in dilute quantity on a "constant feed" basis. The finished Liners are then cycled into the container growing area.

In conclusion, production of nursery stock would seem to be dependant upon two things: system and facilities. The system should be such that it is reproducible yet alterable for improvements, and records should be kept at every stage in propagation. The facilities should be such that they are complete and are specifically designed for the use of the propagator.

The relative success of production, by and large, will depend upon the degree of care taken in selection of the system for propagation and of proper propagation facilities and equipments.

MODERATOR SPRING: So we strive on for our ideals. While Mr. Petersen has described a very ideal facility, I know that it will be a long while before many of us can attain this ideal, but it certainly has proven itself, I understand, in the profits returned on assured methods of plant propagation.

Our next speaker will be Mr. Paul W. Moore, who is Director of Research and Development for Willits and Newcomb Citrus Nursery, Thermal, California. In preparation for this position Mr. Moore obtained a degree, specializing in sub-tropical horticulture, at the University of California. From there he worked for a while at the University of California at Los Angeles as a Technician in Sub-tropical Horticulture. He was a Farm Advisor, both in San Bernardino County and in Los Angeles County. For seven years he was chairman for the Citrus Grove Rejuvenation Research Group at the University of California Citrus Experiment Station, Riverside. Since 1960 he has been with Willits and Newcomb in his present capacity. This is one of the larger citrus nurseries in California, specializing in the propagation and distribution of virus-free budwood -- Mr. Paul Moore --

CURRENT METHODS IN THE SELECTION AND PRODUCTION OF CITRUS NURSERY STOCK

Paul W. Moore

Willets and Newcomb Citrus Nursery
Thermal, California

The objective of the reliable citrus nurseryman is to produce trees which are typical of the variety, have a high yield potential, and which will be long lived. To accomplish this requires a thorough knowledge of variety and strain characteristics, careful scrutiny of budwood sources for mutations, acquaintance with the known virus diseases which affect production and longevity, and a knowledge of rootstock-scion interactions and adaptations.

The prosperity and success of the citrus industry, and the financial solvency of individual growers, depends in no small measure upon the integrity, the knowledge, and the sound judgement of the nurseryman.

During the last three years over 5 1/2 million citrus trees have been grown for planting in the commercial orchards of California. Every one of these nursery trees consisted of two parts, scion and rootstock. The scion variety was chosen first for the variety - such as orange, lemon, tangerine, or grapefruit, and secondly, as a particular strain of the variety, selected for some outstanding trait or adaptation to a specific climatic zone, and freedom from virus diseases. The rootstocks were selected for their tolerance to certain virus and fungus disease, their cold hardiness, and their influence on productiveness, and fruit quality.

BUDWOOD SELECTION

Budwood selection is extremely important in our industry. There are three reasons for this: First, many of our citrus clones and cultivars are infected with bud-transmissable virus diseases. These should not be propagated. Secondly, citrus species, especially oranges, have an unusual capacity to mutate. It is necessary to constantly examine "mother trees" for mutations or sports in order to assure the customer that his trees will be true to type. The third reason is that many new, superior strains have been developed in recent years which are more vigorous and productive than the old ones.

The citrus nurseryman must select the best of these for the areas in which they will be planted. It is no longer a matter of growing Valencia oranges. One must choose between Frost Nucellar Valencia, Campbell Valencia, Campbell Nucellar Valencia, Wood's Valencia, Cutter Valencia, Olinda Valencia, etc. The lemon picture is even more complicated. We maintain a scion orchard of 14 lemon strains and should have at least 5 more if we want to satisfy the requirements of all areas.

SELECTION OF DISEASE-FREE BUD SOURCES

The recognition of the importance of selecting virus-free propagating material is a rather recent development. In 1933 Dr. H. S. Fawcett of the University of California Citrus Experiment Station, first proved the virus nature of sorosis. Since then at least 10 virus diseases of citrus have been described. Four of these are known to cause serious economic loss when present in the wrong scion-rootstock combinations.

