offered in 1977. Macon County Extension personnel published a brochure for their "Horticulture School." Their facilities accommodate an audience of 85 as an advance enrollment was taken for each program. A nominal enrollment fee was charged to cover the cost of refreshments and reference materials distributed to the "students."

The Horticulture TeleNet Series enabled the Macon County Extension Service to present programs for the homeowner on a wide range of horticultural topics. Without TeleNet this would not be possible. Macon County, like most Illinois counties, does not have a horticulturist on the county Extension Service staff.

The Horticulture TeleNet Series began in 1971 when the landscape design specialist received more requests for county meetings than he could fulfill. After surveying the problem and the possible solutions the specialist decided to try a program on the newly established TeleNet system. The TeleNet system at that time had 17 permanent installations. Other locations were added for the program via a dial-up auxiliary connection.

The specialist in cooperation with TeleNet staff members arranged for the program and duplicated and distributed a slide set to each county participating in the program. The specialist presented the lecture via TeleNet in coordination with slide sets shown at each location. A question and answer session followed the lecture.

The initial program was well received by the audience. During the question and answer session many questions were asked about pruning and care of ornamental plants, though the lecture was limited to landscape design. The questions encouraged the specialist to design three new programs: Pruning Evergreens, Pruning Deciduous Shrubs, and Pruning Ornamental Trees.

In subsequent years programs have been added by other horticulture specialists in response to requests from county personnel and the audiences. Twelve programs were presented in 1977 discussing the culture of house plants, small fruits, tree fruits, ornamental trees and shrubs, vegetables, annual and perennial flowers, and lawns. Four programs on landscape design completed the series.

For many citizens in the more urban counties the Horticulture TeleNet Series programs are their first contact with the Cooperative Extension Service. Since the audiences are predominately new extension audiences and since programs are available that were not previously available, these audiences tend to accept the tele-lecture method of program delivery. Evaluations reveal a high degree of audience satisfaction. The results of audience surveys indicate that we can accomplish effective extension communication in home horticulture via remote means.

Extension horticulturists design and deliver their tele-lecture home horticulture programs in the manner and style that best fits their material and personal skills. Some specialists talk from notes and deliver live programs. Others prerecord the lecture talking from notes or from a complete script. Lectures delivered live are taped during the live presentation. Therefore tapes are available for all of the programs. These tapes serve as a record of the program, provide a basis for improvement, and may be used as a part of packaged horticulture learning packets.

Slide sets and tapes are available to county Cooperative Extension personnel for loan or purchase. The programs on tree fruits also have complete scripts available. These materials may be borrowed at any time throughout the year. Garden Clubs, garden centers, junior colleges, high schools and other groups may borrow the materials through their county Cooperative Extension Service offices. Many counties have purchased one or more of the slide sets and have them locally available for loan to interested groups. Counties owning a slide set are notified when revisions are made. The availability of slide sets, tapes and scripts for county use at times other than the scheduled TeleNet program is a side benefit from the Home Horticulture TeleNet Series.

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Incandescent Lamp Maintenance in Plant Growth Chambers[1]

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Additional index words. controlled environment, light

Abstract. **The cause of the premature burn-out of incandescent lamps used in plant growth chambers was determined. Group replacement of lamps can be practiced on an annual basis with proper lamp selection.**

Plant growth chambers usually contain a few incandescent-filament lamps in addition to the main light source because they result, in most instances, in markedly improved growth (1, 3, 4, 5, 6, 7). Unfortunately, in plant growth chamber operations the relatively brief (750 hr) life of the incandescent lamp creates a considerable maintenance problem. This is especially true when the chamber is equipped with a barrier between the lamps and the growing area. Thus in many controlled-environment facilities, and especially in phytotrons, lamp maintenance can become a serious manpower drain if a conscientious effort is made to provide uniform light quality.

A series of tests were made at the NCSU Phytotron to determine the actual life of various kinds of incandescent lamps under growth chamber conditions.

The objective was to select a lamp that would provide the longest life with the least sacrifice in light production.

