JIM WELLS: Any misting system?

DR. WHATLEY: Yes, we had it under intermittent mist. One minute every fifteen minutes during daylight, from about 7:30 a.m. to about 4:30 in the afternoon.

HANS HESS: Our next topic this afternoon is by Sid Waxman on the propagation of blueberry cuttings under various light intensities.

PROPAGATION OF BLUEBERRIES UNDER FLOURESCENT LIGHT AT VARIOUS INTENSITIES

SIDNEY WAXMAN
Plant Science Department
University of Connecticut
Storrs, Connecticut

Introduction

The trend in propagation as well as in the growing of plants has been toward a more controlled environment. For example; shading, bottom heat, mist and the plastic tent, all are forms of environmental control. By rooting cuttings under controlled conditions more consistently uniform results may be anticipated.

Although the use of such expensive controls as growth chambers, in which light, temperature and humidity are closely regulated, is not economical; structures can be used in which these environmental factors are more easily and perhaps less expensively controlled.

For example, a roof-covered pit house, built 7 - 10 feet into the soil and insulated, may be the most ideal unit for the rooting of cuttings. The buffering effect of the soil surrounding this unit could prevent temperatures from getting too high in the summer and too low in the winter. With such temperature control the relative humidity would not vary appreciably. Sudden losses of water vapor from the leaves on a partly cloudy day could be avoided in this type of structure because the light source is always under control and at a uniform intensity.

The deciding factor as to whether the use of such a structure is economical lies in the light energy input required, i.e., in the cost of lighting. There is no need to provide a light intensity equal to that of the sun. Although the sun may provide up to 12,000 footcandles of light, most so-called "sun-loving" species can grow normally with a maximum of 2,000 footcandles. "Shade-loving" plants, are able to grow at intensities as low as from 200 to 500 footcandles.

An experiment was made to observe the response in rooting of a shade-loving plant (blueberry) to various intensites of light in a plastic tent and under a mist system. Specifically, the object of the experiment was to determine the minimal range of light intensity under which root initiation and development may occur.

Materials and Methods

Two benches, one for mist propagation and the other for propagation under a plastic tent were constructed of galvanized sheet metal.

The plastic tent bench was completely covered with 4 mil polyethylene, and was tightly sealed. The mist bench was uncovered, but had side walls of polyethylene to confine the mist spray to the bench.

Heating cables, set at 70° F., were placed in each bench beneath a peat-perlite medium; 65% :35% by volume. In the mist system an electric timer activated a solenoid value which turned on a mist spray for three seconds every 10 minutes. Within the plastic tent the cuttings were sprayed only when the tent was opened for inspection, about once every three weeks.

The experiment was done in an unheated room that received no sunlight. Each bench was illuminated with six 8 foot cool-white flourescent lamps plus six incandescent bulbs. The flourescent lamp fixtures were hung from chains attached to the ceiling and were placed over the benches at an angle so that the light striking the cuttings ranged from a minimum of 110 footcandles to a maximum of 365 footcandles. Seven varieties of blueberry cuttings, six to eight inches long, were obtained from a commercial blueberry farm on July 12, 1965. Each cutting was wounded at the basal end by removing a thin strip of bark one half inch long. A mixture containing 10 parts of 50% wettable Captan and 100 parts Hormodin No. 3 was applied to the base of each cutting.

Flourescent lamps, controlled by a timeclock, were operated for 20 hours daily.

In ascertaining the rooting response, only cuttings having a root-ball (roots plus attached media) 1½ inches in diameter

Table I. Rooting of Blueberry Cuttings under Mist While Exposed to Various Intensities of Fluorescent Light

	Percent Rooted*		
	110-195 Footcandles	195-280 Footcandles	280-365 Footcandles
Atlantic	83	72	66
Coville	86	96	100
Jersey	92	80	72
Pemberton	100	89	96
Rancocus	74	78	53
Wareham	100	93	92
Weymouth	64	88	56
Mean	86	85	76

*Includes only cuttings with Root-balls 1½" in diameter or larger

or greater were considered rooted. Cuttings having smaller root systems were considered as being too meager to be potted and were classified as not rooted.

Results and Discussion

Rooting was first observed four weeks after the cuttings were made. In October when the cuttings were removed from the benches, most had root balls approximately three inches in diameter. The mean percent rooting on cuttings under mist and those in the plastic tent were similar except for the cuttings subjected to the 280 to 365 footcandle range (Table I and II).

The highest rooting percentages occurred at the intermediate low intensities, whereas the lowest percentages were observed at the highest intensities.

There was a greater decrease in rooting at the high intensity range in the plastic tent than in the mist bench (Table II).

It was also observed that the color of the foliage under the high intensity range gradually changed from deep green to bronze.