The most spectacular of these is Quick Decline or Tristeza. In 1937 the disease was first reported in the state of Sao Paulo, Brazil. Twelve years leter it had spread to all citrus areas, destroying 6,000,000 trees, or 75% of all the citrus in that state. In 1944 Tristeza made its California debut near Covina. Ten years later most of the oranges on sour orange rootstock in the San Gabriel Valley were dead. It is currently completing its destruction in Orange County and is ravaging the Redlands-Riverside area.

Fortunately, it is not present in any of the orchards in the Coachella Valley and is still rare in the San Joaquin Valley. Nurserymen in both areas are required by law to use only Quick Decline-free bud sources in order to preclude its introduction into these areas.

In California, serious economic losses from the disease can occur when sweet orange varieties are grown on sour orange, Citrus aurantium, rootstock. In areas where the disease is now indigenous, losses can be avoided by propagating oranges on tolerant rootstocks. The nurseryman has a wide choice of such stocks, including sweet orange, Rough lemon, Trifoliate orange, Cleopatra mandarin and Troyer citrange. A few new hybrid rootstocks such as Citrumelo 1974, Citremon 1449, and the Carrizo citrange look very promising and will undoubtedly be used in the future.

Psorosis, the first recognized virus disease of citrus, causes a slower decline but takes its toll from among trees that should be in their prime producing years. A survey of the orange industry in California made by the author in 1954, revealed that approximately 10% of the mature trees were exhibiting various degrees of deterioration due to this virus. All oranges, lemons, grapefruit, and tangerine varieties are affected by psorosis.

A third disease, exocortis, causes early death or severe stunting of all infected citrus varieties grown on Trifoliate orange or Rangpur lime rootstock. It will also stunt and reduce yields of trees grown on Troyer citrange rootstock. Exocortis-free sources of propagating materials are available for most of the commercial citrus varieties. Nurserymen should take advantage of them when propagating any varieties grown on Trifoliate, Troyer, Rangpur lime, and Trifoliate-hybrid rootstocks. If he is uncertain of the exocortis status of his bud source he should grow them only on tolerant rootstocks such as Cleopatra mandarin, Rough lemon or sweet orange.

Xyloporosis (cachexia) is a fourth virus which limits the production and causes the death of certain orange varieties on susceptible rootstocks such as Sweet lime and of many mandarine and tangelo varieties.

The task of obtaining virus-free budwood would have been many times greater if investigations of a phenomenon called "nucellar embryony" had not been made by Dr. H. B. Frost starting in 1913. It is largely from his nucellar seedlings of the important commercial varieties that we have been able to find virus-free propagating material.

The mechanics of this process may be described briefly. Many citrus varieties produce more than one seedling per seed. One of these may be a seedling resulting from the normal process of pollination, and would be a hybrid of doubtful value. All of the others arise in the seed tissue called the nucellus and are called nucellar seedlings. Nucellar seedlings might be described, in an over-simplified way, as arising from buds within the seed. Just as other plants propagated from buds are genetically like their parent, so are nucellar seedlings genetically like their seed parent. The pay-off in nucellar seedlings is that apparently viruses do not move from the tree into the seed. Nucellar seedlings are, with few exceptions, virus-free. Thus it is possible to get clean sources of propagating material, true to the parent type, by using nucellar seedlings.

Within the last 6 to 8 years the citrus nursery industry has almost completely switched from the old strains to propagating the nucellar lines.

A few varieties do not produce nucellar seedlings and so the search must be made for disease-free sources and other techniques must be used to detect them.

Fortunately, as the result of research on the part of citrus virologists, it is possible to detect the presence of any of the above viruses by inoculating seedlings of citrus species which develop well-recognized symptoms, either as foliage patterns, bark shelling, stem pitting, or gum deposits in bark. These are called "index" plants.