Generally the amount of light from the incandescent lamps is set at 10% of the total illuminance although there is no experimental evidence that this light level is optimal. Determining how many lamps are needed to produce the 10% illuminance was supposed to have been facilitated when someone determined that it would result from installing 30% of the wattage as incandescent lamps. Unfortunately the 30% figure has been used as a constant whereas it actually depends on the efficiency of the light sources being used. For example, a 25 watt (w) incandescent lamp produces 8.8 lm/w, a 60 w lamp 14.8 lm/w and 100 w lamp 17.4 lm/w. Thus it would seem that eight 25 w lamps would be required to produce about the same light as a single 100 w lamp. Moreover, when the original incandescent lamps are replaced the replacement lamp may be rated for 130 v instead of 120 v because many university and commercial physical plants have begun to use 130 v lamps exclusively. The result is about 285% increase in life but with a 24% reduction in light output.

Preliminary tests using General Service 130 v lamps in 120 v sockets, Extended Service lamps and Westinghouse Super Bulbs indicated that they were failing much faster than calculations (2) and manufacturers' data predicted. Lamp company engineers examined a random sample of the burned out lamps and found that they

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[2]Director of Phytotron. The author wishes to express appreciation to the various lamp companies that provided assistance during the course of this study.

had been subjected to "hot shock while lighted," that is to vibration.

We had known for many years that vibration was the major cause of lamp failure in chambers where direct-expansion refrigeration systems were mounted on the frame of the chamber. However, the controlled-environment rooms used in the lamp tests operated from secondary coolant so compressors, pumps and control valves, as well as lamp ballasts, were remotely mounted and not attached to the chamber.

Therefore, the major sources of vibration in the reach-in, direct-expansion chambers were not present in the walk-in, secondary-coolant rooms. The only sources of vibration remaining were the 12 centrifugal blowers used to circulate air through the lamp area. These blowers circulate about 71 liter/sec of air to produce a rather steady linear velocity of no more than 23 m/min; which is hardly enough to produce appreciable lamp vibration. Fan vibration results from pneumatic pulsation of the frame due to pressure pulses from each impeller blade as it passes, and by dynamic unbalance of the rotor motor. Modern blade angle design and use of all metal, well balanced blowers would normally be expected to reduce these factors to an insignificant level. Nevertheless vibration did seem to be a factor influencing lamp failure in the preliminary examination so vibration resistant lamps were included in our tests.

Four types of incandescent lamps were used: General Service 130 v and Super Bulbs with the common No. 8 axial filament, Industrial Service and Duro Test ATC with the more vibration resistant No. 9 filament. The IES Handbook (2) contains illustrations of the filament types. One No. 8 and one No. 9 filament were paired in each of the duplex sockets so that every vibration level would be tested with each filament type. A total of 84 lamps of each type were equally distributed into 7 plant growth chambers. All lamps were terminated at 7000 hr. It should be common knowledge that environmental conditions during testing the real life of incandescent lamps is not important, unless those conditions become extreme. The filament of a 100 w lamp operates around 2500°C so 100° or so change in ambient temp does not noticeably alter the filament temp which is the major factor determining life and light output. Thus ambient temp have virtually no effect on lamp performance unless they cause the lamp base temp to approach 190°. Our lamp loft temp were controlled however and averaged 32°. Unlike fluorescent lamps the no. of starts does not greatly affect the life and light output of an incandescent lamp. Therefore the fact that we started once per day and used the lamps for periods of 9 to 12 hr should have no influence on the results.

Results of our test (Table 1) shows that, with the exception of the General Service lamp, the predicted life was attained. The distribution of the burnouts (Fig. 1) however was quite different from typical mortality curves (2). The earlier loss of lamps is attributed to the vibration factor.

Table 2 shows the relative life and light output of several kinds of incandescent lamps. Although the exact role of the light from incandescent lamps has not been completely

Table 1. Measured and predicted average life of 4 kinds of incandescent lamps used under controlled-environment room conditions.

Lamp type	Avg life (hr) Measured	Avg life (hr) Predicted[z]
General Service 130 v	1457	2138
Westinghouse Super Bulb	2985	3000
Industrial Service	3984	3500
Duro Test ATC	5884	4000
LSD01	884	

[z]From manufacturers data.

