out. Sometimes the wood may be perfect, but the understock may be growing so fast it will push the buds out.

If you have any control over the moisture of the soil, through irrigation, that is the thing to watch out for. In other words, don't irrigate in advance of inserting the buds, but do it when the wood is more or less on the firming up side, but the wood will slip.

MODERATOR MEAHL: We will have to close the question period on this topic at this time, but we should give Charlie a good hand here for his presentation. Thank you very much, Charlie.

Our next exhibit about which we will have a discussion is one having to do with the effect of the length of day on the growth of plants, and this, as I mentioned earlier, is work which has been done by Sidney Waxman, a graduate student at Cornell University. Unfortunately Mr. Waxman was unable to be here, but his work and his paper will be presented by one who is well qualified to do so—Dr. J. P. Nitsch, who is Assistant Professor of Ornamental Horticulture at Cornell. He has been there since September, folowing Bill Snyder's move to Rutgers.

Dr. Nitsch comes to us from France, receiving his undergraduate, as well as some of his graduate work in France. He took graduate work in this country at the California Institute of Technology under Dr. Went, and, after that continued postgraduate studies at Harvard University. He comes to us, then, with a very fine background and he is going to present to us the material of Mr. Waxman on photoperiodism.

DR. J. P. NITSCH: I won't be able to present his work entirely. I am here for the first time, and I am not a nurseryman and most of the things you are talking about are new to me, but very interesting because I am interested in the ultimate mechanism of propagation and plants. I am not going to read the paper, just try to summarize it.

. . . Dr. Nitsch read Mr. Waxman's paper on "The Effect of the Length of Day on the Growth of Woody Plants." (Applause)

THE EFFECT OF THE LENGTH OF DAY ON THE GROWTH OF WOODY PLANTS

SIDNEY WAXMAN

Cornell University, Ithaca, N.Y.

It was as far back as the year 1686 that the length of day was observed to effect the growth of plants.

Between 1890 and 1905 many workers used arc lamps to determine the effect of additional light on the growth and flowering of various greenhouse plants.

Garner and Allard in 1920 carried out a great amount of research proving definitely that long days and short days effected the growth of many herbaceous plants in different ways.

The name they gave to this daylength effect was Photoperiodism.

To site an example of the effect of the "photoperiod" one can use the chrysanthemum. It will keep growing all summer when the days are

long and will flower when the days get shorter as they do in late summer and fall.

Much intensive research has been and is being carried out concerning the flowering of herbaceous plants.

As a result of much research, this principle is now being used on a commercial scale. Eighty percent of the chrysanthemum growers of New York now use this principle in their cut flower and potted plant production.

By artificially giving their plants "short days," that is, by pulling a black cloth over them; or by giving them "long days," that is, by turning on lights at night they are able to manipulate the time of flowering so that they now have chrysanthemums in the market the year round instead of just during the fall months.

Now the question arises—are the woody plants affected by the photoperiod as are the herbaceous plants?

Wareing in England working with 1st year seedlings of Scotch Pine found differences in the amount of growth under various daylengths.

Last June an experiment was set up in the greenhouse to find out just which woody plants would react to the photoperiod.

The plants were set into pots or cans and were separated in different plots that had their own lighting systems. All of the plots were covered with black cloth from 5 o'clock in the evening until 8 o'clock in the morning. In this way, all of the plants in the different plots received the same amount of sunlight and any additional light they received came from 4-60 watt mazda bulbs. (6′ above bench)

There were 7 different daylength treatments ranging from 9 to 24 hours of light per day.

As an example, the 15 hour light treatment received 9 hours of sunlight and then when the black cloth was pulled the mazda bulbs were turned on by time clock for 6 more hours. In this way the plants received a total of 15 hours of light and 9 hours of dark. There was one additional treatment that was given normal day conditions with no additional light nor shade applied.

The intensity of the light given off by the bulbs ranged from 8 to 30 foot candles which is fairly low when compared to the intensity of full sunlight which is about 10,000 foot candles.

In all we used 8 different species of plants. Two of the plants showing good response are the Pink Flowering Dogwood and Weigela.

In the case of the dogwood, treatments were started at the start of the second flush of growth on June 27.

In three weeks, those plants held in the short day plots (the 9 hour day and the 12 hour day) became dormant. They had an average of two leavse per shoot and havent't grown any since then.

Those held under long days (15 and 18 hour day) remained active, and are to this day still actively growing and producing new leaves.

From June to September there were an average of 13 leaves produced on each shoot on the 18 hour day plants as compared to two leaves on the 9 hour day plants and for leaves on the normal day plants.