It is, therefore, possible for the commercial nurseryman to take advantage of these techniques to screen his budwood sources. Since the W-N Nursery is engaged in the sale of budwood to other nurseries, we have established what we call a permanent indexing block. In the block are 50 commercial varieties, each on 5 indicator rootstocks, sour orange, Trifoliate orange, Rangpur lime, Orlando tangelo, and Morton citrange.

Any varieties on sour orange rootstock which have Tristeza will die within 2 to 3 years and cause stem-pitting on Morton citrange. Any having exocortis will cause typical bark scaling and stunting on Trifoliate orange, Morton citrange and Rangpur lime. Those having xyloporosis will be identified by its reaction on Orlando tangelo.

Our primary sources of budwood have been entered in the State Department of Agriculture's psorosis registration program and have been certified psorosis-free after indexing on Mexican lime indicator plants. Any nurseryman desiring to locate psorosis-free parent trees may obtain a list of registered trees from the State Department of Agriculture, Bureau of Nursery Service, Sacramento, California

There are a few varieties that are known to carry viruses and for which there are no known clean sources. The Temple orange is an example of this. Since it is infected with exocortis and xyloporosis it must be grown on tolerant rootstocks such as Rough lemon or Cleopatra mandarin.

Currently the University of California has undertaken a citrus variety improvement project. The goal of the program is to develop a bud bank of high-yielding, true-to-type, virus-free citrus varieties This collection will become the source of propagating material for foundation blocks to be established by the citrus nurserymen of the State as sources of certified, virus-free nursery stock. The program is to be supervised and administrated by the State Nursery Service. Availability of certified buds from these sources for the nursery industry is still about 5 years away, pending the completion of the indexing terms for exocortis and xyloporosis. When this certified budwood becomes available a great stride forward will have been made in citrus nursery stock production.

SELECTION OF TRUE-TO-TYPE BUD SOURCES

The possibility of inadvertently propagating inferior bud sports or mutations is an ever-present danger. An illustration of this is found in the work of Dr. A. D. Shamel, "Citrus Fruit Improvement-A Study of Bud Variation in the Washington Navel Orange". Dr. Shamel started a study of individual trees in several Washington Navel orchards in 1909. He eventually found and described at least 13 strains possessing very distinct characteristics. Trees bearing ribbed fruit, pale yellow fruit, brown stained fruit and juiceless fruit were common. Others had long fruit, pear-shaped fruit, or flat fruit. High-producing and low-producing strains were also found. Each one was a distinct genetic mutation. The lowest percentage of off-type trees found in the commercial orchards which he studied was 10% and the highest about 75% of the total trees in the orchard.

The first two Washington Navel trees, from which the entire Navel Orange industry of California has been established, were planted at Riverside in 1873. The first propagations were made in 1875. Thirty years later, roughly 15% to 30% of the Navel trees of the State were inferior, mutant, progeny.

This phenomenon is not a thing of the past. This spring one of the owners of our company examined what was reputed to be one of the best young, true-to-type, Navel orchards in Central California before cutting budwood. He found 10% of the trees to be obviously off-type.

These illustrations emphasize the necessity of careful selection of budwood from bearing trees. Ideally, the trees should be examined annually while in fruit for the purpose of discovering and eliminating any bud sports or mutations from one's "bud bank" or "mother trees". Although this practice is as old as plant propagation it is as modern as tomorrow.

SELECTION OF ROOTSTOCKS

A third essential in the production of citrus nursery trees is the proper choice of rootstocks. This a choice of life or death, success or failure.

Rootstocks are chosen for their tolerance of virus diseases, their resistance to root diseases, their influence on productivity and fruit quality, their adaptability to adverse soil or water conditions such as high salinity, high boron, or high lime, and for their ability to impart some frost tolerance to their scions.

