

# VEGETATIVE RESPONSE OF CITRUS ROOTSTOCKS TO PHOTOPERIOD

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This report will describe a technique which is widely used by nurserymen in flower crops but, as far as I know, is little used for woody plants such as citrus. I refer to the use of photoperiod control which could reduce the time required to bring young trees to marketable size.

Until very recently most citrus varieties in Hawaii were grafted on Rough lemon rootstocks or were "air layered." Only very recently the citranges, Cleopatra mandarin, and sweet oranges have come into use as rootstocks. Trifoliolate orange has not been used by nurserymen; it was believed to be too slow in growing, taking 3 or 4 years to reach grafting size. When lined out in the field it made almost no growth from September until the following April or May. The common explanation was that it needed winter chilling. Temperatures near sea level in Hawaii are seldom lower than 65° F. and average in the high 70's which is considered unlikely to be a limiting growth factor for citrus.

We subjected rootstocks to three photoperiod treatments: 8 hour, 16 hour, and normal day lengths.

The 16 hour treatment was produced by a normal day plus a 4-hour light break in the night with 100 watt incandescent lamps. Shoot growth was greatly increased by such long day treatments as shown in Table 1. Cleopatra mandarin shows a smaller but highly significant response to long days than Trifoliolate orange or Troyer citrange. Growth under normal day lengths (10 hr. 50 min. to 13 hrs. 10 min. in Hawaii) was intermediate, between that obtained under long days and short days

Oranges and tangerines grafted on these rootstocks also responded to photoperiod treatment producing in some cases up to 4 or 5 times the shoot growth obtained under long day treatments. This is shown in Table 2.

It is evident that temperature is not a limiting factor in growth of citrus in the tropics. All the citrus species investigated responded to some extent to long day (short night) treatment. In temperate climates, citrus plants should make extra growth in heated glasshouses with long day photoperiod treatments given during winter.

**Table 1. Shoot growth of citrus rootstock seedlings under 3 photoperiod treatments (after 17 weeks)**

Photoperiod	Rootstock shoot growth—cm. <sup>a</sup>		
	Trifoliolate orange	Troyer citrange	Cleopatra mandarin
Short (8)	23.5 a	54.0 d	44.5 c
Normal (12 ± 1 hr. 10 min.) (Hawaii)	30.7 b	64.4 e	51.0 c
Long (16)	47.2 c	100.4 f	57.4 d

<sup>a</sup> Means followed by different letters are significantly different ( $P > 0.01$ )

**Table 2. Degree of increase in shoot length of grafted citrus under long days compared to short days (after 28 weeks)**

Scion variety	Rootstocks		
	Trifoliolate orange	Troyer citrange	Cleopatra mandarin
Frost Washington	5.1 <sup>a</sup> * *	2.0	2.3
Clementine	3.9 *	1.2	3.7
Dancy	1.5	4.1 * *	3.7
Minneola	3.3	1.4	2.3
Owari		4.4 *	2.6

<sup>a</sup> i.e., growth under long days (16 hrs.) was 5.1 times greater than under short days (8 hrs.)

\* Difference significant ( $P = > 0.05$ )

\* \* ( $P = > 0.01$ )

MODERATOR CURTIS: Any questions of Dr. Warner?

VOICE: Was that a photoperiodic light response or a photosynthetic response?

BOB WARNER: The long day treatment was with 100 watt incandescent lamps which do not give enough light to make any photosynthetic difference. It is believed to be a triggering of the phytochrome pigment, changing it from a far-red to a red receptive form so that it promotes vegetative growth instead of permitting the buds to go dormant. These trees, especially the trifoliate orange and the Troyer citrange seem to go almost dormant, not quite; but they quit growing about the first or middle of September, when the days get around 12 hours in length. In Hawaii we only get about an hour and 10 minutes difference each side of 12 hours either in the summer or the winter. But I think we have to go to a 14 hour day length to get good vegetative response from citrus. Of the citrus we've worked with, including a number of tangerines and a number of citranges, they have all responded to some extent; but the rough lemon rootstock, which I didn't show here, gave less difference in response to the long day, compared to the short day, than some of the others. This was true also of the tangerines. This is probably the explanation why tangerines are well adapted to the tropics. We can get them to grow right through the winter in Honolulu by giving them long day treatments. I don't know what happened to this chilling requirement.