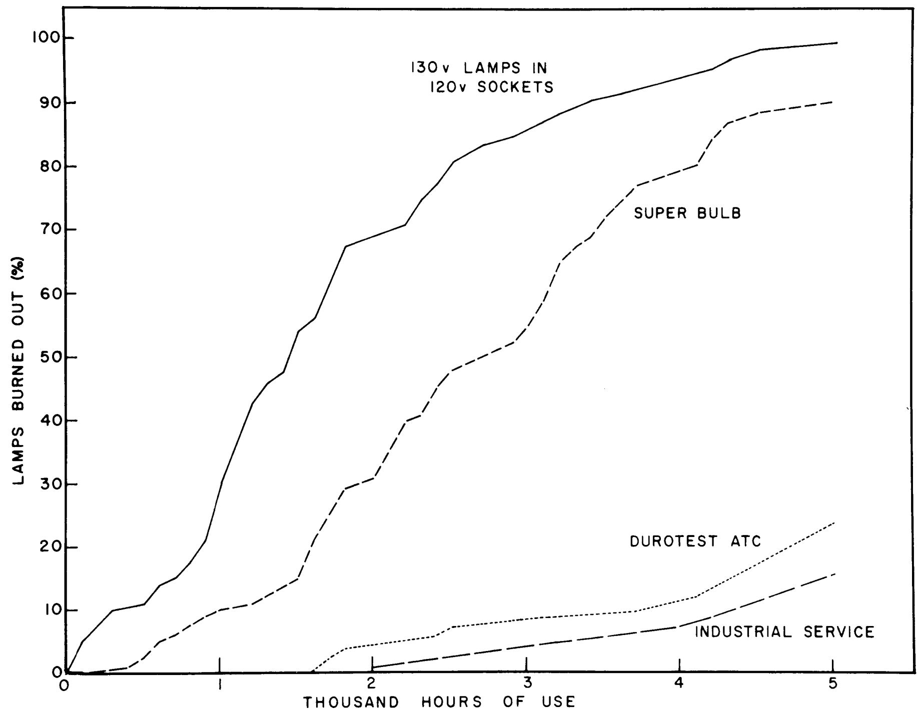

Fig. 1. Rate of burn-out of several kinds of incandescent-filament lamps during plant growth chamber operation. predicted rates would be 10% at 70% of rated life, 20% at 80%, 30% at 90% and 50% at 100% of rated life (2).

Table 2. Relative life, light output, and cost of various kinds of incandescent-filament lamps (based on 120 v General Service lamp).

Lamp type	Lamp volts[z]	Filament	Life	Lumens	Measured[z] I	Measured[z] Pr	Cost per hr of life
General Service	**120**	**CC-8**	**100**	**100**	**100**	**100**	**100**
General Service	130	CC-8	285	76	76	76	42
Extended Service	120	CC-8	333	83	79	92	49
Super Bulb	120	CC-8	400	84	87	100	50
Rough Service	120	C-17a	133	70	73	83	131
Rough Service	130	C-17a	380	53	47	57	55
Industrial Service	125-130	C-9	817	64	49	61	28
Industrial Service	120	C-9	467	74	–	–	40
DuroTest ATC	120	C-9	533	74	66	77	68
DuroTest ATC, Clear	120	C-9	533	74	67	75	73
Heidt GS	120	C-9	533	74	–	–	55
Street Light, 105 W	120	C-9	1600	64	70	88	22
Traffic Signal, 116 W	125	C-9	1866	64	49	65	11
DuroTest, 90 W	120	C-9	467	74	92	97	90
Heidt, 90 W	120	C-9	533	74	–	–	76

[z]All lamps operated in 120 v sockets. Life and lumens of 125 and 130 v lamps calculated from manufactures' data as described in reference 2. All lamps are 100 w unless otherwise stated and except as noted can be obtained from G.E.,, Westinghouse or GTE Sylvania.

[y]I = relative illuminance (100=900 lux); PR = relative flux density of photomorphogenic radiation between 700-850 nm (100=2.04 w/m^2).

explained, a large part of the biological response must be due to reduction in the P_{fr} form of phytochrome by the increased 700-850 nm radiation. Thus the flux density of photomorphogenic radiation (PR) may be more important than illuminance or photosynthetically active radiation (PAR). Therefore PR and illuminance, as well as irradiance and PAR were measured using a Lambda LI-185 quantum/radiometer/photometer meter. Voltage and reflectance of the surroundings were of course kept constant. Three sets of 3 reading were made on 3 to 5 lamps of each type.