A few examples of climate-soil-rootstock-scion interactions will illustrate the process of rootstock selections for a specific orchard site:

For our first example, let us assume that John Jones wants to plant Navel oranges on a piece of land that has a relatively high frost hazard. He would like to market his fruit as early in the

season as possible to avoid holding fruit on the trees during the cold winter days of December, January, and February. The soil has a neutral reaction and is low in free lime but is heavy and has a tendency to remain wet for long periods following rains or irrigations.

His first choice of a rootstock would probably be Trifoliate orange. It is the most frost-tolerant of citrus rootstocks. It matures fruit earlier than any other stock and is nearly immune to the common root-rots which are associated with wet soils. It will not stand soil containing high amounts of lime or which have a high pH. But, since this soil has neither limitation, Trifoliate can still be used.

His choice of scion variety would normally be an early-maturing strain of Navel. This is found in the Atwood Early Navel. However, most, but not all, Atwood Early Navels are infected with the exocortis virus. Trees having this virus are a complete failure on Trifoliate rootstock. Since there are some exocortis-free trees of Atwood Early, his nurseryman must seek them out. One safe procedure would be to take buds from vigorous, healthy trees already growing on Trifoliate rootstock and which are at least 10 years of age. In the above case, the nurseryman has had to consider certain factors of microclimate, soil conditions and disease, and tailor trees to fit the situation.

A second case will illustrate a choice with another set of factors. Lester Smith has just lost a Navel orchard from Quick Decline in the East Highlands area. Soil, water, and climate are ideal for citrus growing. He has a low frost hazard and can hold fruit on his trees several months after they reach maturity.

A study of some of the factors show that the acreage of summer Valencias has declined 48% in the last 13 years. The areas suitable for growing late Valencias is limited to Southern California counties and much of this has become urbanized. Subdivision prospects are still many years in the future in Smith's area.

Smith's first choice of rootstock would be the Troyer citrange, a hybrid of the Navel orange and the Trifoliate orange. It is resistant to root-rots and is one of the few stocks that perform well on old citrus soil. Most of the standard rootstocks perform very poorly when planted to soils previously occupied by citrus. Trees on Troyer produce high quality fruit and are above average in production. Most important, trees on Troyer root are immune to Quick Decline. However, they are stunted by the exocortis virus.

This grower's first choice of scion variety should be the Valencia orange. But, there are several strains of Valencias, some of which are known to be infected with exocortis and psorosis. For a highly productive orchard he must be sure of having virus-free trees. Fortunately, there are new strains of Valencias which are free of the known viruses and have proven records of high yield potential and good quality fruit. One of these is the Frost Valencia, named after its originator, Dr. H. B. Frost of the Citrus Experiment Station.

In this case, the over-riding considerations in choice of scion and rootstock were: the market picture as related to variety, tolerance to "old citrus soil" conditions, immunity to Quick Decline, freedom from virus diseases, and yield performance.

A grower in Ventura County will need a rootstock tolerant to high boron levels in irrigation water and one that is not subject to micronutrient problems such as iron chlorosis. His choice of rootstock will be one which has recently been proven in experimental orchard trials, Citrus macrophylla.

Our current practice of selecting disease-free varieties, and good performing rootstocks would have been impossible without the tremendous amount of research conducted by the Citrus Experiment Station and Crops Research stations of the USDA. It has been through the efforts of their staffs that we can now identify obscure but dangerous virus diseases and that we have virus-free sources of budwood. It is also through their efforts that we will soon have rootstocks to fill almost every production requirement. By utilizing this relatively new knowledge, citrus nurserymen are growing trees today which are distinctly superior to those produced in yesteryear. Research work now in progress promises that the time is not far distant when every citrus grower can have trees tailored from specific strains of scions and rootstocks for his own climate, soil, water, disease and pest conditions.

MODERATOR SPRING: The meeting is now open for questions on this section of the program.

The first question is one directed to Dr. McClintock.

