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MODERATOR PINNEY: Our next speaker is Dr. James Kelley from the University of Kentucky.

ROOTING OF CUTTINGS AS INFLUENCED BY THE PHOTOPERIOD OF THE STOCK PLANT

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Photoperiodism is the phenomena in which the relative length of light and darkness influences the development of plants and animals. The influence of photoperiod on the development of plants was first recognized in 1923 (1). Since then the majority of plant physiologists have focused their attention on the flowering phenomena, however they were aware that photoperiod influenced the vegetative growth of many herbaceous and woody plants.

In more recent years the effect of photoperiod on woody plants has studied by Waxman (5) and others. It has been shown that if one divides a group of actively growing dogwoods (*Cornus florida* L.) into two groups and places one of them under long days of 15 hours or more and the other one under short days of 12 hours or less, one will observe that the plants under long days will continue to grow but those under short days will stop growth within 2 weeks. In other words, these plants become dormant.

Waxman (5) showed that when cuttings are taken from *Cornus florida* or *Weigela* plants growing under long days and rooted under various photoperiodic treatments, the number of roots produced per cutting was lower under short-day than under long-day treatments. Piringer (3) has reported that the rooting of holly and boxwood was favorably influenced when the

short natural days of winter were lengthened with incandescent light. He extended photoperiod by interrupting the middle of the natural night with 3 hours of light. In general the long photoperiod or light interruption resulted in earlier and heavier rooting on both boxwood and holly.

It is well known that the cuttings of most species of plants root better at certain times of the year. The reason for this being environmental. One environment factor that is of particular interest is photoperiod or day length. The longest day of the year in the northern hemisphere is June 21 and after this date day length becomes increasingly less. For example here in Cleveland the longest day is 15 hours and 11 minutes on June 21 while the shortest day is 9 hours and 10 minutes on December 21. This is a net change in day length of about six hours. However, when we take cuttings from a plant at various seasons in order to study rooting response as influenced by photoperiod we have other environmental factors that influence the condition of the stock plant such as temperature, soil moisture, changes in stored food within the plant, etc.

We were interested in the effect of photoperiod only and what if any influence it would have on the stock plant. The purpose being to more clearly understand the role that it might have on stock plants and cuttings in the rooting bench.

Ilex crenata 'Hetzi' was the plant used in our work. Stock plants were grown in containers during the summer months and on July 26 all plants were given long days (18 hours). The supplemental light source was 100-watt incandescent lamps with reflectors spaced at 4-foot intervals 4 feet above the plants. On August 25 the plants were divided into 5 groups. One group was placed in a short day (10 hour) environment provided by using black shade cloth. Every 10th day thereafter an additional group was placed under the short day environment until 4 groups had received short days. On October 4 we had five groups of stock plants that had received 40, 30, 20, 10 and no short days. At this time cuttings were taken from plants in all treatments. The cuttings were then divided so that ½ the cuttings from each treatment could be rooted under short days (8 hours) and the other ½ under long days (16 hours). This resulted in 10 treatments. Cuttings were rooted in Perilte and under intermittent mist. Root-inducing chemicals were not used. In mid-December, 72 days after the cuttings were stuck they were removed from the rooting medium and the number of primary and secondary roots as well as the length of each primary root was determined.

The results of this work indicated that the stock plant as well as the cutting responded to photoperiod. Cuttings taken from plants receiving the greatest number of short days rooted best. Total root length was greater, more root were initiated, length of roots was increased and the number of secondary roots was doubled. Cuttings taken from stock plants receiving no short days rooted least (Table 1).

Table 1. Rooting response of *Ilex crenata* 'Hetzi' as influenced by photoperiodic treatment of the stock plants and cuttings.

No of short days received by stock plant	Cuttings Received Short Days (8 hrs)			
	Total length of roots/cutting[1]	No of roots initiated/ cutting	Av length of roots/cutting	No of secondary roots/cutting
0	4.5	4.4	1.01	6.9
10	5.4	4.7	1.14	9.4
20	5.4	4.9	1.12	9.1
30	7.0	5.5	1.24	12.8
40	7.4	5.6	1.30	13.7
	Cuttings Received Long Days (16 hrs)			
0	5.8	4.5	1.28	9.9
10	6.8	4.8	1.44	12.9
20	6.9	4.9	1.41	12.4
30	8.0	5.2	1.55	15.5
40	8.9	5.5	1.62	16.1
L.S.D. 5%	0.5	0.2	0.02	1.2
L.S.D. 1%	0.6	0.3	0.03	1.6
	Differences Due to Daylength Cutting Received			
L.S.D. 5%	1.1	NS	.23	2.0
L.S.D. 1%	2.5	NS	.31	NS

[1]Measured in cm

Cuttings rooted under long days produced more total root length and a greater number of secondary roots than those receiving short days. However, photoperiod received by the cutting did not affect the number of adventitious roots produced.

