RESPONSE OF EASTER LILIES GROWN IN ROCKWOOL, PEAT-LITE AND SOIL MEDIA TO WARM WATER IRRIGATION

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Easter lilies were grown in soil, peat-lite and rockwool media and irrigated with warm and cold water. Quality plants were produced in peat-lite, rockwool and soil respectively, regardless of water temperature. However, the plants irrigated with warm water reached their blooming height faster. Soil-grown plants in both water temperature treatments bloomed significantly later than those in rockwool or peat-lite. There were no differences in the bud count due to media. Post harvest life of plants grown in all three media, were comparable.

It is probably safe to say that the majority of pot plant growers in the United States had, until the mid-1960s, grown their plants in some type of mixture that included field soil as a major component. The U.C. Manual (1) published in 1957 contributed to drastic changes in growing media content. The U.C. approach involved sand and sphagnum moss peat in various combinations. The next important change in the make up of container growing media was the development of the Cornell peat-lite mixes (2) in the mid-1960s. White (9) reviewed the status of a growing media for greenhouse crops and indicated: "they can be grown in any non-toxic substance that supplies anchorage, water, oxygen and essential nutrient elements." The nutrient film technique (NFT) system promoted in Europe in the 1970s proved that plants grow relatively well without a medium, providing proper nutrients and oxygen are supplied to the roots. However, the NFT and peat substrate growing methods in Holland have gradually given way to rockwool growing (7).

Little research on the use of rockwool as a plant growing medium has been reported in the United States. Hanan (5), in a 1983 project, found that rockwool could be used as a potting medium amendment. No differences were found in Geranium, Chrysanthemum or Kalanchoe plant responses to different mixtures, but physically incorporating the rockwool was a problem and shrinkage was extremely high.

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For a number of years, when the Park Floral Company of Englewood, Colorado was visited during the lily season, the grower would always comment on height and earliness of plants in certain areas of the greenhouse. Upon discussing the situation it was noted that the first plants watered, 25 to 30, with each hose were ahead of the remaining ones on the benches. The city water used by Park Floral in the winter months came from melted snow and probably never reached a temperature greater than 40 to 45°F in the distribution system during the winter. However, upon reaching the greenhouse facility, the irrigation water in that portion of the lines was warmed to at least the night growing temperature (60-62°F) and used for irrigating the same plants each day before the colder water was obtained. The methodical sequence of watering compounded the influence.

The growing medium generally used by Park Floral consisted of wood shavings, composted plant materials and used soil, sphagnum peat, and field soil.

Research on the use of warm water (55° to 85°F) to irrigate floricultural crops has not been extensive in recent years, especially involving some of the new growing media. Carpenter and Rasmussen (3) determined that irrigation water temperature influenced the height and fresh weight of rose and chrysanthemum plants grown in a soil medium in the late 1960s. In 1978, McMurry (8) grew Easter lilies in a soil medium using 55°, 65, 75 and 85°F irrigation water. He reported little difference in plant responses between treatments except that root masses were more dense in the two warmer water temperatures and plant fresh weight increased.

Colorado State University has been conducting extensive experiments using shredded rockwool provided and supported by Rockwool Industries since August 1985. In addition to the proposed research, an experiment was designed to compare the growth responses of an Easter lily crop grown in rockwool, peat-lite and soil media. Midway through the growing period a water temperature study was incorporated.

Methods and Materials

Easter lily *(L. longiflorum)* bulbs cv. 'Nellie White', size 8 to 10, were planted on 12 December 1985 into 6-inch standard pots using three treatments of different media. Treatment 1 (20 pots) was a Colorado State University soil mix containing 1 part Fort Collins clay loam, 2 parts Sphagnum peat, 1 part humph peat and 1 part no. 6 perlite (v/v); treatment 2 (20 pots), commercial Sunshine® peat-lite mix; and treatment 3 (20 pots) Hortiwool®, a shredded rockwool product. The plants were grown in a FRP covered greenhouse heated to 62 to 64°F day and night and cooled to 70°F during the day with CO_2 level approximating 1,000 ppm.

Plants in all media treatments were watered with a fertilizer every other day. The continuous feed program used at Colorado State University was described by Hanan (6). The plants were drenched with Banrot® at planting and at 5-week intervals throughout the growth period. Long day conditions were provided by a two-hour night break, using incandescent lights from 19 to 26 January 1986. The air temperatures were not increased to try and have all plants blooming by Palm Sunday. Warm water treatments were not started until 14 February 1986. A Nepco[2] rapid heat, gas fired hot water boiler was installed and the plumbing designed so the fertilizer treated water could be applied to the plants as heated (70 to 80°F) or unheated (40 to 50°F) water. One half (10 pots) of the plants in each medium were randomly selected for the warm water treatment. The water used for both the heated and unheated treatments reached a constant temperature before it was applied.