Rather than try to force the artificial term "cultivar" on the nursery industry might it not be more appropriate for the taxonomic community to strive for consistency and leave the English term "variety" as indicating the cultivated sorts of plants, retaining the Latin term "varieties" as an expression exclusively for botanical varieties?

DR. McCLINTOCK: Well, we're talking about two different things when we use the term "variety". We're talking about botanical varieties and we're talking about cultivated varieties. Actually the term "cultivar" is not really an artificial term. It's a term which has a good meaning. It simply is taken from the two words "cultivated variety" and has been shortened to "cultivar". It is an international term and has been so accepted, although it may not be accepted by horticulturists at a local level.

MODERATOR SPRING: Another question: Why do you believe "cultivar" will never be accepted as a term in ornamental horticulture?

DR. McCLINTOCK: I would not go so far as to say that it will never be accepted but its acceptance will be slow, perhaps because some people sort of rebel against accepting a new term, but it is accepted on an international basis.

MODERATOR SPRING: Another question: How would you name a hybrid other than assigning a cultivar name?

DR. McCLINTOCK: Well, hybrids can actually be named by giving them a Latin name and describing them in the same way that you describe a new species. That is acceptable, but because so many hybrids, once they have been established, go into the nursery trade as vegetatively propagated plants which are really clones; it is, I think, a good idea to establish as a clone the plant selected from the particular hybrid and to give the selected plant a clonal name. As an example, I would like to cite Photinia x fraseri, a hybrid between P. serrulata and P. glabra. In order to distinguish the plant introduced by the Fraser Nurseries, Auburn, Alabama, from other plants originating from the same hybrid group, the cultivar name, 'Birmingham', has been given to this plant. A clone is simply material vegetatively propagated which has originated from one particular plant and which maintains itself because it is vegetatively propagated - so you are always dealing with the same plant. It's just the same as nucellar seedlings. You are dealing with a part of a single plant actually which has been divided up again and again, but all the new young plants have the same genetical constitution as the original plant which was the beginning of the clone.

MODERATOR SPRING: Next question: Is there a good book or reference work to establish identification and correct nomenclature for bamboo, inasmuch as this has been omitted from your list?

DR. McCLINTOCK: There is one man in the United States who knows more about bamboos than anyone else. He's the one to whom bamboo questions can be referred; we left bamboos out of our list because we felt they were a specialized sort of a group and that, even though they are woody plants, their nomenclature is very involved. I hope that maybe sometime we can make up a list for bamboos alone or have bamboos treated separately.

QUESTION: Who is the gentleman to whom you referred?

DR. McCLINTOCK: He is Dr. McClure; he can be reached at the United States National Herbarium, Smithsonian Institution, Washington, D. C. He has published a paper recently on all the species of Phyllostachys, but he hasn't studied all the genera of bamboos which we cultivate. There is a recent publication - a USDA bulletin on the bamboos cultivated in the U. S. It contains a key, but it's based on very technical characters. I've just received the bulletin; Dr. McClure is one of the co-authors. It costs about 35 cents and is available from the U. S. Govt. Printing Office, Washington 25, D. C. It lists all the genera of bamboos, I believe, that are cultivated in the U. S. but it doesn't give the species nor the cultivated forms.

QUESTION: There is an air of uncertainty as to the validity of the names in the forthcoming list. Will we be correct in using it as a "Bible" for labeling our plants?

DR. McCLINTOCK: Well, you can use the names in this list and then if we ever should find, sometime in the future, that some other name should replace a particular name, then we will use that other name; but I think for the time being we should certainly be able to use what is in the list until we find out the list is in error. We've drawn up this list to the best of our present knowledge and it is the best that we can do at this time.

MODERATOR SPRING: And the last question directed to you, Dr. McClintock - We are asked repeatedly to identify plants. How do we address inquiries to your attention?