This work demonstrates the role that photoperiod might play in the seasonal variations found in rooting. At least it has been demonstrated in the case of *Ilex crenata*. It has been shown by others that the number of root primordia produced on cuttings is related to the level of plant auxins. The fact that increasing numbers of short days on the stock plant increased the number of roots formed as well as their growth suggests either the accumulation of certain inducing substances that accumulate to the greatest degree under shorter days or the possible destruction of natural rooting inhibitors when the plants receive short days. At present we are attempting to determine, by using Hess's bioassay method, the relationship in plant response and the presence of cofactors.

The effects of photoperiod on stock plants has been also shown in the case of *Populus canadensis* that had been exposed to 0, 4, 6 and 13 weeks of a 10 hour day. Our results differ in one important way. Roots initiated per cutting were less with increasing numbers of short days for *Populus*, for *Ilex* the reverse was true. It appears that with some plants conditions which tend to stimulate active growth inhibits rooting while with other conditions that tend to inhibit active growth stimulate rooting response.

In summarizing let me emphasize that day length of the stock plant of the cutting plays a role in rooting response. We cannot at this time by chemical analysis determine when a cutting is in an optimum condition, neither are we restricted to the old rule of thumb method. Great improvements can be made in propagating techniques without having a complete knowledge of how or what the plant does from a biochemical standpoint, but simply by recognizing that light, temperature, water and other environmental factors influence stock plants as well as cuttings. By using the limited knowledge of how they affect rooting we can improve rooting response. It very well may be that at some date in the near future it may be desirable to control growth of stock plants by regulating photoperiod and other environmental factors just as, today we partially control the rooting environment in order to obtain better rooting percentages and better root development.

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STEVE O'ROURKE: I believe that there is an item misunderstood, that is blossoms are born on the same stem as the leaves in early Spring. This would indicate that floral formation is on the short day of the preceding seasons. Now if these plants were grown under short days and floral initiation did not take place, does this mean that these cuttings were in a more vegetative state and that the flower-forming substance, if any, was depressed?

DR. KELLEY: Certainly. With short days, we certainly inhibit our induced vegetative growth. In other words, the plants that had never received any short days were the most vegetative, if you want to put it that way. They had the most vigorous growth.

STEVE O'ROURKE: Did you carry the stock plant on to see if they bloomed the following spring?

DR. KELLEY: No, we didn't. We just had too many.

RALPH SHUGERT: Dr. Kelley, have you ever done any work or read of any work in using light on an item such as *Juniperus Chinenis Pfitzeriana* which in my case roots slowly, poorly and I was wondering if light would promote 75% - 80% rooting in four months.

DR. KELLEY: You mean light on cuttings or on the stock plant?

RALPH SHUGERT: Light on cutting bench.

DR. KELLEY: It would be rather difficult. The only work I know of is some work at Illinois and they found that junipers rooted better under short days.

RALPH SHUGERT: This is the cuttings under short days or the stock plants?

DR. KELLEY: Cuttings. This was done several years ago.

VOICE: Did you have a check in regard to the evaporation and desiccation caused by your lights? In other words, was the moisture content of the plants that are shaded the same as moisture content in leaves of the ones that had additional light?

DR. KELLEY: We hope so. Shall we say, they all received the same treatment other than a variation in photoperiod.

DR. WAXMAN: Jim, we did some work with the lighting of stock plants and got the same results you described in working with poplar. Now I was wondering about the plants you're working with. Do they have to keep on growing or did they grow and then stop and remain dormant all summer?

DR. KELLY: No, Ilex continues to grow all summer. And we made them grow all summer by putting all stock plants initially under 18 hours so that we would be sure that they would grow.

DR. WAXMAN: So then couldn't it be that you were taking cuttings from plants of active growth, the ones which were receiving zero short days as compared with one that had stopped. Therefore that plant would have a greater food supply than the cuttings receiving zero short days and be in active growth.

DR. KELLEY: Yes, except that the only thing that was somewhat different is that we could get this response with just 10 days. In other words, a very short time. Of course, we can't say that you don't get any food build up in the ten days but this significant difference seemed to be more than you would expect in just these 10 short days.

DR. WAXMAN: How many more roots per cutting was that?

DR. KELLEY: About a ½ or ¾ roots per cutting. However, this was a significant difference in this case.

MODERATOR PINNEY: Dr. Makoto Kawase from the Morden Experimental Farm, Manitoba, Canada, will be our next speaker.