Statistical Procedures

The hypothesis that watering with warm water would hasten plant elongation was first tested (= .05). Height was standardized across treatments by expressing it as a percent of maximum height achieved before flowering. Height was selected as the variable to describe growth over a number of other possibilities, including biomass and leaf area, because it was non-destructive.

Rate at which 100 percent of maximum height was approached was modeled for each treatment as a simple log growth function of the form $a(1 - e^{bx})$, where a = % height max (always equal to one) and b = rate of height growth. The equation was fitted using SPSS nonlinear procedures. Growth rates among treatments were tested for significant differences (= .05) by applying the T-test normally used in linear regression analysis to develop confidence intervals for coefficients.

Absolute differences in maximum height between treatments were then compared using two way ANOVA followed by Sheffe multiple comparison procedures (= .05).

[2]*Nepco International Inc., Seattle, Washington.*

There was not enough information to generate a rate of blooming curve, however, the probability of blooming on March 28, 1986, when differences were most evident, was compared. Fisher's exact test and Chi Square procedures were used to compare warm vs cold water treatments by media, and, overall media comparisons, respectively.

Results and Discussion

Plant height. There was a significant (P > .05) difference in the rate at which lilies growing in all three media approached maximum height with warm water being faster than cold water. There was no significant difference (P > .05) in the rate of increase in plant height with respect to media. A plant growing in Hortiwool® approached its maximum height at the same rate as one growing in peat-lite or soil within the same water temperature treatment. Media were therefore pooled and height growth curves for warm and cold water were generated (Fig. 1).

Media, not water temperature, seemed to determine the absolute maximum height (Fig. 2). Plants grown in peat-lite

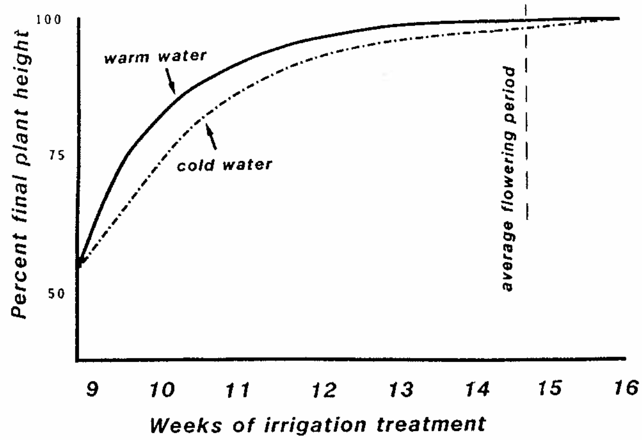

Figure 1: Rate at which Easter lilies approached their maximum height, regardless of medium, when watered with warm (70-80°F) and cold (40-50°F) water during the last 9 weeks of development.

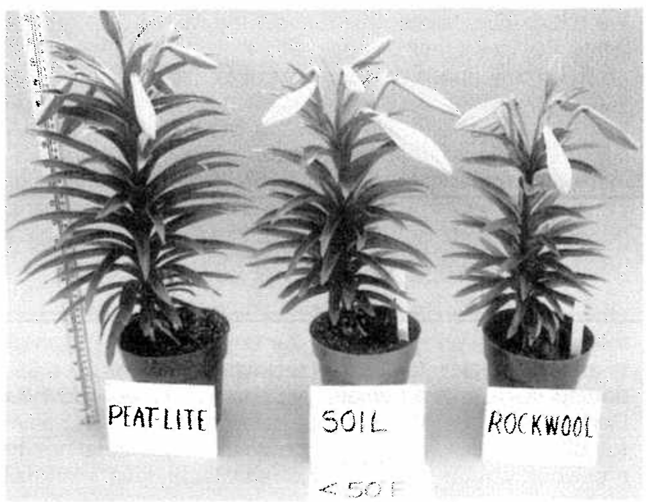

Figure 2: Lilies grown in the peat-lite medium were significantly taller than those in the other media treatments, when irrigated with both warm and cold water.

were significantly taller ($P < .05$) than those in Colorado State soil and Hortiwool®, the latter two not significantly different. Average heights for lilies growing in peat-lite, Colorado State soil and Hortiwool® were, 33, 27, 29 cm, respectively.