DR. McCLINTOCK: You just send them to me at the California Academy of Sciences, San Francisco 18, and I'll be glad to answer them. If you send the plant, try to send as complete a representation of the plant as you can. Don't pick off one leaflet of a compound leaf, but send a branch so that I can see the plant not only has compound leaves, but the plant has opposite or alternate leaves. If you have flowers, or if you have fruits, or if you have something else that will be helpful in the identification of the plant, that's fine.

MODERATOR SPRING: Thank you very much, Dr. McClintock. I'd like next to call on Dr. Alley. How are grapes indexed for virus?

DR. ALLEY: Indexing for grape virus diseases is done at Davis by the Department of Plant Pathology of the University of California. For instance, there are certain varieties that are very susceptible to certain diseases. Let's take the variety, Mission. When it becomes infected with leaf roll, the basal leaves of this variety will tend to curve downward in the fall of the year. They will also develop a reddening color which will progress upwards along the shoot or the cane as the season advances. These symptoms generally start showing from the middle of September onward. I'm speaking just now about indexing for the leaf roll virus. The plant pathologist will take about four or five buds from the variety that he wants to test. Let's say we have the variety, Zinfandel, that we want to test to determine if it is virus diseased. We select a vine that looks very healthy as far as we can tell visually. We will take five buds and bud it into five young growing cuttings of Mission. This bud will be placed below the young shoot. It will be grown in the greenhouse for about 6 weeks. Then it will be planted in the nursery or into the vineyard. It is grown here for two years. If the original Zinfandel vine is healthy, no symptoms will show on the leaves of Mission. Probably our chief indication is the way the leaves "turn". If this Zinfandel should be infected, let us say, with leaf roll and if it's a mild strain, it may not have shown on the original vine. But the basal leaves of the Mission will start to curve slightly downward - a convex curving - also the leaves start to become discolored. First it will be a light red, turning a darker red as the season advances. If the virus is very severe, symptoms will show the first year. If it's not severe, generally by the second year one can observe these symptoms in the

leaves of Mission. Now if you want to index, let's say, for the virus disease - fan leaf, the St. George rootstock which is commonly used in California, is considered one of our best indicators. We will take cuttings of St. George and root them in the greenhouse until the shoots get about six inches long. Then we will take buds from selected vines that we believe are healthy, and put a bud into each of five or six young growing vines of St. George. If the Zinfandel has fan leaf, the symptoms would be expressed in the leaves of St. George. In the shoot, or in the young leaves, symptoms appear like a vein-clearing or even a slight mottle. Now this same technique is used on other indicators, for example with Emperor. Another good indicator, which is not in the program, but is considered very good, is Baco 22 A - for the leaf roll virus disease. It gives a shock symptom. Healthy Baco 22 A will grow very vigorously but if we bud from a variety that has leaf roll in it, it goes into a shock - it refuses to grow. Where the healthy vine might be 2 feet high, the Baco vine infected with leaf roll will be stunted. We can pick it out immediately. It is this type of indexing that is being used on grape vines to test the vines to make sure they are virus-free. Now there are many varieties that will show symptoms of these virus diseases at certain times of the year. When it is very severe in a variety, fan leaf will show in the early spring of the year, in May and June, and then as the temperature gets warm, the vine appears to grow out of this symptom. With many of the degeneration viruses like fan leaf, yellow vein, or yellow mosaic there is a noticeable reduction in crop and a shot berry condition. With leaf roll you generally have a delayed maturity of fruit and a reduction in sugar. In other words, there are symptoms to look for on the vines, but to make sure, if you can't catch them at the right stage and in case some of the vines don't show these symptoms, the plant pathologist will also use an indexing system as I have outlined using this budding technique.

MODERATOR SPRING: Mr. Petersen, there is one question for you - That very simply is, first where is Morton's Soil Drench C available, and secondly, what fertilizer do you generally recommend to be used in propagation feeder lines?

MR. PETERSEN: The answer to the first question - Morton's Soil Drench C is now available from any Niagara distributor. In the San Jose, California area: Moyer Chemical, or Garden Valley Fertilizer.