At the intermediate range the foliage was reddish green while at the lowest intensity the foliage remained a dark green. These changes in foliage color were also observed on the mist treated cuttings.

Leaf temperatures within the plastic tent were approximately 4.5 degrees higher in the section receiving the high range of intensity than were those located in the low intensity range while those in the mist bench were relatively uniform throughout (Table III). The decrease in rooting and increase in chlorophyll destruction at the highest intensities of fluorescent light were more prevalent on cuttings in the plastic tent.

These responses may be attributed to the intensity of the fluorescent light, per se, or to the combined effect of high inten-

Table II. Rooting of Blueberry Cuttings under A Plastic Tent while Exposed to various Intensities of Fluorescent Light

	Percent Rooted*		
	110-195 Footcandles	195-280 Footcandles	280-365 Footcandles
Atlantic	72	69	54
Coville	80	82	65
Jersey	100	76	80
Pemberton	86	100	80
Rancocus	71	65	59
Wareham	71	93	48
Weymouth	100	92	36
Mean	83	82	56

*Includes only cuttings with Root-balls 1½" in diameter or larger.

Table III. Temperature Readings Within the Plastic Tent*
Degree Fahrenheit

Light Intensity	Leaf	Air	Medium
110-195 fc.	74.3	75.6	71.6
195-280 fc.	77.0	80.4	74.0
280-365 fc.	78.8	82.4	75.2

*Temperatures taken with Thermistor probes

sity and high temperature. Stoutemyer and Close using an intensity of 400 footcandles also reported bronzing of foliage and decreased rooting (2). They reported that the problem was overcome by decreasing the intensity of light.

Just why this type of injury occurs under fluorescent light at about 300 - 400 footcandles is difficult to explain since similar cuttings propagated in a greenhouse either under mist or in a plastic tent received considerably higher intensities of sunlight and yet exhibited neither bronzing nor poor rooting. Also, temperatures within the plastic tent in the greenhouse were mainly in the 90's; higher than those in the plastic tent under the fluorescent light.

In the earlier experiment, cuttings of *Rhododendron mucronulatum* propagated in plastic trays in a growth chamber having cool-white fluorescent and incandescent light sources exhibited similar responses. Bronzing and decreased rooting occurred on trays of cuttings receiving from 285 to 1200 footcandles, while cuttings receiving 92 to 220 footcandles had a higher percentage rooted.

Generally, the highest percent rooting occurred on the cuttings receiving the lower ranges of intensity employed in this experiment. The mist and the plastic tent method of propagating the blueberry were equally effective at the low and intermediate light intensities.

New shoot development occurred from the base of all varieties with the exception of Weymouth. Initiation of new shoot growth occurred in response to the long photoperiods employed (3). Similar varieties propagated in the greenhouse under normal photoperiods did not develop new growth. The length of the new shoots varied from two to six inches, some having grown as long as the original cuttings.

Apparently, the energies of light used in this experiment may have been more than what was required for the blueberry to develop roots. With shade-loving species as the blueberry, the use of artificial light in an insulated building may be feasible because of the low energy input required.

Summary

Blueberry cuttings taken during July rooted rapidly and at high percentages with fluorescent and incandescent lamps as the sole light sources.

Both mist and the plastic tent technique of propagation were effective. The highest percentage of rooting occurred on cuttings exposed to low and intermediate intensities of light. At the highest intensities rooting was reduced and the foliage discolored especially under the plastic tent. New growth developed on most varieties in response to the 20 hour photoperiod treatment.

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JOHN ZELENKA: I would like to know what time of the year these cuttings were taken. Were they soft wood cuttings?

DR. WAXMAN: They were taken July 12th; the plants had made their growth and stopped. The terminals were firm.

JOHN ZELENKA: They were firm; they were not in the active growing stage?

DR. WAXMAN: No.

JOHN ZELENKA: In what medium were they rooted?

DR. WAXMAN: Peat and perlite, 65:35.

JIM WELLS: Sidney, it wasn't quite clear to me the relationship between temperature in the rooting medium and the light intensity. Did you say that you had a higher temperature under the plastic and it went up to 85 - 90° F.? Is that correct?

DR. WAXMAN: You are comparing the mist and the plastic. The temperatures under the mist were cool, the medium as well as the air. Under the plastic the temperatures were very high. At the highest intensity area it got up to 97° F. and remained there. At the lower end of the same bench it was about 88° F. And they all rooted in a matter of 4 weeks and could stand this very, very high temperature.

ARIE RADDER: Sid, did you have the lights on 24 hours or did you use less?

DR. WAXMAN: Twenty hours in this case.

HANS HESS: Next, Dr. Stu Nelson will give a progress report on root promoting actiivty in juvenile and adult phases of *Malus robusta* 5.