concluding Remarks

Based on our present level of knowledge concerning long-term shipping in reefers, we feel it is a viable system and one which will achieve much greater use in the future. We also feel that certain limitations apply: First, plants to be shipped must be acclimatized and have a moist potting medium at time of shipping. Secondly, high humidity must be maintained within the reefer at all times, and lastly, temperatures must be specified for foliage crops to be shipped. Suggested temperature ranges are supplied for some foliage plants in Table 1.

Table 1. Suggested shipping temperatures (°C) for acclimatized foliage plants shipped in reefers for different time periods.

Plant name	Duration of shipping	
	1-15 days	16-30 days
<u>Acoelorrhaphe wrightii</u>	10-13	^z
<u>Aglaonema</u> 'Fransher'	13-15	15-18
<u>Aglaonema</u> 'Silver Queen'	15-18	15-18
<u>Ardisia crispa</u>	10-13	-
<u>Aspidistra elatior</u>	10-13	-
<u>Brassaia actinophylla</u>	10-13	10-13
<u>Chamaedorea elegans</u>	13-15	-
<u>Chamaedorea seifrizii</u>	13-15	-
<u>Chrysalidocarpus lutescens</u>	13-18	15-18
<u>Citrus madurensis</u>	10-13	-
<u>Codiaeum variegatum</u> 'Norma'	15-18	15-18
<u>Cordyline terminalis</u> 'Dragon Tongue'	15-18	-
<u>Dracaena deremensis</u> 'Janet Craig'	15-18	-
<u>Dracaena deremensis</u> 'Warneckii'	15-18	-
<u>Dracaena fragrans</u> 'Massangeana'	15-18	-
<u>Dracaena marginata</u>	13-18	15-18
<u>Ficus benjamina</u>	13-15	13-15
<u>Ficus nitida</u>	13-15	-
<u>Howea forsterana</u>	10-18	10-18
<u>Philodendron selloum</u>	13-15	-
<u>Phoenix roebelenii</u>	10-13	-
<u>Pleomele reflexa</u>	15-18	-
<u>Rhapis excelsa</u>	10-13	-
<u>Schefflera arboricola</u>	10-13	10-13
<u>Spathiphyllum</u> 'Mauna Loa'	10-13	13-15
<u>Yucca elephantipes</u>	10-13	10-13

^zData not available, and it is not known how they will tolerate shipment beyond 15 days.

^yPlants observed to lose quality beyond 15 days shipping duration.

Some interesting physiological observations emerge from our studies, all of them relate to the area of senescence. For example, it is generally accepted that exclusions of light stimulates decay and senescence. Most of the work in this field was performed with detached plant material. Our work, showing the general ability of foliage plants to withstand dark storage for several weeks (at moderate temperatures), indicates that exclusion of light has in fact a less dramatic effect on intact plants. Further, it has been often shown that detachment of leaves accelerates subsequent senescence of the excised organ. Our results with detached Dieffenbachia leaves (Section 2.6) is therefore an interesting exception. Finally, the existence of genetic variability in the senescence syndrome has received almost no attention. This attitude is unjustified, and we believe that storability of many of the perishable agricultural products could most probably be significantly improved with the proper genetic manipulations.

List of Publications

1. Ben-Jaacov, J., Poole R.T. and Conover C.A. (1982) Effect of Nutrition, Soil Water Content, and Duration of Storage on Quality of Dieffenbachia maculata (Lodd.) G. Don 'Rudolph Roehrs'. HortScience 17(4) : 611-612.
2. Ben-Jaacov, J., Poole R.T. and Conover C.A. (1982). Effects of Long-term Dark Storage on Quality of Schefflera. HortScience 17(3):347-349.
3. Ben-Jaacov, J. Steinitz B., and Tendler Y. (1984). Dark storage of Calamondin, HortScience 19(2): 263-264.
4. Ben-Jaacov, J. Steinitz, B. and Ziv D. (1984) Light intensity during Production affect differently clones of ficus during dark storage Hassadeh 64: 1393-1395.
5. Ben-Jaacov, J. Poole R.T. and Conover, C.A. (1984) Long-Term Dark storage of Dieffenbachia sprayed with Cytokinin. Gaetenbauwissenschaft 49 5/6 (1984).).
6. Conover, C.A. 1982. Florida '82: A fitting finish and a final report Florida Nurseryman 29(10):52-53, 59.
7. Conover, C.A. and Poole R.T. (1982). Results of the Florida Test Shipment. Florida Nurseryman 29(4):29.
8. Conover, C.A. and Poole R.T. (1983). Environmental Factors Influencing Long-term Shipping of Tropical Foliage Plants. ARC-Apopka Res. Rept. RH-1983-3.

9. Conover, C.A. and Poole R.T. Handling and Overseas Transportation of Acclimatized Foliage Plants in Reefers. Nurseryman's Digest 17(3):30-32.
10. Conover, C.A., and Poole, R.T., (1984) Simulated shipping of Chrysalidocarpus Lutescens (Areca Palm). ARC-A Research Report RH-84-1.
11. Poole, R.T. and Conover C.A. (1981). Dark Storage of Foliage Plants. Foliage Digest 4(6):8.
12. Poole, R.T. and Conover C.A. (1982). Influence of Cultural Conditions on Simulated Shipping of Ficus benjamina L. Proc. Fla. State Hort. Soc. (In press).
13. Poole, R.T. and Conover C.A. (1983). Factors Influencing Chilling Damage of Foliage Plants. ARC-Apopka Res. Rept. RH-1983-4.
14. Poole, R.T. and Conover C.A. (1983). Packing of Foliage Plants for Shipment. ARC-Apopka Res. Rept. RH-1983-6.
15. Poole, R.T., Conover, C.A., and Ben-Jaacov, J., (1984). Long Term Storage of Foliage Plants. Scientia Hortie (Accepted for pub. 25 June 1984).
16. Poole, R.T., Conover, C.A. and Staby G.L. (1984). Storage of Foliage Plants with Reduced Oxygen content ARC-A Research Report RH-84