The second question is more difficult to answer. What is the best fertilizer? Two things we have to consider, three things actually, the type of medium the liners are growing in, the facilities that are available, and the type of transplanter pot. If we are using peat pots, for example, we can generally get by with something less in the terms of concentration of fertilizer because they do not appear to have the drainage characteristics that we see in other pots. We prefer that a fertilizer be applied at every irrigation, and a typical formula would be in the order of 3 to 5 pounds of ammonium nitrate, 1 to 2 pounds Di-ammonium phosphate, and 1 to 2 pounds muriate of potash per 1000 gallons of water as applied. However, these are very broad directions - it would depend, for example, upon: how much fertilizer

was incorporated in the original mix, when the mix was prepared, and the age of the material. Often times we can manage quite nicely on only nitrogen and potassium, providing sufficient phosphorus was incorporated in the original mix.

MODERATOR SPRING: Thank you very much, Fred. Now I'd just very simply like to say: remember again the work Mr. Van Rensselaer did in organizing this part of the program. I feel that the quality of the talks presented certainly proves the wisdom of his choices and I for one thank him very deeply. I will now turn the meeting back to our Program Chairman, Herman Sandkuhle.

CHAIRMAN SANDKUHLE: Jack, thanks a lot. Ladies and gentlemen, these are, in my estimation, real basic subjects. If we are going to propagate, we must start correctly. We must know what we are propagating because there is no use propagating something unless it is true to variety, because we are mixed up today on some things and we are doing our best in the industry to correct this; as was stated earlier this morning, when we order something or start writing about something we must all know that we are talking about the same thing.

This is an organization that will lead to no commercialism. But, in future meetings, we like to have you people - if you have some new innovation that we don't know about, and you think it is of some importance - bring it along with you; we would like to take a short time to demonstrate it. Now I'm going to call on Carl Schmidt from Pt. Reyes, who built a Connecticut light integrator to control a mist unit, to give us a few minute dissertation. You people who are more interested in the details can see Carl after lunch and he will put it out in the sun where it actually performs.

MR. CARL SCHMIDT: Well, this is actually an unscheduled demonstration. I was simply asked by some who have seen this instrument working in my greenhouse to give other people who are using a mist system the opportunity to see it. I'm not really prepared to give any formal lecture. I will just simply give a brief description of it and show it to you. Later on if someone should be interested in seeing it working, I will take it out in the sunlight because there is not enough light in here to operate it fast enough. In the misting of *cuttings in a greenhouse the requirement for water usually varies* according to the brightness of the sun. On bright days the evaporation would be fairly rapid. On dark cloudy days when the rate of evaporation is extremely low, there is little or no need for mist. The basic mechanism that operates this mist controller is a photoelectric tube that responds according to the brightness of the sunlight falling upon it. The original idea for such a controller was conceived by Dr. Hans Petersen of Denmark while a visiting professor at Cornell University. The Agricultural Engineering Department of the University of Connecticut has modified the unit making it more flexible, and therefore more adaptable for propagation purposes. I simply have obtained the blueprints[a] from these people and put one together;

(a) Whitaker, J. H. and S. Waxman, Instructions for a light-operated interval switch for controlling a propagating bench mist system. Univ. of Conn. Mimeo. Leaflet. 1960.