Flower development. Because plants of all media watered with warm water achieved maximum height at a faster rate than those irrigated with cold water, one would expect all of the warm water treated plants to bloom quicker than those watered with cold water, regardless of media. This was not the case. Lilies grown in Colorado State soil treated with both warm and cold water bloomed significantly ($P < .05$) later than those growing in rockwool and peat-lite. On March 28, only 50 percent of the plants growing in Colorado State soil had bloomed in contrast to 85 and 90 percent for the peat-lite and rockwool, respectively. Plants in peat-lite and rockwool exhibited a trend toward faster blooming with the warm water treatment. The sample size, however, was too small for the infrequent measurements to statistically evaluate a difference.

Root development was visually greatest and similar in the soil and peat-lite media (Fig. 3). Much less root development was present in the rockwool medium. However, there were no visual differences in plant development other than height. The greatest occurrence of root rot was in the soil medium, but did not manifest itself enough to cause leaf loss.

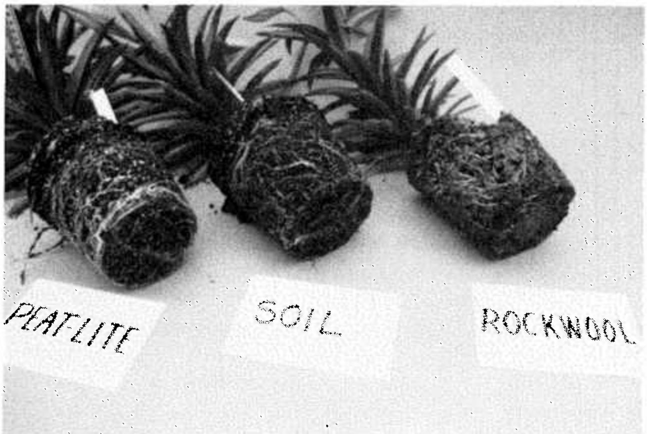

Figure 3: Similar root development occurred in soil and peat-lite media grown Easter lilies, but they were much larger and less dense in the loose rockwool medium.

Keeping life of plants and flowers in all media were similar in home conditions. During the growing stages, water could be squeezed from rockwool located in the top of the pot. In the home, the plants were watered when the top of the medium was dry to the touch.

A major problem involving rockwool as a medium for growing Easter lilies was the presence of gnats and spring tails and to a degree algae formation on the surface. The insects were noticeable in the home and under commercial situations, and could be objectionable. Insects might be controlled with an insecticide drench during the greenhouse culture period.

Conclusions

Warm water irrigation increased the rate of elongation of Easter lilies in three substrates that are very dissimilar in aeration and water holding capacity. It can be tentatively concluded that the growth stimulation is a direct effect of the warm water, not an interaction between media and warm water.

Media, however, does seem to affect final plant height and the relationship between different growth stages, especially the relationship between secession of growth and time of blooming. Ecke and Goldsberry (4) reported that the height of mini pot poinsettias was directly related to the amount of water available during the growth period. Similar relationships occurred in this experiment due to the moisture holding capacity of the three media. However, the high water content retained in the rockwool may have inhibited the final plant height.

Even though quality Easter lilies were grown in rockwool, the experiment will be repeated in 1986-87 and the water treatments started when the bulbs are planted.

Appreciation is expressed to Harry Sharp and Son and Rockwool Industries for materials and Nepco International for financial assistance.

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FORT COLLINS GREENHOUSE CLIMATOLOGICAL SUMMARY FOR FIVE WEEKS, BEGINNING JULY 27, 1986. (See Bulletin 426 for details.)

	Week beginning									
	July 27		Sept. 3		Sept. 10		Sept. 17		Sept. 24	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Average outside temperature (°F)	78	65	75	63	77	62	75	65	75	63
Maximum outside temperature (°F)	96	77	93	78	95	78	98	82	88	78
Minimum outside temperature (°F)	—	55	59	53	58	49	59	55	55	53
Degree-days of heating	—	—	—	7	—	11	—	—	—	7
Average hours in the period	11	13	12	11	13	11	12	13	12	12
Accumulated total solar radiation (MJ/sq.m.)	141	—	136	—	141	—	116	1	122	1
Average relative humidity (%)	33	49	46	68	41	64	50	70	47	68
Maximum relative humidity (%)	68	88	100	100	84	96	84	100	93	99
Minimum relative humidity (%)	10	17	14	25	10	24	11	20	22	32
Average absolute vapor pressure (mb)	11	10	14	25	10	24	11	20	22	32
Average wind speed (mph)	2	1	2	1	1	1	1	1	2	1
Maximum wind speed (mph)	21	11	20	13	21	15	16	16	16	11
Average CO_2 concentration (Pascal)	17	—	18	—	18	—	18	—	18	—
Maximum CO_2 concentration (Pascal)	26	—	25	—	29	—	29	—	29	—
Accumulated gas consumption (cu.ft./sq.ft.)	—	1	—	3	—	3	—	1	—	2

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