Although the heating time for 90% lumens is only about 0.13 sec, each lamp was operated 5 min before measurements were made. Illuminance data provided in Table 2 instead of photon flux density of PAR because the amount of radiant energy from incandescent lamps in plant growth chambers has been reported as % of illuminance with very few exceptions. The data are presented relative to the 120 v General Service lamp simply to facilitate comparison of the various lamps.

Because vibration can be a factor in reducing incandescent lamp life in plant growth chambers, even when it isn't obvious, only those lamps with filaments having 4 or more supports (no. 9 and 17a) are considered acceptable. PR flux densities should be at least 75% of the 120 v General Service lamp.

The 120 v Rough Service lamp meets these criteria but the expected life is little improvement over the General Service type. The street lighting lamp has an impressive performance rating, providing very long life with an acceptable level of PR. The additional watts required, however, may prohibit their use; not only because of the increased power consumption but also because of the additional heat they will release into the lamp loft.

The Duro Test ATC and Industrial Service lamps performed well in the tests reported here and current studies suggest the Heidt GS will be equally satisfactory.

Some growth chamber users will believe that any reduction of the incandescent portion of the radiant energy is to be avoided and consequently have resisted the tendency to use 130 v lamps in the 120 v sockets. In such cases the DuroTest and Heidt 90 W lamps will provide longer life than can be attained with 120 v General Service, use less power but still provide essentially the same level of PR. This is accomplished by filling the lamps with krypton which, in part because of its lower thermal conductivity, allows the filaments to get hotter, and therefore brighter, than would be the case with conventional argon gas. Thus the filament in the 90 w krypton-filled lamp produces about the same amount of light that the same filament would produce with 100 w in an argon lamp. Preliminary tests however, suggest that the life expectancy in controlled-environment rooms is considerably less than that obtained on the manufacturers test stands.

All the lamps that perform well in controlled-environment rooms cost more than conventional ones. However, when annual costs are calculated, the increase is small even when man-hour reductions are not included. For example, even if vibration was not a factor and the general service lamps operated for their rated life they would need to be replaced four or more times a year as compared to once a year for the longer life lamps. Thus our data illustrate that by proper lamp selection, group lamp replacement in the growth chamber can be practiced on a yearly basis. Some premature burnouts are inevitable but the barriers would not have to be removed more than twice a year to maintain a high level of spectral uniformity.

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Effectiveness of 2,3-dihydro-5,6-diphenyl-1,4-oxathiin for Disbudding of Chrysanthemums Grown under Different Environmental Conditions[1]

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Abstract. **Delayed development of *Chrysanthemum morifolium,* Ramat, induced by relatively low temperature and light intensity affected timing, and concentrations of 2,3-dihydro-5,6-diphenyl-1,4-oxathiin used for chemical disbudding.**

Various chemicals have been used in attempts to control side shoot development or disbudding of chrysanthemums (2, 13-16, 19). Disbudding using these chemicals was very variable and depended upon exacting conditions and thus not adapted for practical use. The 2,3-dihydro-5,6-diphenyl-1,4-oxathiin, (P-293) was used rather successfully as a chrysanthemum disbudding chemical recently (3, 4, 17, 18, 20). These investigations established that lower concn of chemicals were required generally on plants exposed to shorter photoperiodic treatments. Development or destruction of buds by chemical means would depend on the ontogenetical status of the plants and the chemicals would have a greater effect if used at an earlier stage of the flower bud initiation (5, 8) and development. There is also some evidence to show that, besides photoperiodic treatment, cultivars, and the seasonal and growing conditions, may influence the growth (1, 6, 7, 9, 11) and the successful use of these chemicals (2, 4, 12, 14, 15). This work shows that growing conditions are affecting the development of chrysanthemums and thus the effectiveness of P-293 as a disbudding agent.

Rooted cuttings of a standard type, 'Wildfire' chrysanthemum were planted in a 3 soil:2 peat:1 sand mix on a greenhouse bench with 10 x 12 cm spacing on May 19. The same cultivar was also planted in the same soil in 12.5 cm diam plastic pots and placed in a growth chamber. Plants in both locations were grown as single stems for 18 LD periods before the SD treatment (dark period

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[2]The supply of the 2,3-dihydro-5,6-diphenyl-1,4-oxathiin by Uniroyal, Inc., the plants from Yoder Bros., and the technical assistance by Mr. J. L. Grainger is gratefully acknowledged.