The average length of the stems on the 18 hour day plants was 9 inches as compared to 1¼ inches on the 9 hour day and 2½ inches on the normal day plants.

The Weigela plants used were cuttings that were rooted the previous year. They were placed in the plots during active growth. As you may have seen on the exhibitors table there was a large difference in the amount of growth between the long day and the short day plants.

One treatment of special interest is the one that receives light for 9 hours during the day, and then, during the middle of the night they are given just one hour of light. The growth in this plot was much more than one might expect with plants receiving a total of 10 hours of light, but the plants were as tall as the long day plants receiving 15 to 18 hours of light.

The use of an one hour light break during the middle of the night has the same effect as giving the plants 9 hours of additional light. This is important to remember when considering its practical use.

The second phase of the experiment was to determine if the day-length affected the rooting of cuttings.

On June 27, cuttings of *Cornus florida* were placed under mist and given treatments of 9, 18 and 24 hours of light and one additional treatment which was given normal days.

The cuttings were removed after one month and it was found that those cuttings under the 18 hours day treatment had twice as many roots as those under 9 hours of light and 1½ times as many as the normal day cuttings.

Also there were 2 more leaves on each cutting in the 18 hour day group, which had been produced during the rooting period.

I would hesitate to say that the 18 hours of light directly caused the greater number of roots.

Probably it was an indirect effect, that is, the 18 hour day caused new leaves to form which in turn caused a more rapid initiation of roots probably due to a greater supply of hormones coming from the actively growing tops.

The practical application of this daylength effect seems very promising.

Perhaps it would be best to say now that not all plants respond to the photoperiod and of those that do, the effect could vary among the different plants. Boxwood, *Viburnum prunifolium,* and flowering cherry showed no response.

Those giving indications of an increase in top growth are *Magnolia soulangeana, Viburnum opulus, V. Carlesii, Juniperus horizontalis,* (under continuous light only), and *Rhododendron catawbiense.*

By giving additional light to cuttings in the propagating bench and then continuing the light treatment following rooting, it is possible to obtain as much as 3 years growth in one season.

This has been done with cuttings of the pink and white flowering dogwoods and it is probably that it may work with other plants sensitive to the length of day. Also there is good indication that additional light over seedlings would give a similar result.

Further experiments will be carried out this spring to determine:

1. Which plants respond to the photoperiod.
2. When to start and when to stop the light treatments.
3. The least amount of light necessary to obtain the most growth.

* * * * *

MODERATOR MEAHL: We are indebted to Dr. Nitsch for his willingness to discuss the work of Mr. Waxman on the effect of daylength on the growth of woody plants. There will be time for a limited number of questions.

MR. ALBERT LOWENFELS (White Plains, N.Y.): What kinds of light did you try on these plants?

DR. NITSCH: Incandescent light was used. It is more effective than fluorescent light. I am certain that Dr. Borthwick will give more information on this point tomorrow.

MR. HANCOCK: Could not these cuttings be taken earlier in the year to get the benefit of the long day?

MR. CHARLES HESS SR. (Hess' Nursery, Mt. View, N.J.): That is fine, but who, commercially, has the time at that time of the year?

MR. HANCOCK: We try to finish our work by the first of June. Then we immediately make our summer cuttings. Incidentally the lateral cuttings will root just as well as stronger cuttings.

DR. NIETSCH: I would like to add that if you are late in doing your propagation you can always supplement the day by some artificial light.

MR. GRAY: Just a point of clarification. I am wondering about the statement you made that it wasn't the length of day as much as it was *the length of the night, and as you indicated, one hour of light added in* the middle of the night will do the job. Did I understand that correctly?

DR. NITSCH: That is correct, however Dr. Borthwick will talk about it tomorrow in detail. You can reduce the length to perhaps a matter of minutes if you use the right light at the right time.

MODERATOR MEAHL: Since a later session of this meeting is devoted to a detailed discussion of the effects of daylength on plant growth, I suggest that further discussion should await the paper on this subject by Dr. Borthwick. It has been a pleasure to hear of Mr. Waxman's work and we thank you, Dr. Nitsch, for presenting it to us.

The last scheduled speaker at this afternoon portion of the Speaker-Exhibitor Symposium is Mr. Constant De Groot of the Sheridan Nurseries Ltd., Sheridan, Ontario. Mr. De Groot will discuss the results obtained at that nursery with the use of Chloromone on summer and winter *cuttings.*

Mr. De Groot presented his paper entitled "The Use of Chloromone on Winter and Summer Cuttings." (Applause)