that is, the only part I had in it. Now within the unit there's a phototube that responds to the energy from the sun, and through several steps, causes a magnetic counter to rotate. After 100 clicks - in my case, I have modified this to 90 counts - to get a more stabilized period - the mist is automatically turned on for a short, predetermined period. The frequency of the rotation of the counter is determined by the level of light intensity falling on the phototube. There are two dials - a coarse and a fine adjustment. By adjustment of the dials the frequency of misting can be increased or decreased. This feature permits the rooting of a wide range of materials, from plants requiring frequent misting to those requiring only occasional mist. There are differences in rates of water loss among various species of plants. By an adjustment of the sensitive dial the particular needs of a cutting can be satisfied. In other words, on the fine rate there is a great variability which you can use to determine the number of times that your predetermined "on" period will come on. I will make this a little clearer when I actually demonstrate the device. Now, once the cuttings have initiated roots, the frequency or misting should be gradually decreased to harden off the cuttings and this can be accomplished by turning down the sensitivity dial a little each day. You simply keep on decreasing it as you go along. This will cause a more delayed misting and will permit the foliage gradually to become firmer. Another feature is the third dial which can change the slope of sensitivity to sunlight. For example, if the dial is set on number 2, there will be frequent misting on bright days and little on dark cloudy days. That's the normal setting here (2). If, however, a little more mist is desired on those dark days, then the dial may be turned to the No. 3 position. There is no need to have a 24 hour clock to turn the controller off at night or on during the day because it automatically slows down and stops as darkness approaches and will start itself with the rising of the sun. If, however, some mist application at night is desirable, then the dial can be turned to the No. 1 position, that's on the slope calibration, and in this position the controller acts as a time clock and provides a steady frequency of mist. These are the basic features without going into the more theoretical details; what it actually amounts to, to make it very simple, is that the photoelectric tube triggers a discharge from a gas tube, which in turn operates a magnetic counter. The frequency of triggering, of course, being proportionate to the light intensity falling on the photoelectric cell, and while the current flowing in the gas tube is not sufficient to operate the counter directly, a relay in the circuit allows each discharge from the gas tube to be counted or accumulated by the counter, and with each 100 counts - and in my case, 90 - a micro switch on the counter activates a program timer which subsequently turns the mist system on and off. An adjustment on the timer can be made to provide whatever length of misting period is desired. This device can be extended to operate outlets for any number of solenoid valves. I have used it since January; it has never failed me and it is doing a real good job. The ordinary time clock is more or less a semi-manual operation because it does not react to the weather. We have to make frequent adjustments. In this case, the light is doing it for you. Now, as I say, I've built this myself but you people would not have to go to this trouble because, in the meantime, I have received brochures stating that a very similar instrument is now available

commercially, using basically the same idea.

CHAIRMAN HERMAN SANDKUHLE: Thank you very much, Carl. I'm sorry that we had to rush you through.

THURSDAY AFTERNOON SESSION

October 26, 1961

q The session convened at 1:30 p.m. with Dr. Vernon T. Stoutemyer, Department of Floriculture and Ornamental Horticulture, University of California at Los Angeles, presiding. The subject of this Symposium was: Light in Relation to Plant Propagation.

MODERATOR STOUTEMYER: The amazing thing about light effects is that many people who almost made the important discoveries, didn't. The men who should have made these, I think, were the Germans who dominated plant physiology from 1850 into the beginning of this century. The one who probably should have discovered photoperiodism was a man named Klebs. He almost had it; but two men in the U. S. Department of Agriculture, Garner and Allard, were unquestionably the first to present proof of this phenomenon of photoperiodism.

We are covering many subjects related to light in this discussion, not only photoperiodism, but many other things. I'm sure there are things that we will be doing with light some day in propagation that we're not doing now. For instance, by exposing stock plants to an unbalanced spectrum, you can change completely the type of roots formed, the amount of callus in the relation to the roots, and the ease of rooting.

LIGHT AND PROPAGATION

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The subject of light in propagation is an example of a badly integrated field of knowledge with a conspicuous lack of communication between the workers in basic science and those who represent the applied side of agricultural science and technology. It is also an example of a rather haphazardly worked basic field with many conspicuous gaps in our knowledge. It is difficult to explain why researchers have given so little attention to some of these problems. One example is that almost no information is available on the effects of different light qualities and intensities on the stock plants for cuttings. The voluminous literature on the influence of light on seed germination is somewhat confusing for reasons which will be discussed later, although the rapid progress of recent research is clarifying the situation.