MODERATOR CURTIS: Thank you very much, Dr. Warner. I understand we have two more groups of slides for tonight. Percy Everett, one of the charter members of this organization, has something for us. Percy:

PERCY EVERETT: Thank you, Bill. At the meeting at Los Gatos several years back, I showed a few slides, gave a little talk on some new developments at the Rancho Santa Ana Botanic Garden. Of course, one of the best, I think, that created the most interest and also got us into a little trouble was the *Berberis* or *Mahonia*, as you might know it—"Golden Abundance". This went out and then somebody found the plant in Bill Curtis' nursery supposed to have gone to Canada; and we had a stop order from the U.S.D.A. Since then the plants have gone through all the tests for wheat rust resistance. Not only did the U.S.D.A. pass the original clone but the seedlings from the clone, because they were afraid somebody might start growing seedlings from the original clone. We have thought the clone is so good, after consulting with many nurserymen, that the Botanic Garden is now in the process of patenting it. Since I left the Garden three years ago, I don't know exactly what its status is now; however, I know that the papers are now at Washington and you who have had experience with patenting know about how long it takes. However, what the Garden plans to do is to sell a little tag with the plant. They cannot be

sold unless that tag is on them. The tags will be very inexpensive. I don't know what the Board of Trustees has decided upon, but it will probably be in the neighborhood of 10 or 15 cents a tag. So I thought I'd bring along three slides that I took at the Botanic Garden this year to show you the appearance of the plant. This picture shows you the real meaning of the words, "golden abundance". I have learned that one or two of the nurseries that have taken cuttings of this have had complete failure. I am not prepared to say what percentage of cuttings we have rooted, but we have done a great deal better than that. In fact, we have rooted them so well that we figured that it certainly is commercially possible after you once get on to the technique. This plant is a true hybrid between *Mahonia aquifolium* and *M. amplexans*. The seed was collected from one plant of *M. amplexans* which was growing not too far away from a *M. aquifolium* plant. After planting these seedlings, I discovered this one plant and thought it was so good that I watched it for about two years. After that I called it to the attention of the director of the Garden and he, too, thought it was good and he said let's call it "Golden Abundance". We have since had Dr. Robert Thorne, the Garden botanist, look at it for its technical description; he said it is a complete hybrid in that every botanical feature shows the effects of both parents. So it seems to be split right down the line. It's a very vigorous plant. I've been growing it in my own yard for the past 6 or 7 years and it does very well under garden care

MODERATOR CURTIS: Any questions for Percy?

VOICE: I would like to know if those plants are growing out in the full sun and where?

PERCY EVERETT: Yes, they are in full sun. They're growing in the Indian Hill Mesa area of Claremont, California, where we had temperatures this last summer up to 115° F. It behaves beautifully; I cannot say that it is free from the leaf miner but this pest can be easily controlled by systemic insecticides. I have found in my own personal garden that if it is given good air circulation, there is very little leaf miner present. If it's in an area where the air circulation is not very good, then it is highly susceptible. The original clonal plant has, to my knowledge, never shown any leaf problems.

LES CLAY: How is it for hardiness?

PERCY EVERETT: The plants were tested by the U.S.D.A. at the University of Minnesota for wheat rust susceptibility. I don't know whether they plant them outside or not. Maybe someone knows more than I do as to how they test them back there. I have no fear of its hardiness. I think *M. aquifolium* has been grown fairly far eastward and I know that *M. amplexans* grows at an elevation that certainly does get down well below freezing. I don't have any definite figures at the present time; this is one characteristic we need to test out a little more.

VOICE: How long does the flowering period last?

PERCY EVERETT: I suppose 3 weeks or more. It is equal to any of the *Mahonias* that are on the market. In fact, it is so superior that I don't see how anyone can grow any other *Mahonia*, except if they wanted a compact dwarf type, which often doesn't even flower. When 'Golden Abundance' is in fruit, it's equally beautiful. I was just too lazy to go down to the Botanic Garden and get a slide of it in fruit. I had some taken and showed them to the group here several years ago; but it's magnificent. The clusters of hanging fruit are long and those who have seen the clone have said it has two stages of beauty, or three, perhaps—the plant, flowering, and the huge fruit clusters.

BILL CURTIS: While we're speaking of *Mahonias*, on the way down, Bob Ticknor, Warren Ferris and I stopped at Bob Boddy's Nursery at Fort Bragg, California. Bob has gone over part of one row of his stock plants of *Mahonia aquifolium* with a circular lawn mower. He cut the plants off close to the ground and now he has tripled or quadrupled the amount of cuttings that he gets, and they're nice, lush cuttings. So if any of you have a stock block of *Mahonia compacta*, and they are getting a little bit late, I suggest that you go over them with some mechanism or other and cut them off right close to the ground. I've been tempted to do that to mine. I was a little bit hesitant about doing it but when I get home, I'm going to cut them off as close to the ground as the circular mower will do it. I think this will result in getting a lot more cuttings.

#### THURSDAY MORNING SESSION

October 7, 1971

MODERATOR FURUTA: Dr. Charles E. Hess, who wears many hats, is from the New Jersey Agricultural Experiment Station at Rutgers University. He is Director of the Experiment Station, also Dean of the College of Agriculture, and as if he doesn't have enough to do with those two jobs, he is in the process of setting up a new College of Environmental Sciences. So it is a great pleasure for me to introduce to you this morning, Dr. Charles Hess: