PRESIDENT'S ADDRESS

Louis Vanderbrook
Vanderbrook Nurseries
Manchester, Connecticut

Our industry, during the next few years, will experience some of the most drastic and revolutionary changes ever to occur in its history, and it will definitely result in the survival of only the most fit.

For some time we have been experiencing the effects of labor shortages and a scarcity of good skilled labor, which will become much more acute as the years progress.

To survive and surmount these difficulties, it will become necessary for us to tax our ingenuity to the utmost, and it will most decidedly be to our advantage to be teachable and observant of the methods of management and operation of other industries, which we may come in contact with, and to emulate their success by adopting that which may be of value to us in curtailing time and costs of production.

To accomplish these things, we must observe, think, plan, decide and act. How many men do you know who observe? How much do you trust their observations? When we say observe, we mean gather facts. How do men gather facts? By travel, by reading, by talking with other men. How many men have systematic ways of filing facts for future references? How many men spend their whole lifetime in gathering statistics, in reporting facts? Do you usually go to these men for advice when wanting a decision? Or, do you go to that person who, having seen and observed these facts or reports, thinks about them? How many men do you know who think? When we say think, we mean putting "two and two together."

Having observed and thought, how many plan? Plan this way and that way, and again some other way. As has often been said, "There are a thousand ways to do anything, but just one best way."

So, before we can do anything or even decide to do anything, we must observe, then think and plan. As Lord Francis Bacon has said, 'This may be the work of many,' but to decide which is the best plan is usually the job of the leader and he can't make many mistakes or he will no longer be a leader

There is little in the modern world which compels obedience. There are a hundred ways to get around any course without open revolt, if the decision of the leader is not accepted. It must be wholeheartedly accepted; the logic must appeal, or it is one of those decisions which become meaningless, no matter how loudly they are proclaimed.

And then having observed, and thought, and planned, and decided, why is it that we just jog along on our own quiet way and nothing happens? Because again, how many men do you know who will act? Not tomorrow, or next week, or when and if so and so happens in the future, but now, this instant, with all the strength that is in them?

Have you ever seen the batter in a ball game? The ball is thrown, he watches it intently, he observes, he thinks what it and he will do, he plans if he should bunt it, hit a grounder, or try for a home run. He decides that is is a strike and not a ball, and that he had better hit it with all his might. He acts and we hear the sharp crack of the bat on the ball. We see the furious dash for the base, legs flying, arms pumping, the utmost in action. We, all of us, love to watch this sequence. We watch it again and again and never weary of it. We make national heroes of those who can observe, think, plan, decide and act all in a few seconds, at once, and on the instant

How many men do you know who observe, think, plan, decide and act, in other words, play ball every time you meet them?

These are the cardinal virtues which we should and must adopt in these times for our own salvation and that of our industry and I might add, for the salvation of the Nation as well.

Let us strive to rise above the common level of man, ever remembering that in the Trial Balance of Life, "It isn't the job we intended to do or the labor we've just begun that puts us right on the ledger sheet, it's the work we have really done. Our credit is built upon things we do, our debit on things we shirk The man who totals the biggest plus is the man who completes his work. Good intentions do not pay bills, it's easy enough to plan To wish, is the play of a stupid boy, to do, is the job of a man."

PRESIDENT VANDERBROOK. The first topic on our program is a symposium on "The Propagation of Spruce." At this time, I would like to have Dr. Robert P Meahl come forward and moderate this panel. Bob, I will give you my gavel and allow you to introduce your own panel members

MODERATOR MEAHL (Pennsylvania State University, Univ. Park, Pa.): I am very happy to have this opportunity to appear before you again and discuss the propagation of spruce.

As you will note from your program, we are to have a review of the literature followed by three people who will discuss the various aspects of spruce propagation. So, very briefly, I would like to go over some of the literature which we might find related to the propagation of spruce.

Dr. Meahl presented his paper on the "Propagation of the Genus *Picea*." (Applause)

PROPAGATION OF THE GENUS PICEA

R. P. Meahl
Department of Horticulture
Pennsylvania State University
University Park, Pennsylvania

The genus *Picea*, or spruce, is one of our important evergreen groups. Many species are valued for their use in reforestation, lumber and pulpwood, Christmas tree production, and general ornamental or landscape use The most efficient methods of propagation are then of primary importance to the nursery industry. The three primary methods of propagation are by seed for those species which will come true, and either grafting or cuttings for those which will not. These three areas will be considered separately bat on the ball. We see the furious dash for the base, legs flying, arms pumping, the utmost in action. We, all of us, love to watch this sequence. We watch it again and again and never weary of it. We make national heroes of those who can observe, think, plan, decide and act all in a few seconds, at once, and on the instant

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SEED PROPAGATION

One of the best sources of information on seed propagation is the Woody-Plant Seed Manual (10). If possible, it is best to collect the seed for one's own use. The cones should be collected in the fall, beginning just before the cone-scales start to open. After collecting, the cones may be spread out in thin layers to dry in the sun or in well ventilated cone sheds to prevent heating or molding.

After extraction, it may be necessary to store the seed for a period of time. In addition to the viability there are three factors related to good storage. These are the oxygen supply, moisture, and temperature. Seeds of *Picea glauca* and *P. rubens* have kept their viability for 10 years when stored dry in sealed containers at temperatures just above freezing (36° to 40°F.). *Picea abies* and *P mariana* seed have retained their viability for 5 years in sealed containers in cool cellars. *Picea abies* seed also retained satisfactorily viability for 5 years when stored in the cones in a dry loft. *Picea engelmanni* seed kept its viability for 3 years when stored in sealed containers in cool cellars, although germination dropped about 20 per cent at the end of 5 years. It is probable that when stored under proper conditions spruce seed can be kept viable for 10 years (10).

Of ten spruces reported (10) *P. abies, P. breweriana, P. engelmanni, P. glauca, P. glauca albertiana, P. mariana, P pungens, P rubens, P. sitchensis,* and *P. smithiana,* all except one had some degree of dormancy, although this may have changed after further testing. *Picea glauca albertiana* showed no internal dormancy. The dormancy may be broken by stratification at around 41°F. for 30 to 60 days, or the seeds may be sown in prepared seed beds in the fall. The lower winter temperatures (outside) provide the same general conditions as stratification.

GRAFTING

Grafting has been for many years a method of propagation of varieties of spruce which do not come true from seed. There is little in the literature regarding experimentation or research on grafting practices of spruce · Textbooks and bulletins usually give general or specific recommendations which, if followed, are effective. These are based for the most part on practices developed through experience and not upon specific research Wells (9) states that grafting is the normal method of producing Koster and others forms of Blue spruce. He recommends *Picea abies* as the most satisfactory understock and suggests grafting be done in February or early March. Terminal shoots should be used for the scions although the terminals of side branches can also be used.

CUTTINGS

Attempts to root cuttings of spruce have been made for many years in an effort to simplify the production of those types which do not come true from seed. Rooting results have varied and no one procedure has been developed which will guarantee satisfactory results.

Deuber (1) conducting experiments with cuttings of Norway spruce, Eastern White pine, Red pine, Lace-bark pine, Japanese red pine, and Canadian hemlock, found that roots formed more readily on some species than others. He concluded that the rooting process was influenced by internal and external factors. Those of greatest significance appeared to be the season at which the cuttings were collected, the age of the parent stock, and the clonal variation in rooting capacity.

That the age of the parent plant greatly influenced the rooting of difficult to propagate plants, was reported by Gardner (5). He discovered by chance, in the winter of 1927 - 28, that stem cuttings of apple from 1 year-old seedlings rooted very easily in contrast to older wood. Additional studies with other species showed a definite relationship between the age of the plant and rooting. Cuttings from 2 year old plants of *Picea abies* rooted 90 per cent while cuttings from old plants rooted 50 per cent. The same relationship was found with *Pinus strobus.* Cuttings from 1 year old plants rooted 98 per cent, from 2 year plants 50 per cent, and from 3 year plants 12 per cent

Another important factor influencing rooting is the position on the plant from which cuttings are taken. Grace (6) working with Norway spruce, took dormant cuttings from the upper and lower regions of a tree to determine whether there was any relationship to ease of rooting. He treated the cuttings with talc, and talc containing 1000 parts per million of indolebutyric acid, using sand as a rooting medium In 10 weeks the rooting was 75 per cent from cuttings of the lower region while only 43 per cent from the upper region. After 19 weeks the rooting percentages were 86 for the lower and 48 for the upper regions. In addition, cuttings from the lower region produced roots twice the length of those from the upper.

Although the cuttings from the lower portion of the plants gave better rooting, the resulting growth of the young plants was not as desirable. Deuber (2) reported a tendency for the growth on plants from the lower branches to be somewhat horizontal. Such plants eventually assumed upright growth, although in some cases this did not occur for 3 years.

Farrar and Grace (3) conducted extensive experiments on the season of taking cuttings of Norway spruce as related to rooting response. They found that cuttings taken from mid-July to October gave good rooting with percentages ranging from 82 to 98. Rooting was not as satisfactory on cuttings taken later Those taken in April rooted 78 per cent. June cuttings rooted poorly. Kirkpatrick (7) reported that cuttings of *Picea pungens* rooted best when taken in February and March

The type of cutting and rooting was studied by Farrar and Grace (4). They found that simple cuttings rooted better than those with heels whether taken in July, August, September or October. They also found that a rooting medium of sedge peat was superior to sphagnum peat or sand.

In 1956 Teuscher (8) reported on the rooting of the Montgomery Blue spruce. This originated as a chance seedling and is grayish-blue in color and is very symmetrial and dwarf in habit. Best rooting was secured in medium-fine, slightly acid, sand kept moderately moist. Any addition of peat moss decreased the rooting percentage. He found that the needles at the base must be left on and that additional wounding was harmful. Rooting hormones were not helpful, in fact, all those tested caused injury or death. Cuttings taken towards the end of June, when the young shoots were well formed but not fully hardened, gave 60 to 75 per cent rooting. Those taken after August 1 to January did not root until the following spring and by then many had died. However, cuttings taken towards the end of February and early March, given bottom heat of 50 to 55 degrees and an air temperature of 40 to 45 degrees, callused quickly and rooted 90 per cent or more by early May.

It is thus apparent that further work needs to be done to determine the proper procedures for rooting spruce cuttings.

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MODERATOR MEAHL: That completes our review of the literature and since we are not going to have questions at this time we will go directly into the specific phases of propagation of spruce. The first method we are going to have discussed is the propagation of spruce by seed, and to tell about that we have Thomas S. Pinney, Jr.

MR. THOMAS S. PINNEY, JR. (Evergreen Nursery Co., Sturgeon Bay, Wisconsin): Maybe some of you are rather surprised and I was too, to find myself as a replacement for my father. We are sorry he couldn't be here.

Mr. Pinney presented his paper entitled "The Propagation of *Picea* by Seed" (Applause)

THE PROPAGATION OF PICEA BY SEED

THOMAS S. PINNEY, JR.
Evergreen Nursery Co
Sturgeon Bay, Wisconsin

INTRODUCTION

The germination of a seed and a seedlings subsequent growth are two of natures most fascinating and complex phenomena In the propagation of *Picea* by seed, as is true with other plants, this process of germination is of utmost importance Over a long period of time plant propagators have developed many cultural practices designed to regulate the germination of a seed and its subsequent development. The cultural practices described in this paper may not agree with all the very latest scientific findings on the subject, since the practices discussed are based upon ones actually used at the Evergreen Nursery in Northwestern Wisconsin They have been developed over the past 92 years by continual study of scientific and commercial findings along with our own experience. Further, the discussion which follows is limited to those *Picea* species and varieties commonly grown from seed by our nursery. *Picea abies, Picea pungens glauca, Picea glauca* and *Picea glauca densata.* The propagation of *Picea* by seed is limited to those species and varieties which do not require asexual reproduction Propagation by seed is almost always used whenever it is possible since it is considerably cheaper than other methods.

SEED

In almost every discussion of propagation by seed, the importance of good seed selection is emphasized. Stressing the fact that it is important to secure high quality seed is an excellent idea, although the actual problem of securing this type of seed is often difficult and exasperating. We find it necessary to have seed sources in Japan and Europe as well as the United States. Since the source of seed has become increasingly important in this phase of propagation, the field of genetics also has become more important in helping to solve some of the problems in seed source and selection. Good seed dealers take a great deal of care to select the type of seed which is desired by the customer. Once the cones have been collected it is necessary to have a very strict labeling procedure, since this will be the only sure means of identification between strains of the same varieties and species. Very often it is necessary to buy seed for two or three or more years in advance when there is a good crop, since the next year (s) the crop may be rather poor. The *Picea* which we are discussing may all be stored in sealed containers at 40 degrees Fahrenheit for a maximum of five years without a great deal of loss in germination percentage White spruce, Black Hills spruce and Colorado Blue spruce can often be kept even longer than this. Generally we do not store our seeds for periods longer than three years.

It is an excellent idea to run a germination test or a cutting test on the seed you plan to sow. We usually run a cutting test, and where we obtain seed from sources that we are not too familiar with, we will also have a germination test made for us. A cutting test is by no means a sure indication of whether or not the seed will germinate, since it is hard to pick out weak embryos and rancid seed. Generally the actual germination will be between 10 to 20% lower than the cutting test indicates. The advantage of this test is that it is very fast and can be performed in a rather short time. We all realize that in order for seed to germinate there are several factors which must be favorable. These can be broken down into two general classes. The first is that of environmental conditions that are necessary for good germination. When these external factors will not permit germination, the phase is often referred to as quiescence. Moisture is one of these influencing factors, the lack of it, or an over-abundance of moisture will prevent germination. This is why we must have ample drainage for seed bed areas. Oxygen is another factor which must be present in order to have germination. If seeds are covered too deeply or water stands in certain areas, oxygen will not be sufficient. Although light is usually not necessary in the very early stages of germination of *Picea,* it certainly is necessary as soon as the germinating seedling pushes its way to the surface. There is a rather critical time when the straw or mulch must be removed from the germinating beds in order to insure the subsequent development of a good seedling. Temperature is another factor which is very important to germination. Spruce seeds will germinate rather slowly and poorly during warm weather. That is one of the reasons we plant our seeds in the fall so that they germinate during the cool spring months and have all of the following summer to develop into a strong seedling There are many other environmental factors which affect germination, but they are rather minor, in most cases. The second general classification of factors affecting germination is that of rest or internal dormancy. This will be discussed later under the heading of "PreTreatment of Seed." It is necessary for us to control these factors to the best of our ability through various cultural practices in order that we might insure a good germination and quality seedling. It is well to remember before a seed can germinate, usually a complex series of chemical changes take place within the seed which makes germination possible. The tiny seed is not static but rather a living and dynamic object.

PREPARATION OF SEED BED AREAS

The selection of a proper soil type is extremely important First, we feel it should be a very well drained area with a pH of 6.0 or slightly lower if possible We prefer a sandy loam type of soil with a slight slope for good air drainage We have selected certain areas throughout our nursery which we feel will make good seed bed areas and set them aside for this purpose only. We have also set up a crop rotation program for these areas. Usually the old seed beds are cleaned up at the end of spring and then these areas are treated with 10 pounds of Dalapon plus 2½ pounds of Amino Triazole per acre to eradicate quack grass. After ten days the field is plowed and an application of approximately 50 pounds per acre of a 5-20-20 fertilizer is made. The type and amount of fertilizer applied is based on soil test results. The land is then worked until late June when a combination of oats and alfalfa are sown. This may seem rather late to be sowing oats, but it works out very well for us since we do not cut the oats but allow it to stand as a winter protection for the alfalfa. Because our soils are very low in potassium and boron, we top dress the alfalfa with 0-10-30-B at the rate of 200 pounds per acre in late fall. The alfalfa is grown only until the first crop is ready for harvesting, which is about July 10 of the following year. If quack grass is not under control at this point, we will again apply the quack grass herbicide treatment, wait ten days and plow under the alfalfa crop. We do not remove the oats or any alfalfa from the land. Before plowing the alfalfa down we apply nitrogen in the form of nitro pills to insure quick decomposition of the alfalfa plants. After plowing we apply the necessary commercial fertilizer determined by soil tests to bring phosphorous and potassium up to a high level. Approximately 20 tons per acre of manure is also applied at this time. The soil is then treated for grubs with an application of Dieldrin applied as a liquid which is immediately disked in. We have been experimenting wth Vapam for control of weeds and damping off. If we find it becomes feasible to use this material, we probably would apply it in August when the environmental conditions are right for its usage. Our crop rotation then consists of one year of oats, one year of alfalfa and three years of seed beds, thus forming a six year rotation program. We have adapted this rotation to suit our own needs and it no doubt would not agree with what other seedling growers are using.

PREPARATION OF ACTUAL SEED BEDS

We start our actual preparation of the seed bed during the first week of November. We feel that fall sowing of *Picea* has proved more satisfactory than spring sowing, since nature will stratify the seed very well over the winter, which results in very even germination early in the spring. Also, we believe a larger 1-0 seedling will be obtained by fall sowing. The reason for not starting sowing before the first week in November is to insure that germination will not begin that fall. After a final dragging of the seed bed areas by a meeker which levels the soil, we mark out the beds and prepare them for seedling. The beds always run in an east and west direction, since this gives the proper distribution of light under the shade through the course of the day. We have attempted to mechanize as many of the operations as possible. The beds are marked out with a device attached to one of our tractors which accurately marks out 4 foot wide beds with 30 inch aisles. This size bed and aisle enables us to drive all of our mechanized units over the beds which certainly speeds up many of the operations. After the beds are marked, some of the soil from the aisles is thrown into the bed area with the result that the beds are raised to insure good drainage The beds are then raked by hand with regular garden rakes. Next is a heavy application of Milorganite applied with a 4 foot spreader. We feel that the organic nitrogen will release itself at a rate slow enough so the tiny seedlings will not be injured and yet have a sufficient nitrogen supply for their first year development The Milorganite is raked in lightly and the area rolled. Beds are now ready for seeding.

PRE-TREATMENT OF SEED

Even though the seed is given all of the necessary environmental factors for germination, we still must consider whether or not the seed itself is ready for germination. It has been our experience over the past years that if Norway, White, Black Hills or Colorado Blue spruce is sown in the fall, the possible resting conditions which might exist within the seed and prevented its germination will be overcome by nature during the winter. In the past, most literature suggests that Norway spruce and Black Hills spruce generally do not have any of these resting conditions, while Colorado Blue spruce and White spruce sometimes do. They recommended stratifying these seeds in moist sand at 40 degrees Fahrenheit for approximately 30 to 60 days We feel that it is much cheaper and easier to plant in the fall. If it is necessary to plant in the spring, due to late arrival of seed or inclement fall weather, the storage of the seed in a bag at cold, moist temperatures seems to overcome the resting condition satisfactorily. We pellet our seed with Arasan as a protection against damping off organisms and bird damage. Norway spruce, White spruce and Black Hills spruce are pelleted, but we have not found it necessary to do so on the Colorado Blue spruce.

SOWING OPERATIONS

After the bed has been rolled, the seed is spread by means of a Scott's Spreader, thick enough so that we obtain approximately 40-60 healthy seedlings per square foot, depending on type of seedling desired. It is rather difficult to calculate the exact amount of seed that should be sown since the purity, soundness, germination percentage and other factors all vary with different years and can easily change the number of seedlings that finally develop. In the case of White spruce, the seed is so fine that it is often necessary to slightly roughen the bed area with a broom rake before seeding. After seeding the beds are rolled and labeled as to kind of seed, source of seed and other pertinent data. The seed is then covered with Lake Michigan beach sand to a depth of approximately twice the thickness of the seed. Although there has been a lot of discussion and some scientific data on the depth to cover seed, we have found that it is not as critical as we used to believe. The machine that is used for applying the sand is able to apply this layer of sand to whatever depth is desired Beds are then rolled again and a mulch of combined rye straw is applied to a depth of approximately 2 to 3 inches. We use a converted manure spreader for this purpose. The final step is to place shades over the straw to prevent it from blowing off.

CULTURAL PRACTICES DURING SEED GERMINATION AND THE FIRST YEAR

The following spring the *Picea* seeds will commence germinating between May 15th and 20th The Colorado Blue spruce and Norway spruce generally germinate sooner than the White and Black Hills spruce. It is extremely important during the time germination is expected, to check the beds each day for the progress of the germination process. We uncover the germinating *Picea* seed just before it pushes through the surface of the sand. The shadings are then set to one side and the straw is removed by means of forks and broom rakes. Stakes are driven in along the edge of the beds, wire stretched on these stakes and the shadings are replaced on the wire Now starts a critical period of time during which the moisture level of the soil must be kept at optimum conditions for the development of the very young and tender seedling. This is accomplished by setting up a semi-permanent overhead sprinkling system which will stay in operation during the first and second growing season The water is supplied by means of a 6 inch main through which we are able to pump water from a swamp lake or from a deep well. We prefer to use the rather warm water from a swamp lake in preference to the cold well water During the first season the seedlings are watered every other day for 1 to 1½ hours during the middle of the day. Since the roots are so small and located rather shallow, it is necessary to water often but not too much at a time. As the seedlings develop they are watered less often but with a heavier application. At the present time we still hand weed all of our seed beds since we have not found a satisfactory weed control chemical. However, we do use extensive chemical weed control on transplants. It is difficult to apply the chemical over a thick seed bed so that sufficient chemical reaches the ground at the base of the seedling. Possibly this is one reason for our failures Hand weeding is a rather costly process but unless it is done regularly it will mushroom into a situation in which the weeds are so large that many trees are destroyed during the weeding operation. All of our weeding on seed beds is done by women. We do not fertilize during the first growing season, since the organic nitrogen that we added when the seeds were sown usually supplies sufficient nitrogen for the small seedling. Also, the crop rotation usually gives us sufficient potassium and phosphorous for healthy development of the seedling At the present time we have not found it necessary to spray any of the *Picea* seedlings for insects or diseases as has been necessary with pines It is necessary to give these small seedlings some winter protection which we accomplish by first removing the shadings and then applying a 3 to 4 inch layer of combined rye straw with the same machine that was previously described The straw is tucked under the edge of wire which was used to support the shadings. This prevents the straw from blowing away. The mulch is left until early spring when it is removed by hand.

CULTURAL PRACTICES THE SECOND AND THIRD YEARS

During the second and third year there are no shades over the beds, since we find that with the overhead irrigation we can develop better plants under full sun. At this point we do fertilize with a liquid fertilizer which generally is a nitrogenous type. We prefer ammonium sulphate for this job, since we get a combination of nitrate as well as ammonia types of nitrogen The application of the high nitrogenous fertilizer usually gives a very good growth response because the other nutrients necessary for plant growth are in good supply, due to crop rotation Again all the weeding is done by hand We begin removing the seedlings for commercial distribution and transplanting as 2-0 seedlings. However, some of the spruce are grown on into 3-0 plants The beds that remain after digging operations in the spring are root pruned with a large blade that undercuts the bed. We dig our seedlings by a blade attached to a tractor that digs and lifts the entire seed bed in one operation. The seedlings are then removed to a building where they are run over a conveyor belt for grading purposes. The plants that are designated for shipping are then carefully packed by experts who have had many years experience. We have always felt that packing must be done by people that are skilled in this job and realize that even the best quality seedling is of little value to the customer if it arrives in poor condition In conclusion, we would again like to emphasize the fact that these practices which we follow certainly may not necessarily be the best or fit your particular situation. These practices are ever changing as we put into use new and better ideas in an attempt to most economically produce the type of quality seedlings our customers desire. (Applause)

MODERATOR MEAHL: Thank you very much, Mr. Pinney. We will proceed right along with our next subject, the propagation of spruce by grafting Our speaker is Mr. John Ravestein, Mentor, Ohio.

Mr Ravestein presented his paper, "Our Method of Grafting Blue Spruce." (Applause)

OUR METHOD OF GRAFTING BLUE SPRUCE

John Ravestein
G. K. Klyn, Inc.
Mentor, Ohio

The understock used for the grafting of spruce is not grown at our nursery Norway spruce is purchased from a reliable source as 2 to 3 year old seedlings, preferably once transplanted. You should be certain that the understock is healthy with a fibrous root system These seedlings can vary in size from 6″ to 12″. We always plan to have our understock arrive in the spring in plenty of time to allow us to inspect the plants and to trim the roots in order to establish a fibrous root system. We then heel in the plants for a short time in order to induce some new root growth. They are then planted out

We plan to have the understock grow in our nursery for two years. However, there are exceptions to this, which I will point out later.

We prefer to plant on a sandy soil which is not too rich in nutrients. The ground should be prepared as early as possible in the spring by spreading ¾″ to 1″ peat over the bed and Rototilling to a depth of approximately 8″. We use the peat to get a more fibrous root system, which in our estimation is necessary to make a go of it. At the time of grafting a fibrous root system is absolutely necessary to insure the survival of the understock during the process of establishing a growing graft.

We plant in rows 12 inches apart, spacing our understock 2½ to 3″ apart in the row. This spacing may sound very close to you but we seedlings. However, some of the spruce are grown on into 3-0 plants The beds that remain after digging operations in the spring are root pruned with a large blade that undercuts the bed. We dig our seedlings by a blade attached to a tractor that digs and lifts the entire seed bed in one operation. The seedlings are then removed to a building where they are run over a conveyor belt for grading purposes. The plants that are designated for shipping are then carefully packed by experts who have had many years experience. We have always felt that packing must be done by people that are skilled in this job and realize that even the best quality seedling is of little value to the customer if it arrives in poor condition In conclusion, we would again like to emphasize the fact that these practices which we follow certainly may not necessarily be the best or fit your particular situation. These practices are ever changing as we put into use new and better ideas in an attempt to most economically produce the type of quality seedlings our customers desire. (Applause)

MODERATOR MEAHL: Thank you very much, Mr. Pinney. We will proceed right along with our next subject, the propagation of spruce by grafting Our speaker is Mr. John Ravestein, Mentor, Ohio.

Mr Ravestein presented his paper, "Our Method of Grafting Blue Spruce." (Applause)

OUR METHOD OF GRAFTING BLUE SPRUCE

John Ravestein
G. K. Klyn, Inc.
Mentor, Ohio

The understock used for the grafting of spruce is not grown at our nursery Norway spruce is purchased from a reliable source as 2 to 3 year old seedlings, preferably once transplanted. You should be certain that the understock is healthy with a fibrous root system These seedlings can vary in size from 6″ to 12″. We always plan to have our understock arrive in the spring in plenty of time to allow us to inspect the plants and to trim the roots in order to establish a fibrous root system. We then heel in the plants for a short time in order to induce some new root growth. They are then planted out

We plan to have the understock grow in our nursery for two years. However, there are exceptions to this, which I will point out later.

We prefer to plant on a sandy soil which is not too rich in nutrients. The ground should be prepared as early as possible in the spring by spreading ¾″ to 1″ peat over the bed and Rototilling to a depth of approximately 8″. We use the peat to get a more fibrous root system, which in our estimation is necessary to make a go of it. At the time of grafting a fibrous root system is absolutely necessary to insure the survival of the understock during the process of establishing a growing graft.

We plant in rows 12 inches apart, spacing our understock 2½ to 3″ apart in the row. This spacing may sound very close to you but we are not interested in top growth as much as we are interested in providing a good root system by the end of the year. I say one year, because at this time we dig the largest and the most suitable plants for grafting. These plants are potted in 2½" clay pots using the following mixture: (1) loam soil (not high in nutrients) (2) coarse, #9 sand, (3) peat. The plants which are left in the fields are root pruned.

The potted plants are then heeled in during the month of May, in well drained beds. No protective covering is used on the sides, although we immediately place shade over them which is not removed until about the end of June In our climate we have found that our understock will sun-scorch if we have boards along the sides of the bed. The understock remains in the bed until some time along in the beginning of January.

After the stock has been brought in, the roots that are protruding from the pots are cut off with a knife. Also, whenever necessary an occasional branch is removed in order to give a little more room to insert the scion.

We then place the potted plants in the coolest house we have available; preferably one with a temperature of 50 to 55 degrees. If stored in temperatures warmer than 50 to 55 degrees, new root growth starts which is something we do not want at this time We believe in keeping the understock on the cool side, since we have found, through experience our losses have been higher if a warmer storage temperature is used.

We store them until we find that new root growth has started. You have to be careful not to wait too long because once the tops start growing we think the time to graft them has past. Most of the time they are ready to graft sometime from March 1st to March 15th. This may seem late to some of you propagators, but here in Northern Ohio our winters hang on for quite sometime, even as late as the 10th of April, which occurred last year.

Our scions are obtained from trees owned by a fellow nurseryman who is located near us. These old speciman plants are of the Moerheim variety. We do not cut more scions than we can graft in forty-eight hours. There is quite a bit of controversy concerning the size of the scions that are best for grafting. We originally used small scions, and wound up with a small plant. We then changed to a large scion of reasonable size. We use the simple side graft. We tie the scion to the understock with waxed twine, not waxing the union. Our twine is waxed with light green Rose Bush Wax #410D. The grafts are not generally waxed because we believe the grafts do better without waxing.

The grafted plants are placed in the open bench at a 45 degree angle, with the union facing up The plunging medium in the bench contains a mixture of medium fine sand, peat, and a little Styrofoam. An even temperature somewhere between 68 and 72 degrees is maintained. After they are placed in the bench we try to keep them moist, using a fine spray of water two or three times a day. If the temperature rises during the day and the ventilators of the greenhouse are opened, we place a sheet of polyethylene film over the grafted plants to make sure that the plants are not subjected to drying. Under these conditions we know that it is sometimes very difficult to maintain an even temperature in the greenhouse, especially later in the spring.

After about three weeks, the grafted plants are taken out and approximately ⅓ of the understock is removed. The plants are then replaced in the bench using the following procedure; (1) the plants are placed in the opposite direction, at a 45 degree angle, (2) the plants originally placed on the outside of the case are set in the middle of the bench, while those on the inside are placed on the outside. The plants are then kept in this position until the scions show enough new growth At this time they are set up straight and another ⅓ of the understock is removed The remaining portion of the understock is removed some seven to ten days before placing them in outside beds. These outside beds are located on a well drained sandy loam soil. We also make sure that the bed has sufficient nutrients for plant growth. The grafts are planted 6 to 8″ apart and mulched with buckwheat hulls. We have found this material to be a perfect mulch. The hulls seem to reflect the summer heat more than do other types of mulches. Double shades are then placed over the plants for two or three weeks. If we have very hot weather, burlap is also used over these shades for a few days. After two or three weeks one of the shades is removed.

Immediately after planting we place 12″ boards on the west side of the bed to protect the tender grafts from drying winds These are kept in place until the grafts are established.

From this point on the plants are more or less on their own, except for careful irrigating and spraying We have to admit that our procedure is performed rather late in the season. However, we have had reasonable success with this method and consequently will continue to use it as long as we have satisfactory results By satisfactory results I mean a reasonable stand.

MODERATOR MEAHL: Thank you, Mr. Ravestein, for that very practical discussion on the grafting of spruce.

Going right on with our program, we are going to take up the topic, "Propagation of Spruce by Cuttings." You will notice from your program that Mr. R Warren Oliver, Central Experimental Farms, Ottawa, Ontario, Canada, is listed to discuss this subject. I have been informed that Dr. Stuart Nelson has assisted in the preparation of this paper and will also present it here this morning. I call upon Dr. Nelson at this time.

DR. STUART NELSON (Central Experimental Farm, Ottawa, Ontario, Canada): Thank you, Professor Meahl.

The paper presents facts that have been found through research and consequently does not supply answers to all the problems on this complicated subject.

Dr. Nelson presented the paper on "Propagation of Spruce by Cuttings." (Applause)

PROPAGATION OF SPRUCE FROM CUTTINGS

R. W. OLIVER AND S. H. NELSON
Horticulture Division
Central Experimental Farm
Ottawa, Ontario, Canada

It has long been recognized that spruce as a genus is difficult to propagate from cuttings Older texts give general instructions applicable to conifers as a whole and usually comment that *Abies, Picea* and *Pinus* are so difficult that grafting is more practical.

The most specific of the texts, one by W. L. Sheats, states that five varieties of Norway spruce can be rooted most satisfactorily if taken in October. The cuttings should be stuck in sand overlaying a mixture of peat, sand and loam in a cold frame. They should be covered over winter and kept under shade the next summer, with slight ventilation and hand syringing Well rooted cuttings, up to 75 per cent can be transplanted the following September.

The identification and synthesis of growth promoting substances led many workers, between 1935 - 50, to try them on species such as *Picea pungens,* and *kosteriana,* hitherto considered very difficult As the results were poor to mediocre, few writers published them.

Dr. Meahl has ably covered the literature on this subject in his introductory remarks. A brief review of the Canadian work, chiefly with the forest species *P. abies* and *P. glauca* give some conflicting results that may prove interesting

Farrar (1) and Grace (2) in several cooperative experiments carried on between 1935 - 45 found that:

1. Cuttings from lower branches of the tree rooted more readily than those from the upper branches. This was contrary to the general opinion that cuttings from younger trees root more readily than from older trees.

2 Lateral tips rooted more easily than terminals but do not develop into such good plants.

3. Maximum rooting results with *P. glauca* were obtained from cuttings taken in July when the base of the new growth was beginning to stiffen. Norway spruce, *Picea abies,* rooted more readily and over a longer period but the optimum results were from cuttings taken in December. All cuttings in this experiment were stuck in sedge peat in a cold frame.

4. Long cuttings 10 to 20 cm. were better than short cuttings 5 to 10 cm. Ordinary cuttings of a full season's growth were superior to those with a heel.

5. Treatment with any of the so-called hormones was usually detrimental, though in some instances, roots were longer on treated cuttings indicating that rooting had taken place more rapidly. This does not agree with the early work of Thimann and Delisle who reported that auxins were a great aid. Griffiths (3) working with *P. sitchensis* also found that indolebutyric acid was beneficial.

In early work done at Ottawa between 1940 - 1948, Oliver found that ornamental varieties of *P. abies* rooted best when they were taken in December as compared to those taken in any other month, and, contrary to Farrar and Grace, that sand was superior to peat as a medium. This work was done under syringed cheesecloth in a cool greenhouse with bottom heat. He also found that treatment with growth promoting chemicals was usually detrimental and the ability to root was a varietal character Certainly *Picea abies, ohlendorffi, pygmaea* and *remonti* rooted better than the others tested.

The first trials with mist at Ottawa were started in 1955 using two varieties, *P. abies ohlendorffi* and *P. remonti*. The mist beds included a continuous and intermittent mist bed outdoors, as well as an intermittent mist bed in the greenhouse. Four media, namely, sand, sand plus peat, finely shredded sphagnum moss and vermiculite were used Terminal tip cuttings 6 to 8 inches in length, lateral tip cuttings 2½ to 4 inches and lateral tip cuttings 1½ to 2 inches were treated with various concentrations of hormone.

The cuttings were stuck toward the end of June in the hope that they would be sufficiently rooted by fall. However, rooting did not meet expectations and in order to present a better evaluation, a scoring system was adopted. A value of 6 was given to well rooted cuttings, 4 to medium rooted cuttings, 2 to poorly rooted cuttings and 1 to cuttings showing swollen primordia when they were lifted in late September.

The terminal tips of both varieties rooted poorly with a maximum rooting of 30 per cent. The addition of Chloromone did not increase rooting percentage but did increase the score, indicating earlier rooting.

The results with laterals were more encouraging with rooting up to 90 per cent. Vermiculite, although messy to work with under mist, gave the best root system, whereas sand produced a more brittle, cleaner root system. No difference occurred between intermittent and continuous mist outdoors, although both were superior to the intermittent mist in the greenhouse. Further, no rooting differences were observed between the two sizes of lateral cuttings. The use of Chloromone yielded a better root system, but, in general, was accompanied by a slightly lower rooting percentage.

Although no injury occurred in the mist beds from Chloromone treatment, it should be mentioned that treated cuttings in a plastic tent turned brown and dropped their needles, while the untreated cuttings remained green and rooted 50 per cent In this preliminary trial the plastic tent did not have mist. The temperatures became excessive and the system was entirely unsuitable.

In further trials with hormones, it was found that increased rooting generally occurred with increased concentrations of indolebutyric acid in powder form up to 0 8 per cent.

After evaluation all cuttings were potted even though rooting was nothing more than swollen primordia. They were held most of the winter in a cool greenhouse and when moved to a warmer temperature in late winter, no casualties occurred. Further, although possibly not commercially feasible, the unrooted cuttings in good condition were moved from the outdoor beds to a cheesecloth shaded bed without mist in a cool greenhouse. Bottom heat was applied and all the cuttings rooted in the early winter months.

At the beginning of the 1956 season we were very hopeful. However, instead of a warm sunny summer as we experienced in 1955, much of the weather was dull and there was considerable rain. Rooting of the spruce cuttings stuck in 1956 was severely affected. Maximum rooting for *Picea abies ohlendorffi* was only 63 per cent and no beneficial effects of hormones were found. The rooting of *Picea abies remonti* was reduced to almost nil and *Picea glauca conica* and *Picea abies nidiformis* rooted only 30 per cent

Due to the space used in the propagation beds for transplant studies and the propagation of material of prime interest to the Division, further studies with spruce had to be sacrificed for in the 1957 propagating season.

In conclusion, it is apparent that the terminal tip cuttings do not root very well under mist during the summer While the addition of hormone may result in longer roots the percentage of rooted cuttings generally is not increased.

Lateral tips are relatively easily rooted, but apprehension has been voiced concerning the growth habit resulting from these cuttings. Best rooting occurred in a season where temperatures were high and there was plenty of sunlight.

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2. Grace, N. A. Bio-chemistry Division, National Research Council, Ottawa, Ontario, Canada.
3. Griffiths, B G. Forester, Forestry Service of the Province of British Columbia, Canada.

MODERATOR MEAHL: The floor is now open for questions

MR. MARTIN VAN HOF (Rhode Island Nurseries, Newport, R.I.): I would like to ask John Ravestein if the grafts are placed in a closed or an open bed?

MR. RAVESTEIN: We place them in an open bench without glass.

MR. VAN HOF: While I am standing up, I would like to ask Mr. Pinney if the seed that they use is one year old seed or seed collected that same year?

MR. PINNEY, JR.: Usually we use the current year's crop of seed. However, we can and do store it. I didn't mention anything about it, but as was mentioned in the literature review, you can easily store it for as long as five years in sealed containers We usually use brown bottles, turn them upside down, dip the tops in wax and that seals them up tight.

MR. VAN HOF: Now I would like to ask Stuart Nelson, if current season's wood or older wood was used in the experiments that he described?

DR. NELSON: In all of the experiments, only one experiment was conducted with entirely current season's wood.

MR C E. KERN (Wyoming Nurseries, Cincinnati, Ohio): I might mention that I made several exploratory tests on Blue spruce from the 15th of August to about the 15th of September, grafting on the regular understock. Generally all the grafts we made during that period have been successful and have taken hold. I might suggest there is a field there that should be explored

DR. CHARLES E. HESS, JR. (Hess Nursery, Mt View, New Jersey): I would like to ask Dr. Nelson what the age of the spruce stock plants was from which he got his cuttings?

DR. NELSON: I can't answer that question specifically. They were specimen trees in the ornamental grounds and I would roughly say that they were between 20 and 30 years old.

MR. JIM WELLS (J S. Wells Nursery, Inc., Red Bank, New Jersey): The purpose of making a graft in August or September was discovered by the Dutch in Boskoop. The value is that a graft made at that time makes a normal growth from the terminal bud the following spring, which doesn't occur on grafts made in February and March.

I would like to ask Mr. Ravestein why he puts his grafts on a slant?

MR. RAVESTEIN: I do it primarily because my bench is only six and a half inches deep.

MR. WELLS: I wondered if slanting the grafts was an old-fashioned method, or one which was founded on some good reasoning. I could never see that any value accrued.

MR. RAVESTEIN: I believe that light might have something to do with it First, we slant them one way and then after three weeks we turn them the other way. If you set them straight up from the beginning the bottom has the same amount of light as in the beginning.

MR. JOHN VERMEULEN (J. Vermeulen & Son, Inc., Neshanic Station, New Jersey): Another reason for slanting the grafts under glass is that the unions are closer to the glass and higher temperatures. The higher temperatures resulted in better callusing and knitting. That essentially was the old-fashioned way in Boskoop.

MR. JACK HILL (D Hill Nursery Co, Dundee, Illinois): I wonder if any one on the panel has had experience and are able and willing to report on outdoor grafting of spruce? We know there is considerable outdoor grafting of these plants in Western Europe At one time it was called bottle grafting and has been known by various other names. Has anybody had a reasonable amount of experience with this technique?

DR. NELSON: I would like to attempt an answer to this question. I cannot give first-hand knowledge on this, but Dr. Teuscher at the Montreal Botanic Gardens has been doing this for some years now and presented a paper at the Canadian Nurserymen's Association meeting about a year ago. He actually doesn't use scions in the true sense of the word. What he is doing is the opposite of what you are thinking about, since the stocks are lifted and potted up and the scion is not detached from the tree. He grafts the understock right onto the tree.

Whether this is working or not, I don't know. You can obtain his method and results by writing to Dr Teuscher.

MR HANS HESS (Hess' Nursery, Mt. View, New Jersey): I would like to report on another rather radical method of grafting spruce. I think Jim Wells will verify what I am about to describe. While he was with Koster and Company he visited this gentleman's establishment and saw the method by which he produced Blue spruce with tremendous success. This gentleman brought in his understocks in the fall. He trenched them in outside, and in the spring of the year, around the latter part of March, as soon as the stocks began to show the first root action, he brought them into his cellar. He grafted them and then planted them out in a bed which had cinder blocks for the border, and he put shades over them. He plunged the union about an inch or two below the surface, and there they stayed, scion, understock and everything. This gentleman, although he has since passed on, had the most perfect stand of spruce that I have ever seen. They made a short amount of growth and set a firm, mature terminal bud for the following season's growth.

I know at Koster and Company, propagators have tried to duplicate this procedure but they have not had the success that this gentleman had I haven't tried it myself because at that time of year we are too busy to be thinking about grafting.

Jim, you might like to comment on this technique.

MR. JIM WELLS: Yes, indeed, I can bear out what Hans said. The man's name was William Wright, his success was continuous and phenomenal and wasn't just a flash in the pan. His take was excellent year after year after year. I think the reason for it was his skill as a grafter.

This brings up something that we haven't mentioned here this morning, namely the need in spruce grafting of a very careful attention to the depth of cut, particularly on the scion. When I was at Dundee, we ran some tests on that and found a very definite relationship between the percentage of take and the depth of cut made on the scion. A light cut on the understock, hardly touching the wood, or cutting deep into the understock didn't seem to make too much difference We noticed that a very light cut just revealing the cambium tissue was slightly better than a deep cut. I believe if you can find anything specific for Bill Wright's success, the method of cutting was it.

MR. CONSTANT DeGROOT (Sheridan Nurseries, Sheridan, Ontario): Two years ago we bought 250 Koster Blue spruce from France and they were all triangle or wedge-grafted, quite a different method from the one Jim Wells mentioned, or the usual veneer graft

I would also like to a remark here on Jack Hill's question concerning outdoor grafting. Last year I found a Mugho pine, and grafted it outside right in the bed Only 3 out of the 15 grafts were successful.

MR CARL GRANT WILSON (Cleveland, Ohio): I would like to ask Mr Pinney if he has ever found cones on a real deep Blue spruce, and if so, after seeding, what, if any, percentage of good blues were obtained

MR. PINNEY, JR.: I suspected this question would come up. It is a difficult one to answer since when we buy Blue spruce seed we specify or we hope that our seed dealers will supply us with seed from specimens that are of good color. That doen't necessarily guarantee at all that you will get a seedling that is blue. Once again the answer would have to be relative. What do you consider a Blue spruce? They range all the way from green to the blue Moerheims. If you want a seedling close to a Moerheim color I would have to say that I have probably only seen one or two in my life in our seed beds that came anywhere close to it. If you want something that is relatively blue, maybe you might get anywhere from 20 per cent downwards, depending on what you accept as being blue.

MR. C. W. M. HESS (Hess' Nursery, Mt. View, New Jersey): I would like to say that we have an isolated seed source of Moerheim spruce. There is no chance for pollination with other species. We have picked seeds from this Moerheim block, planted them and obtained only 40 per cent blues. It bears out what you have said, Mr. Pinney.

PRESIDENT VANDERBROOK: In answer to the question you asked, Jack, I think I am safe on saying that bottle grafting has gone out. Dad and I both did bottle grafting of Moerheims, and Kosters. This can be done by first planting Norway spruce in rows, where they can be easily watered. Small bottles which are made especially for bottle grafting are placed so the neck of the bottle is even with the top of the ground. The graft is then made, the scion grafted on the side of the Norway understock, tied, and the base of the graft placed in the bottle containing water. These bottles have to be watched carefully In very warm weather they sometimes have to be filled twice a day with a hose. When the union is complete, sometime in June, and the graft is starting to break with new growth, the top of the understock is completely cut off and the plant allowed to stay in place for two years before it is dug.

MODERATOR MEAHL: I would also like to add a comment on the bottle grafting technique. I have also seen the bottle graft method work. A nurseryman in Pennsylvania did it on a very small scale and was very successful. I would think the particular procedure would have limitations because of its unwieldiness and need for constant attention.

MR J PETER VERMEULEN (John Vermeulen & Son, Inc., Neshanic Station, New Jersey): Can cuttings be used to successfully propagate the Montgomery spruce?

MODERATOR MEAHL: The report of Montgomery spruce was in the May 1 issue of the American Nurseryman in 1956. The Montgomery spruce is a chance seedling that was discovered and saved. Some of you undoubtedly have read about it. The article noted that cuttings could be successfully rooted which brings up the fact that we know from other experiments that certain plants will root readily, whereas, apparently the same kind that looks the same doesn't root. This particular plant has the ability to root readily having given as high as 90 per cent rooting.

MR. HERMANN ENGELMANN (Tipp City, Ohio): Approximately two years ago while working in Holland I became acquainted with a grower who grafted Blue spruce on field established plants in April. This procedure resulted in an 80 per cent stand, but results since have been mostly around 30 per cent.

I worked in the propagation department of the firm of LaFever in Boskoop, Holland There we propagated a large number of Blue spruce We planted our stocks around the 1st of May in an outdoor frame. About the beginning of August we brought these stocks inside the packing shed to dry them out. This seems to be very important to insure good results. After this we grafted the plant and placed them in an outdoor frame under double glass. In this way we got our best results, somewhere between 70 to 80 per cent.

MR VERKADE (Verkade's Nursery, New London, Conn): I would like to ask Mr. Ravestein if he cuts his scion on both sides or one side when he grafts.

MR. RAVESTEIN: I cut them very lightly on both sides.

MODERATOR MEAHL: I think we have had a very stimulating session, and I want to thank the gentlemen who have contributed to the success of this morning's meeting. I am sorry we don't have time for additional questions.

PRESIDENT VANDERBROOK. If you will all please be seated a moment there is one item I would like you to consider. I feel it should be brought up before the membership because it will be discussed at the Saturday afternoon business session Our secretary, Dr. Snyder has found that we are growing so fast as an organization that the work of editing the proceedings and taking care of the business end has become such a terrific job that he cannot do both jobs at the same time. Therefore, he contacted me and I in turn contacted the Executive Committee, giving them a full explanation of this suggested change. It was discussed by the committee, voted and passed, to bring before the membership the amendment to the By-laws, which you have already received. The recommendation was that the By-laws be amended as follows:

"Officers: At the annual meeting of the Society, the Organization shall elect a President and a Vice-President to serve a term of one (1) year. The Executive Committee shall consist of seven (7) members as follows: the immediate Past President, the President, the Vice-president, and four elected members. At the first annual meeting, two (2) members of the Executive Committee shall be elected for a one (1) year term and two (2) members elected for a two (2) year term. Thereafter at each annual meeting, two (2) members shall be elected to the Executive Committee to serve a two (2) year term. No officer elected by the Society shall serve for more than two (2) consecutive terms."

"The Executive Committee shall elect an Executive Secretary-Treasurer and Editor at each annual meeting. The Editor shall edit and prepare for publication the Proceedings of the annual meetings and the Newsletters of the Society."

"All officers of the Society shall serve without remuneration excepting the Executive Secretary-Treasurer and the Editor who shall each receive a salary determined by the Executive Committee."

Now think that over, gentlemen, and have your answer ready when we come to the business meeting Saturday afternoon.

We stand adjourned until 1:30 this afternoon.

The meeting recessed at 12:00 noon.

THURSDAY AFTERNOON SESSION

November 21, 1957

The second session of the Seventh Annual Meeting was convened at 1:30 P.M., President Vanderbrook presiding.

PRESIDENT VANDERBROOK: This afternoon, we will start with the paper entitled, "Propagation of Herbaceous Perennials and Annuals," and continue with a review of modern practices. The first speaker we will have is Mr. Phil Jones, Research and Plant Breeding Department, George J. Ball, Inc., Chicago, Illinois. Mr Jones!

Mr. Jones presented his talk, "Propagation of Herbaceous Perennials and Annuals." (Applause)

PROPAGATION OF HERBACEOUS PERENNIALS AND ANNUALS

PHIL JONES
George J. Ball, Inc.
Chicago, Illinois

The fact that Hugh Steavenson, Vice President of your organization, invited me to address your group, is an indication to me that many of you nurserymen do grow annual bedding plants and a good many of you who don't grow them are perhaps interested in getting into the field.

To start with, I would like to give a brief summary of bedding plant opportunities as they exist.

There is not any question that the market for bedding plants and ornamental plants of all sorts is greater today than in the not too distant past. The home owner's attitude toward the exterior appearance of his home is entirely different from what it was 30 years ago. Just for a moment I would like to quote to you from an article by Paul G. Craig which appeared in the October bulletin of the Ohio Florists Association: "There are a lot more customers around than there were a decade ago, and they have a lot more money to spend. There are today 33 million more persons and 8 million more families than in 1947. There is no let up in sight The population is growing at the rate of 3 million per year, one of the highest rates of growth in the world. Each of these additional persons has $300 more 'real buying power after taxes than he had in 1947, and each of the families has $500 more real purchasing power Census of business data show that florists are not getting their former share of the sale being generated by this increased income! Why not?" It seems rather obvious, that the "why not" is because the plant producers have not gone after the consumer's dollar as intensively as some of the other producers. Keep in mind in this competition for the consumer's dollar it isn't only your competitor or the florist on the other side of the town, but it is anybody who has anything to sell. If he can get the consumer's attention before you can, very likely he is going to separate him from his hard-earned "dough."

All right, let's assume then, for the sake of expediting time, that there is definitely a market. If it exists, it behooves us, if we are interested and want to get into it, to have concern for the merchandising policies or selling methods used to move the product. We must first know how to produce the merchandise and this is the subject which I would like to discuss briefly.

One of the advantages of growing your own plants to compete in this market is that you are able to select the variety of plant to suit your particular trade and climate. You are able to have plants at the time your customers want them, regulating this by when you plant your seeds. Thirdly, you can control the quality of your plants by your growing methods.

I might say by way of digression, our state colleges have been very instrumental in developing many of the cultural, streamlined methods by which growers have been able to cut their costs. Labor is the one big, single item of expense, and any method by which the labor cost can be lowered is certainly worthy of attention.

Let's talk for just a moment about production problems and discuss some of the newer methods being used today. The first general area might be seed germination. I am talking about annuals, such as petunias and snapdragons, the kind of thing people buy in the spring of the year and plant around their homes.

The seeds can be germinated, if they are not too old, in a soil-peat mixture or some other kind of medium such as neutral peat, finely shredded sphagnum moss, perlite or vermiculite, the latter being widely used for germinating seed. Many of the newer germinating media have definite advantages, since their structure is always the same and they are not subject to the vagaries of nature. They are all neutral, relatively free of organic matter and therefore, relatively free of disease organisms. They have no nutritive value. As soon as the seed has germinated in this medium you will be obligated to feed them with a liquid fertilizer.

The method we use for germinating seeds in our experimental greenhouses in West Chicago is to fill conventional flats about two-thirds full of ordinary sterilized, steamed, soil. This soil is then puddled with a hose until it is literally mud. This provides the reservoir of moisture which the seedling will need later. The next step is to place perhaps a quarter of an inch of a germinating medium on the surface of this mud. It may be neutral peat, it may be a mixture of sand and peat, or it may be any of several that I have already mentioned.

We usually drench with Panodrench, which will give us a flat relatively free of organisms. Of course, there are organisms which affect the plant even though the growing medium has been sterilized. However, this operation provides a buffer against any organism that may be introduced at a later date.

The flats are then marked with the word "growing" The next operation is the actual planting of the seed. Many growers sow them broadcast and are successful. We prefer to make shallow depressions an inch and a half apart and an eighth to quarter inch deep. We sow the seed in these shallow rows because we believe we can better keep the seed from drying out before germination and we can also control damp-off. Because damp-off generally starts in one spot, it is possible to confine its spread to the row in which it starts rather than to let it spread at random throughout the flat. Sowing in rows also enables you, when transplanting time comes, to handle the seedlings more easily than if it is sown broadcast.

The matter of temperature control for germinating seedlings is important. Most annuals like a temperature of at least 60 degrees for satisfactory germination. Areas in which this temperature is to be maintained can be provided with heating coils, steam or hot water, or if your operation is small, with electric heating cables.

Because moisture is so important during the germination stage, and the fact that it must be kept so uniformly has led to the development of special methods for maintaining a uniform moisture supply I have mentioned one in speaking of the reservoir of muddy soil under the thin germinating layer This technique has the advantage of being able to carry water up to the surface by capillarity which is activated as the surface dries out.

The use of either automatic or manually-operated misting systems has also proven to be a decided advantage in maintaining a good germination environment Very recently polyethylene plastic sheeting of nearly any size has come into the picture as a seedflat cover. Tucking the ends of the plastic under the ends of the flat will give you a uniformly high moisture level inside this enclosure at all times. It is important from the disease standpoint to get this polyethylene off your plants immediately after the seeds germinate.

Now, let's talk for just a few minutes about handling the seedlings after they have germinated. After they are a quarter of an inch or so in height, most annuals will benefit by moving them to a 50 degree greenhouse I was referring to a night temperature The day temperature will be perhaps 5 to 7 degrees warmer on a cloudy day and 10 to 15 degrees warmer on a sunshiny day. The plants will take water less frequently but more of it as the roots develop and go down. Here, the use of fermate is strongly recommended for control of the damp-off after the seedlings have germinated and been placed in the growing houses.

As far as our growing methods are concerned, they have not changed radically in the last several years. The same cultural procedures that were good ten or fifteen years ago are good today. The only thing new in the growing phase of the operation is the shift to and widespread adoption of the sand-peat mixture in place of soil for growing plants in containers and small pots The work in this country is based largely on the original work done at the University of California, in Los Angeles under the supervision of Dr. Kenneth Baker and carried on by a lot of his co-workers. The use of the sand-peat mixture has grown rapidly in California because of the high salt content that prevails in many of the soils which results from the surface irrigation they are obliged to use Then, too, the sand-peat mixture gives the operator a standardized medium which does not vary greatly from batch to batch. Those of us who use soil without knowing its properties, find our soil requirements, fertilizers, manures, and whatnot vary so much from year to year it is almost impossible to maintain a uniform growing medium. If soil is used, and I must admit most growers use soil today, it must be properly prepared If it is excessively sandy, you are going to have to add something to make it a little more stable, a little more firm, and a little more adhesive. Here, peat wtih the addition of some clay will help. On the other hand, if your soil is heavy you probably will have to loosen it up Peat and sand are the most commonly used media for this purpose.

Bedding plant merchandising is undergoing a minor revolution today. Many growers still practice the operation of seeding and growing large numbers of plants in flats. They dig the plant out from among the other plants and wrap it in newspaper for the sale. In the first place, it costs too much money to wait on people. In the second place, people are too impatient. So, we are growing bedding plants in small pots and small plant containers that will hold anywhere from a dozen to a dozen and a half to three dozen plants.

Another new thing in the growing of plants is the system of feeding all plants with liquid fertilizer at the time of watering. It isn't economical to dry-feed your plants Considerable time can be saved today by growing your plants in temperatures of 50°F. night, 90°F day, and perhaps putting them in the cold during the latter part of their growing period. The oldtime growers who started growing in cold temperatures and then hardened them off during the late spring, actually were just adding to the production cost. The whole operation has been speeded up consistent with the quality, of course.

I would like to enumerate what I consider to be the seven basic requirements for growing good bedding plants. These are negative in approach, and might better be termed the seven things you should not do, or seven possible causes for failure.

1. Poor physical condition of the soil A soil which is poorly aerated, poorly drained, tight and hard can't do much but result in trouble.

2. The seedling or cutting used was too hard or stunted. If you allow your seedlings to become overcrowded you can never expect them to develop into quality plants.

3. Starvation, or simply failure to provide plants with sufficient nutrients. I would say that is probably the prime reason for the majority of second and third grade plants you see on the market today.

4. Disease troubles. The various stem and root rots, while they may not completely kill the plant, in many cases can so hamper the development as to make it second grade.

5. Insects. For one, aphids can literally sap the life out of plants which were in prime condition the week before.

6. Lack of water. We are often too busy and fail to water plants as often as they require it.

7. Growing plants too cold. Actually, with most annuals when you get down to a night temperature of 40°F., photosynthesis and other plant processes practically come to standstill. The plant does not die, but by the same token, it doesn't grow.

Now that I have discussed some of the newer methods of growing and some of the short cuts that are used in plant production today, allow me to mention two other developments which will have a bearing on plant production in the future. Plastic greenhouses used to supplement the existing glass area are working out to the decided advantage of many growers. They are being used, generally, as temporary growing enclosures for a three- or four-month period in the spring of the year. The other development in growing quality bedding plants has been the production of new, improved varieties. I am sure all of you are familiar with the advantages that hybrid field corn has over the old, open pollinated types. They grow faster and yield better. Although yields do not mean anything to people who want flowers growing in their yards, it does to you who are producing the plants. For example, hybrids grow faster By reducing the time required to grow a crop you can delay your sowing and still have a quality plant to sell in the spring If you can save three or four weeks growing time, that, is money in your pocket. Hybrids are more uniform and more vigorous in growth. They present a more attractive piece of merchandise and they give your customer, the home gardener more satisfaction. With hybrids there is generally less mortality as a result of disease and other problems.

I would like at this time to tender an invitation to any or all of you to visit our place any time you are around Chicago, Illinois this coming summer. That concludes what I have to say. Thank you.

PRESIDENT VANDERBROOK: Thank you, Mr. Jones.

The next presentation is, "Present Day Practices in the Propagation and Culture of Perennials" by Kenneth B. Fisher, Kingwood Nurseries, Mentor, Ohio.

Mr. Kenneth B. Fisher presented his paper. (Applause)

PRESENT DAY PRACTICES IN THE PROPAGATION AND CULTURE OF PERENNIALS

Kenneth B. Fisher
Kingwood Nurseries
Mentor, Ohio

The term "perennial," when loosely applied, covers all plants which live for more than two years, and as such applies to woody, as well as herbaceous material. For our purposes today the discussion will be confined only to herbaceous material, for that, after all is the material accepted under the category of perennials by the trade. This broad classification includes probably 3 to 5 thousand varieties.

Even this definition is too broad, for in parts of the United States, such as the far South and far West, some material which is of a true perennial nature, must because of tenderness be treated as annuals in the rest of the country and Canada. Some of the plants in nursery catalogs which are listed as perennials are actually biennials, i.e., *Campanula calycanthema* (Cup & Saucer), *Digitalis* (Foxglove), and *Dianthus barbatus* (Sweet William) Other plants offered in herbaceous lists such as *Iberis* (Candytuft), *Pentstemon* (Beard Tongue), *Phlox*

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The propagation of perennials falls into the following three main categories: (1) by seed, (2) by division, and (3) by cuttings Other methods are used such as grafting and layering. Since many thousands of *Gypsophila* are grown in this country each year, grafting is done on a considerable scale. This method has been used almost exclusively insofar as the large flowering sorts are concerned, i.e. Bristol Fairy, the newer variety Perfecta, and the various pink flowered forms.

PROPAGATION BY SEED

As with most horticultural varieties, this method is not generally used, since the offspring do not come true unless, as in the case of Pacific Hybrid Delphinium, the production of seed is carefully controlled Fortunately, for the grower, there are many seed producers both in this country and abroad who carefully control seed production. As a result it is possible to grow from seed, named varieties of *Aquilegia, Dianthus* (Carnation), *Delphinium,* and the like Many of the herbaceous perennials offered by the trade such as *Delphinium belladonna, Coreopsis lanceolata,* and *Scabiosa caucasica* to name a few, are species which come true from seed. The following table lists perennials usually grown from seed.

Table I. — Perennials propagated by seeds.

Althea rosea	*Digitalis spp.*
Alyssum spp.	*Doronicum spp.*
Anchusa italica	*Echinops spp.*
Anthemis tinctoria	*Gaillardia spp.*
Aquilegia spp.	*Geum spp.*
Asclepias spp	*Gypsophila paniculata*
Campanula calycanthema	*Hibiscus moscheutos*
Campanula carpatica	*Iberis sempervirens*
Chrysanthemum max. Alaska	*Lavendula vera*
Coreopsis lanceolata	*Liatris spp*
Delphinium belladonna	*Linum perenne*
D. bellamosa	*L. narbonnense*
D. Bishop Strain	*Lychnis chalcedonica*
D. Blackmore & Langdon	*Oenothera missouriensis*
D Monarch Strain	*Papaver orientale**
D. Pacific Hybrids	*Platycodon spp.*
Dianthus barbatus	*Primula spp.*
D. Grenedin	*Pyrethrum,* single varieties & double mixed.
D Heddewigi	*Saponaria spp.*
D. plumarius	*Scabiosa caucasica*
Dicentra eximia	*Thermopsis spp.*
Dictamnus fraxinella	*Viola cornuta*
D. fraxinella alba	
Centaurea montana	

*Since this is a true species it can be grown from seed Better root systems are obtained from root cuttings All named varieties are grown from root cuttings

The time of sowing seeds depends on several factors. First, to be considered is the type of growing operation. The use of a greenhouse in the North for certain varieties, while not essential, enables one to start plants earlier, which might otherwise be too small to plant into the field the first season. A good example of this is *Campanula carpatica* and the *Geum* species. If one has only cold frames to work with, these same seeds would be sown in early spring rather than during the winter

Generally speaking, though, seeds are planted indoors in flats of good loamy soil mixed with peat and covered with either more of this same mixture or sand. Some of the very fine seeds, of course are just pressed in. Sphagnum moss can be used and I have seen very fine results obtained with *Helleborus niger* sown in sphagnum and stored in a cold house for two or three months before bringing into the greenhouse. Straight vermiculite makes a fine medium for sowing lupines. We have sown the seeds in this manner and kept them in the vermiculite until transplanted to the open field in early April in the vicinity of Mentor, Ohio. While we use sifted soil or sand for covering perennial seeds I know of one grower who makes rows in his flats with the edge of a lath, sows his seed in the rows and then covers the seed with Perlite. The use of Perlite he feels controls damping-off. One word of caution, however, the Perlite must be free of foreign materials. That offered for use in plastering often has other chemicals added to it which are injurious to the seedlings.

After the seedlings have developed their first or second pair of true leaves they are either potted or dibbled-off into other flats. Many of those plants which we pot could be dibbled into flats and later transplanted directly to the field if they could be handled early enough in the season. But not everything can be so handled and therefore we pot most of them, which stretches out our planting season. Formerly we used clay pots almost exculsively, and some bands. This last season we switched over almost entirely to peat pots, and found them more to our liking. As stated before, however, potted or banded material can go out later in the season, which is a definite advantage during the spring rush While we still hand trowel most potted items into field rows, some of those with larger tops can be set out with a mechanical transplanter, providing there is enough of one variety to go in to warrant its use.

In our area many items make up quite well by early spring sowing directly to field rows. Most plants so sown are of sufficient size the first fall. The list is long but includes: *Alyssum, Anchusa italiaca, Anthemis tinctoria, Aquilegia, Asclepias, Dianthus* (*Carnation*) Grenedin, *Centaurea montana, Chrysanthemum maximum* Alaska, *Delphinium, Dianthus barbatus, Digitalis, Echinops, Gaillardia, Gypsophila paniculata, Hibiscus moscheutos, Althea, Iberis, Liatris, Lychnis chalcedonica, Oenothera, Papaver orientale, Platycodon, Pyrethrum, Saponaria, Scabiosa, Thermopsis,* and *Viola cornuta.* Of these, if the season is poor for growing you might have to grow on for another season the following types: *Aquilegia* Crimson Star, *Iberis, Oenothera* and *Platycodon. Thermopsis* most always is a two year crop. *Dictamnus* very seldom is ready for sale until the third year. This latter item can be sown to the field in the late fall and it will germinate well the following spring. If it is grown inside it should be stratified.

The exact time for outside sowing is difficult to tie down since so much depends upon the season. Usually we start in early April. Such slow germinating or slow growing items as *Aquilegia* and *Delphinium* are always first on the list. Some large growing items such as *Anchusa italica* and *Centaurea montanna* are sown as much as two weeks later in order to control size.

If one does not have the time in early spring, many perennials can be sown in beds as late as July or August and the young seedlings transplanted to permanent locations in the field the following spring. But in order to get a good plant by fall they must go out very early, in our section of the country. Such items as *Aquilegia, Delphinium* and *Pyrethrum* lend themselves very nicely to this procedure.

PROPAGATION BY DIVISION

This is of course, a simple operation. In most cases perennials so propagated must be planted quite early in the spring, although with irrigation, timing is not quite so important. The following table lists those perennials commonly grown by this method.

Table II. — Perennials from division.

Achillea Angels Breath	*Iris kaempferi*
A. Snowball	*I. sibirica*
A. Tagetta	*I. spuria*
Ajugas spp.	*Lychnis viscaria fl. pl.*
Armerias spp.	*Monarda spp.*
Artemesia Silver King	*Myosotis spp.*
A. Silver Mound	*Pentstemon spp.*
Aster Harrington's Pink	*Phlox subulata*
Campanula carpatica Blue Carpet	*P. stolonifera*
C. c White Carpet	*Plumbago larpentae*
C. c. Wedgewood	*Polemonium spp.*
Chrysanthemum maximum Aglaya	*Primula spp.*
C. m. Esther Reed	*Pyrethrum* named double.
C m. Majestic	*Salvia pitcheri*
C. m. Mark Riegel	*Sedum Acre*
C. m. Mount Shasta	*S. spectabile* Brilliant
C. Hardy Garden Sorts	*S. spurium*
Dianthus caesius	*Thymus spp.*
D. deltoides	*Tritoma spp*
Dicentra spectabilis	*Veronica amethystina*
Eupatorium spp.	*V. incana*
Helenium spp.	*V rupestris*
Heliopsis spp	*Vinca minor*
Hemerocallis spp.	*Viola cornuta* Catherine Sharp
Heuchera spp.	*V. c.* Purple Glory
Hosta spp.	*V. odorata* Royal Robe
Iris germanica	*V. o* White Czar

It is difficult to give the size of the division necessary even for one specific plant, since it depends so much on location, soil, weather and time of planting. Generally speaking, the earlier planted division can be smaller. With *Dicentra spectabilis*, one eye is sufficient, but it must be planted as soon as the soil is workable. With such fast growing items as *Artemesia* Silver King, and *Eupatorium*, one runner is sufficient to have a salable plant by fall. Another factor controlling size is scarcity of stock and how quickly you want a salable plant. As long as the division has a root or two or even latent root buds, if it is set out early enough and other conditions are satisfactory, it will take hold. However, such very small divisions may take two seasons or even three to make salable plants. In our nursery, on the other hand, we have some trouble with *Phlox subulata* varieties, particularly such robust types as *Phlox subulata alba* and *Gayi*. If planted early in the spring a small division, with a few roots, becomes almost too large by late fall or the following spring. Garden chrysanthemums make a salable plant by fall if only one runner is planted as late as mid-June in the Mentor area (this is without irrigation). Only with experience under local conditions can the propagator get an idea of the size necessary for the production of salable plants, in one season.

PROPAGATION BY CUTTINGS

This method of propagation can be broken down into two categories, i.e., top and root cuttings. The perennials grown from these two types of cuttings are listed in tables III and IV.

Table III. – Perennials propagated by root cuttings.

Anchusa myosotidiflora	*Polygonum reynoutria*
Papaver orientale	*Rudbeckia* The King
Phlox decussata	*Stokesia* Blue Moon

Table IV. –Perennials propagated by top cuttings

Artemesia Silver Mound	*Platycodon*, double varieties
Aster Frikarti	*Phlox suffruticosa*
Carnations, named Varieties	*P. subulata*
Chrysanthemums, Hardy Garden	*Santolina spp.*
Dicentra spectabilis	*Sedum spectabile* Brilliant
Gypsophila, named Varieties	*Teucrium spp.*
Iberis Little Gem	*Veronica* Blue Spires
I. Purity	*V* Crater Lake Blue
I. Snowflake	*V.* Icicle
Lythrum spp.	*V.* Minuet
Pachysandra spp.	*V. Longifolia subsessilis*
	V. Sunny Border Blue

Of the plants from root cuttings only the *Papaver orientale* is made in the late summer when the plants are dormant. The roots from one year old plants furnish the most and best material. The roots used should be about an eighth of an inch in diameter for best results. The pieces are made about an inch to an inch and a half long and kept upright, since most nurserymen plant directly to 2¼ inch pots. These are then placed in a cold frame where they root and are carried over winter prior to field planting in early spring. In propagating *Polygonum reynoutria* we literally chop up the root sections which have large dormant buds. This is done in early spring and the pieces (about 1½ inches long) are planted directly to the field. *Anchusa myosotidiflora, Phlox decussata, Rudbeckia* The King, and *Stokesia* Blue Danube and Blue Moon are handled somewhat alike. It is best to dig the plants, with some soil, in late fall and store in a cold house until after the first of the year. Although some freezing will not hurt the plants, make certain that you can get to the plants when propagation time comes around. If freezing has occurred thaw them out gradually. Some growers sow their root cuttings in benches in a cool greenhouse, covering with about one inch of soil or sand Other prefer to stand the cuttings upright in rows in grape crates or similar boxes with an inch or two of soil between each row This latter method allows for mobility in the greenhouse and is especially useful if one is lacking bench space. In addition, it also facilitates spring planting since the boxes can be taken directly to the field for planting.

We take top cuttings of *Artemesia* Silver Mound in the winter from forced plants. This variety can also be divided We find however, that with our soil, divided plants often become overly large in one growing season. We therefore prefer to root cuttings during winter and pot or band them. Such plants make up very well after one season in the field Here again if we took very small divisions quite early in the spring we would achieve the same results, although as we know not everything can go out the first week of planting We usually force plants of *Aster Frikarti* during winter and make cuttings at that time. This last September we stuck cuttings in flats of vermiculite and put them under our mist system. They have rooted well and we hope they will now carry along in our greenhouse to be potted later and go to the field this coming spring We have also stuck some *Veronica* Icicle, *V longifolia subsessilis,* and Sunny Border Blue in our outdoor mist system this past July. They rooted well and we intend to leave them there until next spring In the past, these have been made from plants forced in the greenhouse We have always been plagued with the Leaf Spot disease to some extent The infestation is not noticeable on field plants although when material is brought into the confines of a greenhouse it becomes quite apparent. It is our hope that those in the outdoor mist will carry over winter, outside. If so, that will probably become our standard operating procedure. We have done this with *Dicentra spectabilis* with very fine results. One definite advantage of using mist for *Dicentra spectabilis* is that the cuttings do not have to be soft. Soft cuttings will root but so will those that are fairly hard. After rooting, the tops die off and apparently the crop is lost. However upon examining you will find new buds have formed and if left in the frame over winter they are ready to go to the field in early spring

We use standard procedures insofar as other top cuttings are concerned. Most of our carnation cuttings are made in November or December. If we have sufficient plants in the field we just cut off the tops and bring them in to make our cuttings. If it is a variety of which we do not have enough cutting material, we dig some plants for forcing As with most perennials we use Rootone F After rooting they are potted or banded for field planting in the spring. We have already made our *Iberis* cuttings. While they can be made later, we make them at this time in order to obtain larger plants. Fast growing varieties of *Phlox subulata* are propagated by cuttings, since spring divisions give us too large a plant by fall. Such cuttings are made in late March and planted to the field about one month later. *Phlox suffruticosa* is propagated by inserting the dormant shoots, about an inch long, into the sand with just the tip showing. This can be done anytime from very late fall or early winter to early spring. We use somewhat the same method with *Lythrum*. While we have forced old plants in the greenhouse for top cuttings we also find that if the soft top growth of spring is cut, they can be rooted inside in sand and planted directly to the field. We have taken these cuttings as early as April and as late as June with equally good results.

In discussing plants from divisions I have failed to mention that insofar as *Armeria* and *Lychnis* are concerned, we find that if crown divisions are made in December and January, stuck in flats of vermiculite, and then placed in a deep frame, that they will root nicely by spring.

Knowing that I have not kept up to date with practices being used outside my own area I canvassed a number of nurseries which are growing them From the correspondence and telephone conversations I garnered some very worthwhile information. From material supplied by Bill Cunningham of Cunningham Gardens, in Waldron, Indiana the following information was especially interesting It seems they grow around 20,000 *Gypsophila* Bristol Fairy each year They have discontinued grafting, in favor of cuttings These are made in the fall and spring and placed under mist. The rooting medium is composed of ⅔ coarse sand and ⅓ peat. They mix 50-50 fermate and Hormodin #2 for dipping their cuttings. Good plump cuttings are taken from field plants in September and October. These are stuck in the greenhouse bench which is equipped with a mist system using Florida 550 series nozzles The mist is on for 18-20 seconds and off 20 minutes. The cuttings are exposed to full light After rooting, the cuttings are potted directly into peat pots and grown on in the greenhouse In the spring, sometime in April or May, cuttings are made from these pot plants in the same manner as mentioned. When pot bound these and the fall potted plants are set in the field. This method gives a very fine plant by the end of the growing season. Such plants, Mr. Cunningham, admitted, might be too large for mail order and advised that cuttings taken in June and rooted at that time would be ideal for this type of outlet. Last year Mr. Cunningham made an experimental planting of Hardy Phlox (*decussata*) in peat pots They orginally were root cuttings made in the conventional manner Instead of planting to the field, some 50,000 were planted into 2¼ inch peat pots using a loam potting soil. They were set in 6 foot frames, 4 to 5 inches apart. These were then mulched in with a mixture of ½ sand and ½ peat. Weekly feeding was accomplished by means of a liquid fertilizer. Response was so good that they intend to expand this phase next year.

Mr Roderick W. Cumming of the Bristol Nurseries offered the following information: "We are now grafting all *Gypsophila,* such as Bristol Fairy and Perfecta, on roots of either Bodgeri or Rosy Veil. These two understocks, of course, must be grown from cuttings preferably for one full year in the ground. We find that the roots are more fibrous and not as long and unmanageable as those frequently encountered from grafts of *Gypsophila paniculata,* which is the standard procedure. Therefore, they are much more readily shipped in plastic bags during the spring season. We have also found that it is no trick at all to root Bristol Fairy under mist, especially if dipped in indolebutyric acid. The roots of these plants, however, become so very long after a year in the ground that they are completely out of the question as mail orders items" "Some of the members may want to engage in the asexual propagation of *Platycodon,* particularly some of the newer double types. Our method now is to cut the old plants back just as soon as they flower enough to be identified for mixtures. This would commonly occur about late July and the stems are cut back to about one foot. Then by Labor Day they have made a large number of short cuttings from the leaf axils and these root very readily under mist treated with some kind of hormone, by October 1st. Of course, the increase must be carefully protected over-winter in a frame, but in view of the difficulties we once had in introducing our own doubles, it is much simpler today."

Mr. Pitzonka of Pitzonka's Nursery in Bristol, Pennsylvania wrote that most everything they do is standard procedure. He did say that for *Asperula,* the plants are brought in during the winter and planted. As the new shoots sprout they are cut and rooted in sand. Most of their propagating is done during December and January in a semi-cool greenhouse. Day temperatures should go no higher than 80°F. and night temperatures no lower than 58°F. Bottom heat is essential for good rooting. The following paragraph is quoted from Mr. Pitzonka's letter: "When transplanting young perennials, it is essential to plant into a sterilized soil medium since it may contain nematodes, weed seeds and disease organisms that tend to lower plant quality and size. We use chloropicrin in areas where we have ample water to seal the ground and methyl bromide elsewhere, using plastic covers to restrict the loss of the gas"

PRESIDENT VANDERBROOK: Thank you, Mr. Fisher for a very informative and complete presentation on the subject of perennial propagation.

MR FISHER: There are two gentlemen in the audience on whom I would like to call to supply additional information on this subject. Mr. John Sjulin of Interstate Nurseries, wrote me and commented on storage procedures for divisions and layers. Rather than to have read his letter in my formal presentation I am wondering if Mr. Sjulin would comment on this subject?

MR. JOHN SJULIN (Interstate Nurseries, Hamburg, Iowa): Well, as I wrote in the letter, we take our divisions or layers and rather than store them over winter in flats we put them in a box in the freezer. Actually the divisions are taken late in the fall. These are then placed in polyethylene bags, packed in wirebound boxes and put in the freezer room. We have had the freezer down as low as 26 and have not had any damage. We never allow the room to go above freezing for any length of time.

MR. FISHER: Thank you, John. In the November 1st, 1955 issue of the American Nurseryman there appeared an article entitled "Mist Spray Growing and Nutriculture" by Clarence Vanderbrook The actual work was carried on at the C. W. Stuart & Company establishment. Mr. Henry Weller of this firm is here and so I would like to call upon him for comments at this time.

MR. HENRY WELLER (C. W. Stuart & Co., Newark, New York): Aside from our field operation for the past four or five years, we have been growing perennials from the cuttings to maturity under intermittent mist. With our chrysanthemums, the cuttings are taken approximately in the second week of July. We use a 3x5" plastic bag. The mist runs approximately one minute on and five off, during the rooting period. After that, we break down the period, operating it one out of ten. As soon as the cutting has rooted we start feeding. We use a water soluble plant food, which contains the basic nutrient elements. This is continued once a week to September first, after which it is gradually cut down, with an idea in mind of hardening off the plants before shipping. Prior to shipping, through August, in the case of chrysanthemums they are clipped back or nipped three or four times to wind up with a plant six to eight inches in height in full blossom

MR. FISHER: Thank you very much Mr. Weller.

PRESIDENT VANDERBROOK: The next presentation is "New Concepts in the Pot Culture of Perennials," by George Rose, Henry Field Seed and Nursery Co., Shenandoah, Iowa. Mr. Rose!

MR. GEORGE ROSE (Henry Field Seed & Nursery Co., Shenandoah, Iowa): This talk, gentlemen, will be concerned mostly with the production of chrysanthemums. The reason for this is that I think I can give you a little more continuity if I follow through our efforts to develop this one type of mail order plant. Our firm is a mail order retail firm, and as such, our growing and production schedule must be fitted for this type of business. Therefore, some of the material I will present will not be applicable perhaps to your own business.

Mr. Rose presented his paper on "New Concepts in Pot Cutlure in Perennials" (Applause)

NEW CONCEPTS IN POT CULTURE IN PERENNIALS

George Rose
Henry Field Seed & Nursery Co.
Shenandoah, Iowa

Last year Dr. John Mahlstede of Iowa State College carried out a research project for the National Mail Order Nurserymen's Association on the shipping and livability of hardy perennial plants. Perennials of several varieties were purchased from 20 mail order nurseries, without their being aware that the plants were being tested Differences in shipping methods, the type of plants sent, and the livability of the material when planted under ordinary conditions, were all carefully studied and compared One of the rather unexpected highlights of the test was a disclosure that potted plants almost invariably shipped better and had a higher survival than dormant bare-root plants, no matter how such plants were stored, packed or shipped. These weren't exactly joyful tidings as far as the mail order industry was concerned, for potted plants cost more to grow, more to pack and more to ship, than dormant bare-root material. But in this age in competition, the ultimate factor that determines who stays in business, and who doesn't, is customer satisfaction. The mail order nurseryman isn't the only member of the trade who should profit by these particular research findings. Anyone in any wholesale or retail segment of the nursery trade, who produces and ships hardy perennials could well look to his own house. The same findings will also probably apply in his case.

Now the potting of perennials isn't a new idea born in this age of rockets and sputniks. Various types of perennial plants have probably been potted ever since the invention of the potter's wheel. In comparitively recent times, three firms in the United States have made clay pots continuously for over 100 years. Whether they are all in business at this time, I do not know — they were or are — A. H. Hughes & Co., J. M. Thorburn Company and D. Landreth and Co. Prior to 1864, common flower pots throughout the world, had always been made by hand on the potter's wheel, which was propelled by foot or hand power. William Linton of Baltimore, Maryland, perfected and patented the first flower pot-making machine about 1865. Since that time steady improvement has been made in the preparation of the clay and the manufacture of the pot. Today, we have available throughout the country, a smooth, well-made clay pot, in a complete line of standard sizes.

In the matter of the production of potted hardy perennials for mail order sales, however, clay pots have distinct disadvantages and limitations. One, they are heavy and the handling of large numbers of them entails continued movement of a great deal of weight in pot alone. Two, they break easily and must be handled with a great deal of care. Three, because they are porous they are a haven for nematodes and the spores and bacteria of many plant diseases. Four, because of this same porosity, they are very difficult to sterilize, expensive steam sterilization under pressure being about the most satisfactory method. Five, because of the necessary thickness of the pot walls, the pots themselves take up a very great deal of bench, frame, or bed space. Six, plants cannot be shipped in the clay pot that they are grown in because of the weight and fragility of the pots. Plants grown in clay pots, must be knocked out, wrapped in paper, or reset in paper shipping pots before boxing for shipping. This entails a considerable expense in time and money, and in addition, is apt to loosen many of the pot balls, so that the customer is very likely to receive a bare root plant and a handful of lose loam.

Before proceeding further with this talk, I would like to make one necessary differentiation. The subject assigned to me is "New Concepts in Pot Culture of Hardy Perennials." This talk, therefore, will deal entirely with perennials grown in pots, as differentiated from perennials grown in what is generally known as a container. For present purposes, we will define a container as being 6 inches or larger, made of tar paper, such as Cloverset pots, and Mennipots, or metal containers of one sort or another

I doubt there are many firms that ship all, or even any large percentage of their hardy perennial production, either wholesale or retail, in or knocked out of pots, because of the difficulties already mentioned, plus the added expense of the weight of the soil in the pot balls. In our own firm, the shipping of potted perennials in volume really began quite a few years ago when we decided that small potted chrysanthemums from softwood cuttings, or stolon pieces, gave far better results in the hands of the customers than over-wintered, field grown plants. Also, it was no easy trick to succesfully over-winter field grown chryanthemums in storage in those days when we had little in the way of refrigeration.

As is true of any procedure, there were some objectionable features to growing and shipping potted chrysanthemums, and we started at once to try to overcome them There were the previously mentioned difficulties caused by the use of clay pots, plus the added cost of handling and postage caused by the weight of the potting loam We learned that during the second World War, the Army had developed the use of ground sphagnum moss as a light weight potting medium, in order to fly large quantities of experimental plants in airplanes. We began potting chrysanthemum rooted cuttings, or rooted stolon pieces in a sphagnum moss potting medium fertilized as needed with liquid fertilizer, with very satisfactory growth results. The plants grew as well, or better than in ordinary potting compost, and the pot ball weighed about 1/5 as much. It was at this point that we experienced a new difficuty, however, in that many of the plants when wrapped and packed, reached the customer in a rotted condition, seeming to rot at the base of the plant, and in the section in the moss. From Dick Fillmore, who was at the Arnold Arboretum at the time, and who was growing test plants in a moss medium for shipping to other research centers throughout the world, we learned the source of our trouble. We do not fully understand the processes, but it seems that when the entirely organic sphagnum moss in the pot ball is entirely enclosed in a shipping container, heat is generated, and anaerobic bacteria multipy and cause deterioration of the soft plant stems in short order. Mr. Fillmore suggested the addition of finely ground styrofoam to the potting medium of about ¼ volume. These inert plastic particles would separate the ground sphagnum moss particles and prevent the trouble that we were having. It worked, and we have used a mixture of ¼ fine ground styrofoam and ¾ ground sphagnum moss for small pots and soft stemmed plants ever since.

The next problem we tackled was the pot itself. We not only wanted a pot in which we could grow and ship chrysanthemums, but we wanted that same pot for general all-purpose use, and re-use. We wanted a cheap, and thus expendable, light weight pot that could be easily sterilized, and re-used if desired, which would take up less space in the bench than a clay pot, and which would provide proper aeration and moisture drainage to produce plant growth as good or better than a clay pot. That was a large order At that time, we were growing in a 2″ clay rose pot. We knocked the plants out of them, dropped the plant balls into Neponset shipping pots, and wrapped the plants in waxed paper for shipping. It seemed to us this method was unnecessarily slow and expensive., The practical solution seemed to be to grow and ship in the same pot.

About this time many new type pots were coming on the market, and we tried all of them — aluminum, plastic, compressed pulp, compressed peat, dehydrated compressed cow manure, tar paper, Dixie cup types and heartwood bands. As soon as a new pot came out we bought a sample lot and started testing. We have tested better than 25 different types of pots. None of them would fulfill all of our requirements. From most of the pots we could not get the growth that we could with clay pots. Others were too thick and clumsy. Many of the compressed pulp, peat and cow manure pots eventually absorbed water and became too heavy, or disintegrated before we were ready to ship. In addition, we found the cost too high with some, many of them could not be sterilized and reused, and some that apparently should be the perfect answer to our problem, would not produce plant growth that would begin to compare with that of a clay pot. We finally narrowed down to plastic and aluminum, as it seemed that one of these materials ought to provide the pot that we were seeking. Plants would not grow well, however, for any length of time, in either aluminum or plastic 2″ rose pots. Finally, we decided it might be a matter of aeration, and cut a series of slits in a quantity of aluminum and a quantity of plastic 2″ rose pots The aluminum pots never did quite make the grade, and we suspect some toxicity from the metal. The ventilated plastic pots, however, produced plant growth as good as that of a clay pot, or better, had less moisture loss from the potting media, yet lost excess water quicker, and fulfilled all the requirements previously enumerated. We now grow practically every plant we pot in this ventilated pot, including a full line of house plants, and our softwood cutting deciduous liners. We have over a million in use at the present moment and would not trade them for any pot on the market.

We still were bothered with the bottom leaves of the potted chrysanthemums turning brown and dropping off in shipping before they reached the customers. Through research done for a sponsoring group of Iowa Nurserymen by Dr. John Mahlstede of Iowa State College, we learned that we should not use waxed paper to wrap the plants, but that the proper material to use was polyethylene film. We also learned that polyethylene film should not be wrapped around the chrysanthemum plant itself in shipping in moderately warm to warm weather. We now drop our plants growing in a sphagnum and styrofoam potting media in a ventilated plastic pot, into a polyethylene boot, which just encloses the pot and the pot ball. We snap a rubber band about the boot to close it over the top of the pot,and thus the chrysanthemum plant itself is open, and the pot and pot ball are enclosed in a polyethylene container to retain the moisture in the pot ball.

We next tackled the label problem You know the trouble connected with trying to label pot plants and keep the labels where they belong as well as I do. If you stick labels into the soil in the pot, they get knocked out. Often you can't attach them to freshly potted stock because the plants are too small, or there is no place to hook or tie them. If you wait until you ship the plants to label them, you have to stick the labels somewhere in the package, or tie it on some place. Labels often get lost, plants get mixed up, and there seems to be no safe way out of the mess. It seemed to us that where we had our plants growing in the same pots in which they were going to be shipped to the customer, we ought to be able to label the pot somehow. We finally hit upon the idea of printing the plant names, continuously, on rolls of paper-backed adhesive tape. By spacing the printing properly, and using a good tape dispenser, we were able to chop labels off a roll of tape as fast as we could use them. Due to the fact that the pots are plastic, and no moisture can get behind the tape, it sticks to the pot indefinitely. As it works now, if we are potting 1000 plants of a variety, we stick labels on 1000 pots before we start potting. That method has several advantages When all the labeled pots are used, we know without further counting that we have 1000 plants potted. Also, from the moment that the plant goes into that pot, there is absolutely no possibility of further confusion regarding the variety of the plant. It is permanently labeled. Of course, if you have a heavy loss of potted plants, you automatically lose the labels too, but we think that such losses are entirely over-weighed by the many advantages of the system. Now if any of our plants are not true to name, we know that the mixup had to occur prior to the potting, and there is far less chance of that than there is ordinarily, of mixups after potting.

One thing still bothered us and that was the fertilization of our potted material. We used to fertilize upon potting and then repeat in a hit or miss fashion as the plants began to look hungry. Finally, we bought a Solubridge Electronic Soil Testing apparatus, and it is one of the best purchases we ever made. As we began to use it, we immediately realized that without some such device, it is impossible to properly feed plants We found that in waiting as we had before, until the plants looked hungry, we were waiting far too long and it took the plants a long time to regain their vitality, after the periods of starvation that were being imposed upon them. We also found that if you fertilized regularly with no information as to what is going on inside the pots, often in cold, cloudy weather, dangerous build-ups of nitrogen, can occur. We found that in 2″ rose pots, where either compost or sphagnum is used, that most of the available nutrients are leached out in three waterings. We now soil test everything regularly and fertilize accordingly.

It seemed as though there ought to be some sort of a delayed action, slowly available fertilizer, that would cut down the need for frequent fertilizings, and therefore, cut costs. When Uramite and Borden's 38 came out, we immediately tried them. We have a test lot of plants fertilized with Uramite started May 1, 1957. These plants showed 25-30 PPM available nitrogen (Spurway system) when we started, and still show 25-30 PPM. Our tests with Borden's 38 have not been underway as long but also continuously show 25-30 PPM. We think this is the answer to our fertilizer problem, and if so, it will tremendously lower our fertilizer and labor costs. As with any other operation, this method of fertilizing is not perfect, nor entirely safe. In our opinion, without a good soil testing unit, used regularly, this slowly available fertilizer can be extremely dangerous to the plants, as some users have already found out. I recall that after our trials with one of these fertilizers had been under way for a couple of months, and progressing very satisfactorily, the available nitrogen content in the pots suddenly shot up to the danger point. We immediately watered the pots heavily, and leached out the available nitrogen. That is when we learned what could happen in cold, cloudy weather with these slowly available fertilizers, and that, when using such compounds, you must be particularly careful in your soil testing during such weather conditions. We also learned that a particularly dangerous situation will arise during cold cloudy weather, if there is an unbalanced nutrient relationship in the potting media, particularly if the media gets low in potash.

After we thought that we were pretty well along with our chrysanthemums, we began to grow the Hardy Aster varieties the same way, and were equally successful with them. We also grew *Artemesia* Silver King, *Helianthus* Loddon Gold, and *Heuchera* varieties by this method It is our belief that we can eventually expand this method of growing perennials to incude most of those we list.

We have often been asked if growing plants in sphagnum moss caused any trouble after the plants are planted in the field. I have often gone up and down rows of chrysanthemums in which part of the plants were from sales stock grown in sphagnum moss, and part were grown in flats of loam for planting, and were cut out in squares and planted along with the potted material, and I have yet to be able to tell which plant had been grown in the sphagnum medium and which had been grown in the loam. A plant that is seriously pot-bound in a sphagnum medium will react the same way as a plant that is seriously pot-bound in loam when knocked out of the pot and planted directly into the field. Unless the roots are torn up somewhat, and are spread out a bit, the plant is going to have a troublesome time growing, and always will have a ball of roots at its center.

According to our cost accounting figures, our growing, processing and shipping costs for field grown perennials shipped dormant and bare root, break down as follows: (1) Growing in the field — 44.80% of the total growing and shipping cost, not including postage. This includes: propagation stock, payroll, depreciation of trucks and equipment, maintenance and repairs of trucks and equipment, employee insurance, payroll and property tax, rent of land, water, light and power, fuel, truck and tractor operating expense, and truck licenses. (2) Processing expense — 36.59% of total cost of production and shipping, not including postage. Processing expenses are the preparation of plants for shipping, and the storing of material until needed for shipping. They include: payroll, processing supplies, maintenance and repair of equipment, employee insurance, payroll and property tax, rent, water, light and fuel. (3) Shipping costs — 18.56% of total production and shipping costs, not including postage. Shipping costs include: payroll, shipping supplies, maintenance and repairing of equipment, employee insurance, payroll of property taxes, light and fuel.

In all probability, hardy perennials cannot be grown as cheaply as potted plants, as they can be in the open field. We do not have a cost breakdown on the pot perennial plant phase of our business, but perhaps the difference in cost between pot grown and field grown perennials may not be so different when you stop to consider that the processing of a dormant perennial costs almost as much as the growing of it. There is very little processing cost of a potted perennial. Shipping costs, of course, would be considerably higher. On the other hand, the more favorable appearance of the potted plants when received by the customer, and the increased livability, have a considerable value, it seems to me. I believe a very sizeable hike could be made in the price of ordinary perennials potted against dormant stock and the customer would willingly pay the difference. Such an increase would no doubt cover the increased cost of production and shipping, and also increase the profit per plant.

PRESIDENT VANDERBROOK: Thank you very much, George, for a very informative discussion I am sure all of us here are somewhat amazed at the strides that have been made in growing and packaging plants for dissemination and shipment.

As we are running very short on time, we will only allow five or ten minutes for questions. So if you have specific questions for either one of the panelists, please present them now.

MR. BELDON SAUR (Rocknoll Nurseries, Morrow, Ohio): Mr. Rose, are your plastic pots available in any sizes other than two inches?

MR. ROSE: No, they are not. Making a mould costs about $5,000 and you don't make many at that price. Eventually, we hope to make a three inch one.

MR. GEORGE BLYTH: Last year we found some roots coming out of the slits in the sides of the plastic pots. Did you experience anything like that?

MR. ROSE: Yes, but we haven't found that it hurt us much. May I say that I am not selling pots since we developed them primarily for our own use.

MR. BLYTH: When we shipped chrysanthemums this year the plants all came out of the pot by the time they got to the customers and as a result we had an awful lot of complaints.

MR. ROSE: Did you enclose the chrysanthemums in anything?

MR. BLYTH: Yes, we wrapped the root ball in plastic bags. When we took the plant out of the bed I think likely they cut the roots, which was the main part of the trouble. Some of the pots that were packed good and tight were better than the ones that weren't packed so tight. Do you pack the pots good and full with moss?

MR. ROSE. Yes, we do. These pots are extremely thin since we want them that way for lightness and cheapness. There is one danger when you turn a potter loose with the plastic pot who is used to the clay type. He will break many before he finally develops the touch. Since then we have found, and I imagine you have also, that you do not have to pound the plant in there like you were making a brick You aren't doing that. You are trying to pot a plant. If you will pot it gently, the way you should, you won't get any breakage at all. We do not pound the medium.

MR. BLYTH: How do you handle your shrub cuttings?

MR. ROSE: In the greenhouse bench we use only about a quarter inch of sand on which to place our pots containing the rooted cuttings. Actually, you don't have to use anything since they do not lose enough moisture. For deciduous shrub cuttings which were rooted under mist and then potted, we put them into outdoor frames and work sand in all around them for winter protection. They are entirely submerged in sand up to the top of the pot from late fall until the time they are taken out.

MR. HOOGENDOORN (Hoogendoorn Nurseries, Newport, R I): Does that retain the moisture so that they can go all winter without watering?

MR. ROSE: Yes. They are out in frames and they freeze up. No watering is needed

MR. HOOGENDOORN: I would like to ask Mr. Fisher, how he handles *Helleborus*?

MR. FISHER: We do not have *Helleborus* as such, but as I stated, one fellow in our area who grows a considerable quantity of the plants puts the seed in flats of chopped sphagnum moss, holds them in his deep cold house for two or three months and then brings them inside. He seems to have no trouble.

MR. ROGER SHERMAN (Elsberry, Missouri): Mr. Rose brought out his technique for labeling potted perennials. I am interested in knowing how Mr. Jones is labeling damp, band packs.

MR. JONES: Ordinarily for the fellow who sells them at retail level we have devised lithograph colored, waterproof, wedge-shaped paper labels. You do have the problem Mr. Rose spoke about, in that those labels could be misplaced.

PRESIDENT VANDERBROOK: Sorry, gentlemen, I have to interrupt the question period. Our time is at such a premium we will have to proceed with the next presentations I would like to have Mr. Bill Cole come forward and take charge of the next panel.

Mr. William D. Cole, The Cole Nursery Company, Painesville, Ohio, took the chair.

MODERATOR COLE Our first talk is by Dr. L. J. Enright, Department of Horticulture, University of Maryland, on "Vegetative Propagation of *Mahonia Bealei*." Dr. Enright[1]

Dr. Enright presented his paper. (Applause)

VEGETATIVE PROPAGATION OF MAHONIA BEALEI

L. J. Enright
University of Maryland
College Park, Maryland

Although *Mahonia bealei* can be propagated by softwood cuttings under glass, the percentage of success, the time required for rooting and the short period during which cuttings can be taken, have helped to place this plant on the long list of "difficult" woody ornamentals. The variability of seedlings also adds to the need for a propagation method which would produce strong rooted cuttings in a short period of time. Investigations at the University of Maryland have led to interesting responses by a number of woody plants during the past two years. Because it has been possible to stimulate roots on plants heretofore considered almost too difficult to propagate commercially, it was decided to try several of the techniques and methods on the Leatherleaf mahonia.

Cuttings were taken from mature plants and cut to a length of eight inches. In an earlier test it was discovered that all root development on this plant originated at a node For this reason, the treated cuttings were wounded at a node, immediately below a node, for one and one half inches below a node, and over an area which included a node and the area one and one half inches below it The original plan was to slice a thin portion of the bark to induce a wound but the material was so resistant to such treatment that abrasion with a coarse sandpaper block was used for the wounding treatment.

Several chemical root stimulants were used in the investigation but root initiation was brought about only by action of concentrated solutions of indolebutyric acid and water Solutions of 5,000 parts per million, 10,000 parts per million, and 20,000 parts per million indolebutyric acid were used as ten second dips of the basal portions of the cuttings After treatment, the cuttings were placed in a sand filled greenhouse bench under a system of intermittent mist. One hundred cuttings were used in each treatment of this investigation. Cuttings were taken on June 15, July 6 and August 10.

Of the cuttings made in June, none rooted in the check or the 5,000 parts per million IBA treatment In a period of 59 days 70% of those treated with 10,000 parts per million IBA and 97% of those treated with 20,000 parts per million IBA were rooted. Those taken on July 6 did not root in the check, while 2% rooted in the 5,000 parts per million IBA treatment, 74% rooted with 10,000 parts per million IBA, and 100% rooted with 20,000 parts per million IBA treatments. These rooted in 51 days. The cuttings taken in August responded in a similar manner in a period of 52 days. Treated with 5,000 parts per million

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Several chemical root stimulants were used in the investigation but root initiation was brought about only by action of concentrated solutions of indolebutyric acid and water Solutions of 5,000 parts per million, 10,000 parts per million, and 20,000 parts per million indolebutyric acid were used as ten second dips of the basal portions of the cuttings After treatment, the cuttings were placed in a sand filled greenhouse bench under a system of intermittent mist. One hundred cuttings were used in each treatment of this investigation. Cuttings were taken on June 15, July 6 and August 10.

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IBA they rooted only 1%, the 10,000 parts per million IBA dip induced 66% rooting and the 20,000 parts per million IBA treatment resulted iin 99% rooting. None of the August check cuttings rooted The roots stimulated by the weakest solutions were minute and solitary, while those produced from the intermediate strength dip were one to two inches long and in numbers of ten to fourteen. The most concentrated solutions induced roots two to five inches long in numbers up to twenty six per plant.

It is interesting to note that wounded basal sections did not respond to chemical treatment unless the node had been similarly wounded If a node was wounded and the area below it was wounded, (but the two areas were not connected), roots were initiated only from the node. On the other hand, if the node was wounded and the basal portion was wounded in the same way, and they were united, roots developed from the top of the node to the bottom of the basal wound. It appears that concentrated solutions of indolebutyric acid may prove to be the answer to the problem of rooting cuttings of *Mahonia bealei* profitably on a commercial basis.

MR. PINNEY, JR.: Dr. Enright, you mentioned a water solution of growth substance. As I understand it, IBA or indolebutyric acid has to be dissolved in ethyl alcohol. Am I mistaken?

DR. ENRIGHT. No, you are correct You take your powder form of indolebutyric and dissolve in a small portion of ethyl alcohol and bring up to volume with distilled water.

MR. HOOGENDOORN: Will rooting be as good with 2 per cent indolebutyric acid powder?

DR. ENRIGHT: No, that was one of the 200 combinations.

MR WELLS: Dr. Enright, did you try 2 per cent IBA potassium salt in powder?

DR. ENRIGHT: Dr. Morris suggested it and I tried it. The only response was decay at the basal end of the cutting.

MR. WILLIAM FLEMER III (Princeton Nurseries, Princeton, New Jersey): If that is a true leaf cutting, where does the bud or shoot come from when the plant goes on and grows?

DR. ENRIGHT: The new growth comes from the auxiliary buds.

MR. CARL GRANT WILSON: How far north will this species grow?

DR. ENRIGHT: Mr. Coggeshall just told me it doesn't grow in Boston. I will guess and say I believe it grows as far north as New York.

MR RAY E. HALWARD (Royal Botanical Gardens, Hamilton, Ontario): We have two plants of *Mahonia Bealei*. They have been alive for three years in Hamilton.

MODERATOR COLE: Thank you, Dr. Enright The next paper is by Dr. Sidney Waxman, Department of Horticulture, University of Connecticut, on "Effects of Daylength on the Germination of *Sciadopitys verticillata*."

Dr. Waxman presented his paper. (Applause)

EFFECTS OF DAYLENGTH ON THE GERMINATION OF SCIADOPITYS VERTICILLATA

SIDNEY WAXMAN
Plant Science Department, University of Connecticut
Storrs, Connecticut

The Japanese Umbrellapine makes a beautiful evergreen specimen. It has dark glossy green foliage that is very dense. It is pyramidal in shape and does not tend to lose its lower branches. The needles are arranged in whorls with twenty to thirty arising from each node; in an arrangement similar to that of the ribs of an umbrella. It is from this similarity that it gets its common name This tree is not susceptible to any serious disease and is for all purposes a highly desirable tree.

Why is it then that in spite of all these favorable characteristics the Umbrellapine is seen very rarely. The following facts may explain why it is so scarce and why only a handful of nurserymen propagate it. Vegetative propagation is highly impractical since cuttings are very difficult to root. Thirty per cent rooting after approximately six to nine months is considered phenomenal and this rarely occurs. The seeds are extremely slow to germinate, taking approximately 100 days, and when germination does occur, only two leaves ½" long are produced that season. The seedling makes extremely slow growth, for, during the following summer only 4 more leaves are produced, so that one year after germination all that is visible is a seedling 1½" tall with only 6 leaves present. It is only after the fourth year that a more reasonable rate of growth occurs. Apparently to obtain a salable plant, a great deal of time, space and labor are involved.

In previous experiments it has been shown that daylength markedly effects the growth of many evergreen and deciduous trees and shrubs. The seed of the Umbrellapine was included in these experiments to determine the effect of the length of day on germination

Since the seed, which were to be exposed to various periods of light had to be kept constantly moist, the experiment was carried out in a mist bench In each treatment, 100 seeds were placed on the surface of an eight inch pot filled with coarse sand. The lights, which were suspended above the mist nozzles, were operated individually by time-clocks. There were six treatments which provided the following photoperiods (Table 1): (1) nine hours of light and fifteen hours of un-

Table 1—The effect of various photoperiodic treatments on the percentage germination* of Sciadopitys verticillata seed under intermittent mist

Date	Days in Treatment	9	18	24	9/1	9/2	Normal
4/1/56	0	0	0	0	0	0	0
5/9/56	39	4	0	0	0	0	2
5/25/56	55	18	0	0	0	1	6
6/2/56	63	60	0	0	0	1	12
6/16/56	77	76	1	0	4	1	30
8/6/56	127	84	1	2	30	2	43

* 100 seed in each treatment The figures give the percentage of germinated seeds.

interrupted darkness, (2) nine hours of light plus one additional hour of light placed in the middle of the night, thereby dividing the long dark period in two short dark periods, (3) nine hours of light plus two, thirty minute periods of light spaced so that they effectively divided the long dark period into three shorter dark periods, (4) eighteen hours of light with six hours of dark, (5) continuous light without a dark period, and (6) normal daylength. The latter treatment ranged from 13¼ hours on April 1st to a peak of 16½ hours on June 21st and then down to 15¼ hours upon completion of the experiment on August 6th A black cloth was pulled over each treatment at 5 p m. and removed at 8·00 a.m In each plot a nozzle sprayed a fine mist for seven seconds every two minutes. Two, 60-watt incandescent bulbs were placed twenty inches above the seeds and illuminated the cuttings with an intensity of approximately twenty-five foot candles.

Results of this experiment have shown that both the time and the percentage of germination were definitely influenced by the various photoperiodic treatments. Germination occurred first in seed that were subjected to nine hours of light and in seed exposed to normal daylength. In the daylengths of eighteen and twenty-four hours, germination was almost completely inhibited Out of a total of 100 seeds in each treatment only one seed in the eighteen hour and two in the twenty-four hour treatment germinated after 127 days

The one hour light-break and the two, thirty minute light-breaks were effective in counteracting the long dark period effect. Germination was delayed by the single light-break and practically prevented in the double light-break. Thus, the germination response of Umbrella-pine seed to photoperiodic treatment appears to be similar to the flowering response of "short-day" plants We can therefore classify Umbrellapine seed as being "short-day" seed However, in order for the seed to respond to protoperiodic treatment they must be leached. Earlier experiments have shown that germination could be increased by leaching the seed with water before sowing. It may be then, that the delay of germination under natural conditions may, in part, be due to the presence of watêr soluable inhibitors The mist therefore served a two-fold purpose in this experiment by preventing the seed from drying while different lighting treatments were applied and also leaching the seed at the same time.

. Several chemical treatments were also tried and of these the most promising was thiourea. Seed that had been soaked for twenty-four hours in a solution of five grams of thiourea in a liter of water germinated earlier than the controls.

MODERATOR COLE: Thank you, Dr. Waxman. Being short on time we will get on to the next paper by Mr Leslie Hancock, Woodland Nurseries, Cooksville, Ontario. His paper is on "Layering of *Cotinus coggygria atropurpurea.*" (Applause)

PROPAGATION OF COTINUS COGGYGRIA

LESLIE HANCOCK
Woodland Nurseries
Cooksville, Ontario, Canada

Though seed is the common method of production of *Cotinus coggygria* or Smoke Bush, we are discussing the vegetative propagation of desirable clones. The variety *rubrifolia* is the commonest known There was at one time a variety *pendula* but it is the variety *atropurpurea* which I consider most attractive Strangely enough, although our parent stock came originally from Boskoop, it cannot now be procured from that source, which shows how easily the reproduction of good things can lapse

Propagation by layering presents no special problem. Branches are pinned down to the ground in spring in the usual manner. Some hilling up of the young shoots is done as they develop, and both the layered branches and the young shoots develop roots the first year. As in many other cases, it is not the technique of layering but the separation and after-care which requires skill. With us, *Cotinus coggygria* is on its northern limit of hardiness, and the young shoots tend to winter-kill, particularly if wintered in a damp situation. This plant requires a dry situation preferably in rich loam, and plants intended for layering should be established on well drained land.

A previous batch of rooted layers which were separated from the parent plants at the end of the first season, were slow in getting re-established after separation I do not think it is a good plan to leave layers on the parent stock two years as the tops grow too strong, and the would be new plants tend to again draw too much on the old root for sustenance.

This fall, we are trying something new to us. Instead of cutting up each rooted segment to form a new individual plant, we are lifting whole branches of layers to be lined out intact for one more year We then plan to complete separation into individual plants at the end of the second year. For winter protection, these separate layered branches are being stored in a cold pit. We would be glad to compare notes with others who may have had more experience in layering *Cotinus coggygria* than we have had.

MODERATOR COLE: Thank you, Mr Hancock. This is another of the many interesting things you have brought to this meeting.

The next speaker is Mr. George Blyth, of the McConnell Nursery Co., Limited, Port Burwell, Ontario, to present the topic, "Propagation of Evergreen Grafts in Electric Cable Frames."

MR. GEORGE BLYTH: Thank you Mr. Cole.

Mr. Blyth presented his paper which was followed by a series of colored slides (Applause)

EVERGREEN PROPAGATION WITH CABLE FRAMES

George P. Blyth
McConnell Nursery Co
Port Burwell, Ontario, Canada

Since the introduction of soil heating cable to the gardening and nursery trades, many uses have been found for this type of equipment. Since we do not have greenhouses, they have been a wonderful thing for us. Our results in evergreen propagation from both grafts and cuttings through the use of cabled, outdoor propagating frames have been good.

The frames are approximately 6′ x 30′ x 10″, and require 10 hot-bed sash and nine rafters. The frames are constructed of one-inch pine for the slides and ends, with 2″ x 8″ cedar at the base The frames are lined with Tentest for added insulation. One side of the unit is 28 inches high while the other side is 24 inches high, thus giving slope in order to shed the rain.

In locating the unit, we dig down 8 inches below the ground level, filling in the excavation with cinders. The frame is then placed over this area. Two inches of steamed soil is then spread over the cinders Next, the cable is laid so that the loops are evenly spaced at 6 inch intervals. This size bed requires three, 120 foot cables, 1 thermostat, and 1 switch The cable is then covered with 6 inches of steamed soil, which brings the inside of the frame some eight inches above the ground line.

A portable shelter can be placed over the frame, thus enabling a man to work without undue loss of heat. The shelter is made of 1 inch lumber and is six foot by six foot in dimension.

The amount of current used varies according to the prevailing weather conditions. Cost will therefore vary with the locality, although for us it has been found to be quite reasonable. Two inches of peat moss is used over the soil surface only when the frame is being used for evergreen grafts.

For evergreen grafting, seedlings are potted in 2½ inch pots in the usual manner, at the end of October Careful selection of stock is very important to a successful grafting operation. Potted seedlings are placed in frames, previously prepared with peat The peat needs to be well water soaked. Pots are then set upright and are not plunged! After a hard frost (usually around December 1) the heat is set at 50 degrees. It is gradually raised and by grafting time, we raise it to 70°F.

The seedlings are ready for grafting by the first week in January. Every root must be checked. This year our grafting was finished by January 15th, with the exception of *J. virginiana hilli.* Since we bought those scions, they were grafted late, i.e , around January 26, with 100% stand. We use a side graft, tied by a rubber strip. Every ten days a Fermate spray is used as a precaution against fungi.

Taxus cuttings were made from September 20-30th. Tip cuttings 6-8″ were wounded on one side and treated with Chloromone 1-4. Cuttings were placed in flats, using a fine bank sand as a medium, and put in the frame. No peat is used for the cutting frame There is no heat until January 1st when bottom heat is set at 50 degrees.

The cuttings should be rooted by April 1, so the heat can be turned off. The procedure just described is used for juniper cuttings taken in October, and arborvitae cuttings taken in November.

Chloromone rather than Auxan or Stimroot treatment has given us a better rooting percentage. Watering is watched and regulated carefully according to the weather.

Some results selected at random from our 1957 propagation records are listed in the following table.

Table 1.—Electric cable frame propagation results

Plant Type	Number of cuttings Made	Rooted	%	Number of grafts Made	Take	%
Thuja occidentalis (Little Champion)	6975	6275	90%			
Juniperus c pfitzeriana nana	1400	1200	86%	224	223	99 5%
Taxus cuspidata nana	2310	2310	100%			
Juniperus virginiana hilli				500	500	100 %
Juniperus chinensis (Mountbatten)				700	600	86 %

* * * * *

MODERATOR COLE: Thank you, Mr Blyth. We will now ask Mr. Jack Hill, D. Hill Nursery Company, Dundee, Illinois, to explain "Propagating Plants Directly in Containers."

Mr. Hill presented his paper, entitled, "Propagating Plants Directly in Containers." (Applause)

PROPAGATING PLANTS DIRECTLY IN CONTAINERS

J. B Hill
D. Hill Nursery Co.
Dundee, Illinois

Discussing the propagation of plants directly in containers should be prefaced by indicating that the propagation that we have done directly in one-gallon containers has been on an experimental rather than on a production basis. This was done two years ago and was not followed up this past year. I think we have sufficient information about it, and therefore I will describe the procedures we have used and the results obtained.

The reason we did not follow it up this past year was because we thought we could get a saleable plant in one season from going into the container early in the spring with an established, potted or banded liner. Having now had one year's production experience with that program, I am not sure we can do it across the board with the line of deciduous flowering shrubs that we wish to market in one-gallon containers.

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The purpose of attempting to propagate directly in the container is two-fold, namely, to save cost and time. To an extent these two purposes are interrelated.

When I refer to cost, I am talking about the actual cost of handling the plant after it is propagated. The firm of C. W Stuart coined a term that I think is very good. It is called down-time. I think if all of us will look at our procedures and look at the amount of down-time, from the time a cutting is removed from the parent and put down into container and another is taken, and all those down-time plants are picked up and taken to a central working area, where they are again put down in large containers and later put down on a bench, and someone picks one up and makes a cutting and puts it down, and someone takes them and puts them down in containers and finally puts them in the bench.

Examination of procedures of this kind indicate without too much difficulty the genuine economy that could be achieved if it were possible to simply grab that cutting while on the parent plant, cut it, stick it and leave it alone until it is ready to market. Of course, there are practical problems which preclude any of us doing that in our operation, but the more we can eliminate that down-time, the more economical will be the production of our plants Therefore, one of the principal reasons in considering the propagation of plants directly in a container is to eliminate the down-time If you can get a plant to root from a cutting or a seed of the desired variety to germinate directly in the container, you will save cost through this reduction of down-time.

The saving of production time, in addition to the cost of down-time, is another consideration. I wish to differentiate between the time which I have already mentioned and the time that is lost in the production of the plant through disturbing it after it has been propagated in a particular location. For reference, I go back to the series of experiments that were run in England with the tomato seedlings. In these studies they actually germinated the seedlings in pots and utilized several methods for checking against the established procedure of shifting or boosting. They discovered that if they could germinate seed in the size of pot they wanted, they were able to get a plant much more quickly. They had a much more vigorous-growing plant, which invariably produced more pounds of fruit in the first season, than those that had been disturbed. The same factors apply to our plants even though we are principally concerned with vegetative growth rather than flowering and fruit production. If we can grow the plant, like Harvey Templeton does with his Phytotektor, then we can approach the phenomenal growth he gets on plants the first season simply because they are left alone Because the plant is rooted and left right in place, is the reason both Mr Templeton and Mr Hancock are so successful.

Now there are three places where we have attempted to follow this practice of continued, undisturbed growing. The first was in the use of unrooted grafting understock This was done simply by taking an unrooted Hetzi cutting, making the typical graft incision on it, attaching the scion, and inserting them both into a two-inch rose pot filled with the standard sand-peat mixture, which we are now using throughout our operation. We did this with only a small experimental lot. The rooting of the Hetzi understock was good, as was the healing at the union. One of the problems, of course, came in the removal of the rubber band, after the union had healed. It became necessary to completely disturb that plant by lifting it, shaking the pot soil off and then going in and removing the rubber band I would not regard this as an entirely practical operation, although, I believe the principle can be adapted.

The second place we have attempted undisturbed growing is in the propagation of multiple cuttings of the more or less easy-to-root, easy-to-propagate plants that are in our sales program. Among these are the ground covers, *Pachysandra terminalis, Euonymus fortunei vegetus* and *Euonymus fortunei coloratus* We find by sticking three small cuttings directly in a plant band, which are assembled in multiples of 25 in a veneer tray, we get very good results. For this operation, which is done in July we fill the bands with a steamed, sand-peat mixture, and insert three small unrooted cutings. These are then removed to an outdoor frame with board sides, but without heat of any kind. Glass sash is then placed over the top of these frames. They are shaded for a period of three or four weeks. After the three cuttings have rooted the sash is simply lifted off and the plants grown in the frame until ready for market the next year The procedure as we have designed it actually consists of two adjacent frames. One of these is filled one year in July as I have outlined The next year as these plants flush, perhaps during the latter part of June, the top of each is pinched off and inserted in a band in the adjacent frame. These cuttings are rooted and again become the sales plants for the next season Actually, you have a turn-about method of using a single facility that gives you a continuous year-after-year flow of plants. Again, it is difficult to quote rooting percentages, but it has been sufficiently high that when we lift a tray of these bands in preparation for shipment it is seldom that it becomes necessary to replace one

The third place where we have experimented with this growing sequence has been directly in one gallon containers. In early summer of 1956 we stuck single cuttings of three or four varieties These plants included the Dwarf Arctic willow, Redleaf plum, Golden mockorange, and the variegated dogwood. The varieties were not important. since they were all recognized as more or less easy-to-root items. Early in the season we placed single cuttings directly in gallon cans outdoors, without shade or heat Over the top of each cutting, and extending down into the mix to a depth of perhaps three-quarters of an inch we pressed a large-sized Dixie Cup. These plants were interspaced in a growing block of junipers at the time. They were irrigated with up to five-eighths of an inch water, three times a week. They rooted unusually quick. When this was done, in late May and early June, I would guess the soil temperature was running on the warm days in excess of 80 degrees, which favored good rooting results. During the rooting process we kept checking two or three of them to see how they were coming. The minute there was evidence of rooting we opened a corner of the Dixie cup with a sharp knife. It was interesting to see how, when you admitted more light, the plant headed right for that opening. After perhaps a week of what you would call hardening, we pressed in the remaining bottom portion of the malted milk cup which left what was in effect a tube inserted around these plants. Any time after that we lifted the rest of the tube off the plant and once again we had the plant established in a can.

The growth rate this first season I would estimate as nearly double that which you would expect when the same individual is propagated in an outdoor bed, lifted, bedded, and handled in the usual manner. Therefore, once again, one of the advantages of this technique is the increased growth rate one obtains by not disturbing the plant.

* * * * *

MODERATOR COLE: If there are no questions, we will continue our discussion of container propagation by calling on Dr. Ken Reisch, of the Department of Horticulture, Ohio State University.

Dr. Reisch presented his talk on "Hardwood Cutting Propagation in Containers." (Applause)

HARDWOOD CUTTING PROPAGATION IN CONTAINERS

KENNETH W. REISCH
Department of Horticulture
Ohio State University
Columbus, Ohio

I believe Mr. Hill explained the purpose for doing this type of propagation very thoroughly. Here again we are interested in producing plants with the minimum amount of handling by propagating directly in the container in which they will be finally marketed. Our tests on which I will report were conducted during the Spring of 1956 and 1957

Cutting wood was collected in the usual manner in January and February Eight inch cuttings were then made, stored at 70 degrees for roughly two weeks, and then held at 40 degrees until they were stuck directly in the containers in March and April. Multiples of one through four cuttings were used in these experiments. The containers were then put right out in the nursery without any protection. The cuttings rooted and produced saleable 15 to 18 inch plants that same year.

The first year we propagated *Weigela, Forsythia,* and *Philadelphus* by this technique. Although I do not have the percentages I would say we had 75 or 80 per cent stands by this type of propagation. In '57 we did the same thing, with the same plants, plus European privet, and had similar results We found about three cuttings to a container was enough to insure a stand. When we had three, in practically every case at least one cutting survived.

We conducted one other test this past year in which we used rooted hardwood cuttings. These were propagated in the usual manner in the greenhouse. After they had rooted, we planted them directly admitted more light, the plant headed right for that opening. After perhaps a week of what you would call hardening, we pressed in the remaining bottom portion of the malted milk cup which left what was in effect a tube inserted around these plants. Any time after that we lifted the rest of the tube off the plant and once again we had the plant established in a can.

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MODERATOR COLE: Thank you. Are there any questions?

MR. HOOGENDOORN: What do you intend to do with these one year old plants now, cut them back or grow them for another year?

DR. REISCH: I wish I could answer your question. I hope we can sell them next spring although they may have to be cut back to promote branching and then grown for another year.

MR. HOOGENDOORN: It seems to me you would have to cut the plants back next spring and let them sit in there another year. This is the impractical part and the place where your trouble is going to come.

MR. WELLS: What is the growing or propagating mixture used?

DR. REISCH: One part soil, one part sand and one part peat were the components of the mixture.

MR. D D. QUINN (Willo'dell Nursery, Ashland, Ohio): Have they usually been fed with liquid fertilizers?

DR. REISCH: Yes, our fertilizers have been primarily liquid this season. We have some studies under way in which they have been fertilized every two weeks.

MR JACK SIEBENTHALER (The Siebenthaler Co., Dayton, Ohio): Suppose that you took the hardwoods earlier in the year and possibly callused them, put them in the can and put the can in a warm area, such as the greenhouse, do you suppose that you would get initial root growth started much earlier? What would you imagine would be the result on saleability that first year?

DR. REISCH: In the study we ran last year we did protect some of them. There again, however, you get into added cost of handling Whether or not it is practical is a very interesting question.

MR. SIEBENTHALER: They would have to be selected, high value plants.

DR. REISCH: I seriously doubt if you could get the money out of *Forsythia*. The problem of forcing comes up in the early flowering plants. For those that have to grow a couple of months before flowering such as *Abelia*, it will be an ideal situation.

MODERATOR COLE: The next paper is another one just along this line. Harvey Templeton will discuss the propagation and overwintering problems of viburnums.

Mr Harvey M. Templeton, Jr., Phytotektor, Winchester, Tennessee, presented his paper. (Applause)

OVERWINTERING ROOTED CUTTINGS OF VIBURNUM

HARVEY M. TEMPLETON, JR.
Phytotektor
Winchester, Tennessee

As you know, propagation of most viburnums from cuttings is relatively easy and especially so from softwood cuttings under mist, although there is at least one notable exception. Since they are easy to into cans in March and April and put those outside without any protection Our results were good.

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As you know, propagation of most viburnums from cuttings is relatively easy and especially so from softwood cuttings under mist, although there is at least one notable exception. Since they are easy to root and time is limited, I will omit the discussion of their propagation and go on to a phase of their production which, in some cases, is not easy, that is, getting them through their first winter alive and in good condition

Viburnum carlesi is probably the one which gives the most difficulty, although *Viburnum juddi, chenaulti* and even *burkwoodi* can sometimes be troublesome. Notice that plants containing *carlesi* "blood" seem to give the most trouble. The first evidence of winter damage is that the stems crack, usually just above the soil line, during one of the first few hard freezes in the fall. The obvious conclusion is that the plants were not dormant at the time they froze.

Now the question is, "why are these plants slow in becoming dormant in the fall'? Is their dormancy induced by a period of lower temperature or is their dormancy the result of a series of long nights? Or, is a combination of the two factors involved and, if so, what is the optimum combination for causing dormancy? If this information were known, it might be possible to provide suitable conditions for more successful over-wintering by inducing earlier dormancy. Since we do not know how to make them become dormant before the first freeze, all we can do is protect them enough during the early freezes so that they are not frozen enough to be damaged. However, the protection must not be so complete or last so long that they are encouraged to keep on growing as they might under, say, greenhouse conditions, since those conditions would not allow them the dormant period they seem to require. And they do seem to require a dormant period since, in our experience, trying to carry these viburnums and some others through the winter in a growing condition has not been successful. Therefore, our object is to keep them as cold as possible all winter without allowing them to freeze seriously before they are dormant.

Since they are all still growing in ground level beds of soil where they were rooted, it is necessary to erect some sort of shelter over them One simple way is to build a wall of bales of straw around each bed. One bale high is enough. Sections of welded wire mesh are laid across the bed from the top of one wall of straw to the top of the other so as to form a low arched roof over the plants. The arch shape is necessary to shed water and give strength to withstand snow loads. Over the wire mesh is spread a sheet of 2 mil polyethylene and over that a sheet of 46% shade saran screen. Bricks or short sections of lumber are used to weigh down the edges of the polyethylene so that the structure is fairly air tight However, in our climate, if kept enclosed all the time, the plants would stay too warm, so one edge of the plastic is folded back to make an opening about a foot wide the whole length of the bed. This gives free ventilation so that even on a bright winter day the temperature inside the bed is little or no higher than the temperature outside. This amount of ventilation is given continuously as long as the outside temperature is above or only slightly below freezing.

In the early fall, while the plants are still tender, the opening is closed whenever the outside temperature falls to about 27° by simply folding the flap of plastic down against the wall of straw on that side. As soon as the temperature rises the flap is folded back up to keep the bed from becoming too warm. This may have to be done many times each winter since our climate has frequent periods of severe cold. However, it is worthwhile as it does get the plants through the winter in good condition and they are a rather high value crop so that the extra effort is justified.

MR. MARTIN VAN HOF: I would like to ask you if these plants get hardened off sufficiently for our northern climate?

MR TEMPLETON: They do by the time we ship them. They are not hardened off now but they will become thoroughly dormant by January, and we will ship all of them in the spring, in February and March.

MODERATOR COLE: Thank you, Mr. Templeton.

The next paper was to have been given by Mr. A R. Buckley, Dominion Arboretum, in Ottawa, Canada I understand Mr. Buckley is ill and consequently his paper will not be given, but rather included in the Proceedings.

THE GRAFTING OF JUNIPERUS VIRGINIANA VARIETIES ON UNROOTED CUTTINGS

A. R. Buckley
Dominion Arboretum
Ottawa, Ontario, Canada

Successful grafting of scions on unrooted cuttings as stocks is not a new technique of propagation, although references to it in literature are very brief. The best reference I can find among the books at my disposal is the half-page devoted to it in the recent work by Mahlstede and Haber (1) where it is referred to under the heading of "cutting grafting." In Kains & McQuesten a few notes may be found under the same heading (2) and in Bailey's Nursery Manual the method of propagation is confused with piece root grafting.

Preliminary investigation into the use of cutting grafts for the propagation of *Juniperus virginiana* varieties began in 1955 when a number of scions of *J. virginiana hilli* and *J. virginiana canaertii* were grafted on unrooted cuttings of various species of juniper including *J. sabina* and *J. horizontalis.* At that time only a small number of grafts were made and these were placed under a polyethylene tent in a medium of sand and peat. Here they were sprayed with a syringe twice daily for two months. At the end of this period the cutting grafts were lifted and the large majority had rooted and the graft union completed. The established grafts were then potted into three inch pots and left in the tent until June when they were placed in another section of the greenhouses. The grafts made very good growth and were quite sizeable plants when they were set out in the nursery in the fall.

During the Fall of 1956 it was decided to carry out further investigations into this method and to make a larger number of grafts on more diversified stocks. November and December were selected as the best times for taking the cuttings, since at this time of the year there is less possibility of heavy snow fall. It is perfectly obvious that during January and February when snow is usually very deep, it is impossible to bed from becoming too warm. This may have to be done many times each winter since our climate has frequent periods of severe cold. However, it is worthwhile as it does get the plants through the winter in good condition and they are a rather high value crop so that the extra effort is justified.

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The procedure for making the cuttings and grafts in 1956 is as follows. Both the stocks and scions were gathered and brought to the potting shed the same day. Wood was selected from the apical and lateral shoots for the stocks and leading side shoots selected from the pyramidal type junipers for the scions. The stock material from plants such as *J. sabina vonehion* consisted of very large shoots cut near to the base. Where the cutting was less than nine inches, this heel was left as part of the cutting, but where a larger shoot was pulled off, no heel was left. The cuttings were made first and kept moist in water while the scions were prepared. Both the scions and stocks were not more than 1/10th of an inch in thickness. For grafting, the side or veneer graft was used and the grafts tied with polyethylene strips cut from 2 mil. polyethylene sheeting. This was used in place of rubber strips which were unavailable at the time the grafts were made and not because of any particular preference. After the grafts were made, they were dipped in Stim Root 10, a root inducing hormone similar to Hormodin 3.

Instead of using polyethylene tents for the grafts as was done the year previous, it was decided to place them in a cutting bed under mist which was controlled by a Humidistat set at the 75% R H. level. These gave about 30 minutes of spray over a period of 24 hours. At one time during a particularly humid period in January, the spray did not operate for three days, whereas during a very cold spell when the temperature dropped to 30 degrees below zero outside, it operated almost continuously. If the spray had been mechanically controlled, I would suggest that a mist flowing for five minutes every three hours would approximate that given by our controls.

The medium used in this experiment was vermiculite placed on a bench formerly used in constant water level experiments to which adequate drainage was added. I felt that the sand peat mixture might have been too heavy for use under mist in the greenhouse. Under the same set-up, but with coniferous cuttings, Perlite worked very well and is the medium I would use in further experiments.

The cutting-grafts were inserted in the medium so that the level of the graft union was just below the surface. The temperature of the greenhouse was maintained at a level of 65°F. minimum night temperature and a 75°F. maximum day temperature. In the same bench as the grafts were many juniper cuttings, falsecypress, yew, Dwarf spruce and some other grafts of Blue spruce on Norway spruce. There was no disease whatsoever on any of the juniper grafts or cuttings, although every spruce was infested with a fusarium disease which prevented rooting

All the rooted cuttings were potted on May 5, 1957. In most cases they had established graft unions, and in fact, in many of those not rooted, unions of stock and scion had occurred. The potted cutting-grafts were left under the mist for three weeks and then placed outside in the cold frames. During August they were planted out in the nursery by which time the grafts were thoroughly established. The top growth of the stock was removed gradually, some at the time of potting and the rest before planting out.

Table 1.—Rooting and take of various cutting-graft combinations

Scion and stock	Date inserted	No inserted	No rooted	No of successful grafts
Juniperus virg hilli on *Juniperus sabina*	5/11/56	25	17	15
Juniperus virg hilli on *Juniperus virg kosteri*	2/11/56	22	17	16
Juniperus virg hilli on *Juniperus virg vonehron*	2/11/56	28	16	16
Juniperus virg hilli on *Juniperus horiz plumosa*	5/11/56	25	20	20
Juniperus virg glauca on *Juniperus sabina vonehron*	2/11/56	25	18	18
Juniperus virg glauca on *Juniperus virg kosteri*	5/11/56	25	12	10

Cutting grafts of junipers may or may not have any commercial significance. In any case it would be necessary to try out this method on a small scale under prevailing local conditions. The method is valuable as a quick means of ascertaining the types of stocks which might be used successfully for grafting in the ordinary way *J. glauca hetzi* the stock commonly used for grafting *J. virginiana* varieties, was not available in sufficient quantities otherwise it would have been used.

Results of this test would suggest that *J horizontalis plumosa,* the Andorra juniper, is an excellent stock for *J. virginiana* varieties. It roots very quickly and seems to carry the grafts very well.

Cutting-grafting is a much more simple operation than grafting on to established pot grown stocks. It might even be possible to use a tying machine in this operation.

Literature Cited

1. Mahlstede, J. P. and E. S. Haber. 1957. Plant Propagation. John Wiley and Sons, Inc.
2. Kains, M. G. and L M. McQuesten. 1947. Propagation of Plants. Orange Judd Publishing Co., Inc
3. Bailey, L. H. 1920. The Nursery-Manual. Macmillan Company

MODERATOR COLE: Our next speaker will be Dr. L. L. Baumgartner, Baumlanda Horticultural Research Laboratory, Croton Falls, New York. He is going to speak about "Potting Mixtures."

Dr L. L. Baumgartner (Baumlanda Research Laboratory, Croton Falls, New York) : Thank you, Mr. Cole, it is a pleasure for me to be here to discuss the subject of potting or growing mixtures.

Dr. Baumgartner presented his paper. (Applause)

A NEW POTTING SOIL MIX

L. L. BAUMGARTNER
Baumlanda Horticultural Research Laboratory
Croton Falls, New York

The purpose of this report is to describe a new kind of soil mix that has been very satisfactory for container-grown stock Our studies on container-grown stock at the laboratory during the past three years have been directed toward the objective of producing the best mix that could be easily reproduced and would present the best growing medium.

The mixes used in these studies varied widely and included soil-sand-peat, soil-peat, sand-peat, perlite-soil, perlite-soil-peat, perlite-peat (German and domestic), and perlite alone. Within each of these combinations, the percentage of the various ingredients varied in fractions of 25 percent.

These tests included 18 of the common varieties of commercial ornamental plants grown in the Northern latitudes of the United States. The 24,000 plants involved in this work were fed both solid and water soluble fertilizers of two basic types. One type was of a 4-1-1 proportion and the other type was a 1-2-2 proportion. The general conclusions reached from these studies are as follows:

1. Peat moss was essential in all mixes, but no advantages could be noted for it in a quantity of more than 25 percent in any of the mixes except for the perlite-peat combination. In this case 50 percent peat gave the mix a little more body.

2. Sand was excellent in maintaining a more porous mix for the first year, but became more difficult to wet after this period. Some sands presented a cement-like surface which made watering difficult. in lower New York it was very difficult to find uniformity in sand deposits. This caused considerable difficulty in reproducing similarity in mixes.

3. No instance was noted where the addition of soil contributed to improved plant growth. Since this observation is radically different from previous conceptions, the importance of soil will receive further study. If soil can be entirely eliminated there will be less difficulty experienced from contamination by soil diseases and insects.

4. German sedge peats appeared to be superior to domestic peats developed from woody plants for the growth of rhododendrons, azaleas, *Kalmia* and pieris.

5. The most flexible and uniform potting mix was a combination of peat and perlite*. This mixture was the lightest in weight and held the greatest amount of moisture. When dry it can be easily rewet throughout its entire mass within seconds. This uniformity in moisture distribution in the can is believed to be responsible for the more fiberous root systems that developed in the mixes. Perlite keeps the mix porous, appears to resist decay, and does not become soggy. It holds moisture somewhat like particles of virgin soil.

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*Perlite is a porous, sterile mineral derived from volcanic rock which is exploded by high temperatures

MODERATOR COLE: If there are no questions for Dr. Baumgartner, we will go right along to a talk by Tony Shammarello, A. M. Shammarello & Son, Nursery, South Euclid Ohio, on the subject of rhododendron propagation. He will tell us of his experiences with cuttings.

Mr. Shammarello presented his paper entitled "The Propagation of Rhododendrons by Stem Cuttings." (Applause)

THE PROPAGATION OF RHODODENDRONS BY STEM CUTTINGS

A M SHAMMARELLO
A. M. Shammarello & Son Nursery
South Euclid, Ohio

I have been propagating rhododendrons from stem cuttings for the past 20 years In the past it was a matter of luck in regard to the percentage of rooting obtained. However, with the aid of mist, polyethylene, and hormones, the percentage of rooting has increased and is consistent from year to year. Despite these new aids we have to adhere to the basic principles such as the time of taking the cuttings, the medium and amount of bottom heat applied.

I consider it of primary importance to have a stock block of plants to provide an ample number of healthy cuttings We take our cuttings from mid November to mid December, since this time of the year seems to work out well for the rooting of most varieties. A cutting of about one quarter inch in thickness and from two to two and one half inches in length is used. Three or more medium sized leaves are generally left on a cutting, although if the leaves are quite large we trim off a portion of the leaf. Cuttings are then heavily wounded, dipped into 2 percent indolebutyric acid and inserted in the medium. The medium is prepared by thoroughly mixing together 80 per cent German peat, 10 per cent sharp, silica sand, and 10 per cent styrofoam. We maintain a temperature of 75 degrees in our rooting medium. At the time of sticking we thoroughly water the cuttings in, and usually they will require no further watering until they are lifted and potted. The greenhouse bench, which contains the cuttings has a 10 inch high polyethylene covered frame built over it. This cover, which is completely sealed is kept on the bench until the cuttings have rooted. Rooting usually takes place within 60 to 90 days.

We plant our rooted cuttings into a 3 inch peat pot and plunge these 4 inches apart in a 4 inch layer of Michigan peat in our greenhouse benches. They are then transplanted from the greenhouse after the 1st of June, and planted in beds 9 to 10 inches apart, under irrigation This is the procedure which has enabled us to grow rhododendrons on a commercial scale I hope this has been of some interest and I shall be glad to answer any questions which you may have later on. Thank you.

MR. ALBERT LOWENFELS (White Plains, N Y.): What is the source of heat in your greenhouse propagation benches, electric cables?

MODERATOR COLE: If there are no questions for Dr. Baumgartner, we will go right along to a talk by Tony Shammarello, A. M. Shammarello & Son, Nursery, South Euclid Ohio, on the subject of rhododendron propagation. He will tell us of his experiences with cuttings.

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MR. ALBERT LOWENFELS (White Plains, N Y.): What is the source of heat in your greenhouse propagation benches, electric cables?

MR. SHAMMARELLO: No, the heat is supplied by hot water pipes.

MR. MARTIN VAN HOF: Do you have any trouble with losses of transplants in the outdoor beds?

MR. SHAMMARELLO: No, they are planted in the late spring, and are usually well established when fall comes. We use very little fertilizer the first year, since we are not looking for a plant to grow to a height of 15 inches. We rather want a six to eight-inch plant which is good and hardy.

MR LOWENFELS: I would like to ask one more question Can you propagate all varieties, that is, the red varieties as well as the more easily rooted ones?

MR. SHAMMARELLO. I would say, yes. There are some clones that just won't root at all. We haven't been able to learn why.

MR PETER VERMEULEN. Can you tell us how and where you wound your cuttings?

MR. SHAMMARELLO: We make a one inch wound on one side of the cuttings in such a way that we do not cut any part of the wood.

DR. REISCH: How high does the temperature go under the polythylene covered frame which covers the bench?

MR. SHAMMARELLO: I would say the temperature under the polyethylene cover probably goes up to 80 or 90 degrees. It seems heat has never made any difference in the rooting response.

PRESIDENT VANDERBROOK: Do you put shade over your propagation bench?

MR. SHAMMARELLO: No, we do not, and in fact, we do not shade the greenhouse. The shade that results from water condensing on the inside of the polyethylene cover makes it unnecessary to shade the cuttings.

MR. HARVEY GRAY (Long Island Agricultural and Technical Institute, Farmingdale, N.Y.): I have a slide which illustrates the type of installation Mr Shammarello has discussed. With the permission of the chairman I would like to discuss this unit for a moment. We have modified an old grafting case. The polyethylene goes down inside the bench, across the bottom and up the other side. A wire, much like 2″ x 4″ mesh, turkey wire, is formed with a slight bow over the top of the bench. This is covered with a sheet of polyethylene. Plaster lath with a few shingle nails, keeps the material in place Absolutely no inspection is required for a period of six weeks, at which time the cuttings are totally rooted The type of cutting makes little difference, since we seem to get equal success with two per cent indolebutyric acid.

PRESIDENT VANDERBROOK: What is you source of bottom heat?

MR. GRAY: Hot water, circulated through a coil system set around 73°F. is used for the source of bottom heat. The peat in the bench is nothing but straight so-called, Dutch peat, or German peat. It should be uniformly moistened to the point that when you put pressure on it you will get only three or four drops of water coming from it. If you moisten it to the point where water drains out freely, it is too wet.

MR. SHAMMARELLO: Thank you for showing your slide and for helping me discuss this subject, Mr. Gray.

(Editor's note). The following paper was not given at the meetings but has been submitted for publication in this section.

AN EFFICIENT NATURAL ELECTRONIC LEAF

R. E. HALWARD
Royal Botanical Gardens
Hamilton, Ontario, Canada

Last year at the annual meeting of the Plant Propagator's Society I mentioned the use of insect wings as a leaf for intermittent mist control. At that time I was rather hesitant to recommend its general use as it had only one season's trial. It was obvious that some improvements must be made to make it more efficient. To give the leaf a better proving ground, a permanent mist bed, 18′ by 6′ was constructed and a sectional wooden frame covered with polyethylene plastic was used for a cover. Burlap was used for shading. The nozzles used were the Florida 550A type, set a foot above the sand medium and about 40″ apart Water pressure was maintained between 40 and 60 pounds. Ventilation was given daily by raising the ends of the frames.

Materials used in the construction of the leaf included a piece of plastic 2½″ in diameter by ⅜″ thick, 2 flashlight battery carbons, waterproof glue and 2 bumble beewings, which were joined by their outer tips with a spot of glue. In addition, sufficient covered cable for leads to the control box and a metal rod to support the leaf in the medium were required. Holes, one inch apart were drilled in the plastic and the carbons inserted, exposing about ¾″ on the upper side with the metal tips on the underside. The leads to the control box were soldered to these and covered with waterproof glue. Holes were drilled in the upper ends of the carbons and small tips of carbon were made to fit in them. The wing was placed under the edge of these tips suspending it between the two carbons.

The leaf was placed in the mist frame on June 17th and was kept in operation until October 24th. After the preliminary moving about to find the best location, the leaf was not disturbed during this 4 month period and worked efficiently at all times. It was finally located about 2′ from the first nozzle. One observation I would like to pass on was the tendency of the leaf to show polarity around the carbons. One lead was free of deposits, suggesting that by alternating the hook up to one might practically eliminate deposits forming. As a matter of interest, from 3000 cuttings which included 125 species and varieties of woody plants, an overall average of 76% rooting was obtained.

PRESIDENT VANDERBROOK: I would like to extend my thanks to Chairman Bill Flemer and Bill Cole, as well as to the members of this panel It was certainly an interesting afternoon. We now stand adjourned but will meet in the morning at 9:00 o'clock sharp.

The session recessed at 5:30 o'clock.

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FRIDAY MORNING SESSION

November 22, 1957

The session convened at 9:10 o'clock, President Vanderbrook presiding.

PRESIDENT VANDERBROOK: Please be seated, gentlemen. I am pleased to state that we have a higher registration this year than we have had for a long time. We have a total registration of 180, which I believe is a figure we have never reached in our meetings before.

If Fred Galle is in the room and is ready to proceed, I will be glad to have him come up here, take over the gavel and give you the first presentation of the morning session

Dr. Fred Galle took the chair.

CHAIRMAN GALLE: (Ida Cason Gardens, Chipley, Georgia): As you will note from the program, I am going to pinch-hit for Henry Orr, who could not be here. He did, however, send a good deal of the material I have to show you this morning. I am going to try to give you an idea of some of the things that are going on in the South in regard to propagation and ornamental plant selection

Dr. Galle presented his paper entitled, "A Survey of Broadleaf Evergreens Deserving further Consideration." (Applause)

A SURVEY OF BROADLEAF EVERGREENS DESERVING FURTHER CONSIDERATION

FRED C. GALLE
Ida Cason Gardens
Chipley, Georgia

The basic problems of propagation whether in the North or South are essentially the same. We have the problem of controlling the water, light, temperature and other factors which are requisites to good propagation results. Many erroneously think that all we have to do is throw cuttings on the floor or the ground and they take root. We think the same thing of the people up North. We have no easier problem than you do. In fact, we all have problems They may be with different materials but we still have all the same problem, that is, trying to get roots on the basal end of the cutting. We do perhaps have a longer growing season than some people and milder climates, although sometimes our milder climates can be quite varied, because of the ups and downs in temperature. I think in my own section, for example, we have already had colder temperatures than you have had in Cleveland We had 25 degrees about three weeks ago and before I left it was 70 degrees again. These ups and downs in temperature can sometimes be as hard to work with as a more uniform, colder climate. I think we have more sunlight. In some areas we have a higher humidity, although it is not a universal condition all over the area.

Propagation structures in use are quite varied As you get down into the Mobile area they are still using greenhouses as basic structures for plant propagation There are still many new greenhouses being constructed. Although the newer operations have gone to mist propagation there are many of the old structures still being used, and used very satisfactorily. With mist propagation there is a trend favoring the rooting of cuttings in flats which permits easy movement from the mist bed into the hardening-off bed. There is also a trend toward the shading of the mist bed. Propagators are covering the beds with Saran and other similar type materials. Many plastic houses, of course, are going up. We do not have the problem of the snow and ice that is common to some other areas, although we still have the high winds that can tear the plastic. In some areas they are covering the plastic houses with Saran cloth in order to increase the life of the plastic

One other type of propagation that I think some of you are familiar with is the open field propagation common to a few sections of the South particularly around Athens and Huntsville, Alabama, and around Memphis, Tennessee where they are putting hardwood cuttings of conifers directly into the field. I think the Chase Nursery Company was doing this some ten years ago, and have steadily increased it until today, with the use of supplemental irrigation, it is an important phase of their propagation program. With irrigation they have a better control of their environmental conditions. It is quite a sight to see five or ten acres of hardwood cuttings stuck out in the fall of the year. These are grown under irrigation throughout the winter and early spring, and usually dug the following fall.

There are a large number of lath houses used throughout the South. They are used primarily to regulate humidity, and to reduce temperatures and light intensities. The type and construction varies considerably since we don't have to worry about the heavy ice and snow that might form. There has been increased use made of lath houses equipped with mist. In some cases the sides of the lath house are enclosed with plastic, leaving it exposed only at the top.

The media we use are very similar to those used elsewhere. There is perhaps more use made of media that have a higher water-holding capacity, which is necessitated by our higher temperatures. Cinders, even shavings and sawdust are sometimes mixed with the media in various areas. Liquid feeding is standard practice now in the later periods of rooting and for carrying over plants in lath houses or in beds.

Our plant material is perhaps somewhat different. However, before I discuss plant materials I would like to suggest that sometime a period should be spent with the people introducing new plant materials There is the old problem of saying that the landscape people aren't going to use new introductions However, they are not going to use them unless you have them available. It is the propagator who is the essential link in this important chain. I think we need to try new plant materials regardless of what area we are in. If everyone would propagate and grow one or two new plants it would mean a lot to the industry all over the country. I think that in testing plants oftentimes we give up too quickly or draw hasty conclusions Many times we do not understand the requirements of a particular plant and after a brief test discard it for one reason or another. Actually, you should test at least three plants of a particular selection over a period of three to five years. If you lose them the first year, try again another year. Although hard to believe, there is considerable variation in climate even within rather restricted areas. In these areas you can do a great deal more with selected plant materials by understanding the various climatic conditions and the requirements of the plant. In Cleveland, for example you have isolated areas that are mild as well as situations on top of a ridge that is perhaps extreme. This is true regardless of what section of the country you are in In these macroclimatic conditions you can perhaps introduce materials that have never been tried before. They may have a limited use, but it is still a way to introduce new material to different areas.

I think there has been a great deal of interest in the use of the camellias, *Camellia japonica* and *Camellia sasanqua* Dr. Zimmerman of the Boyce Thompson Institute has reported on the hardiness of camellias. If I were to have had the privilege of giving him an opinion of what camellias to, grow, I certainly never have recommended the plant which he has found satisfactory. It is difficult to believe that some of the plants that he is actually finding and proving to be hardy in his area are things that would not grow even in my own section of the country. When we think of growing camellias we select either the very early or very late types. We would not grow a mid-season one, although they actually are grown 50 miles southwest of Chipley. The plant is hardy and it doesn't lose its leaves, but neither does it produce flowers. We therefore consider it unsatisfactory since it is flowering which is the most important aspect of this plant If you are interested in camellias, I think it is a matter of just trying different varieties. We do say that the singles and semi-doubles are adapted in more areas than the full doubles, the anemone and the peony types. There is a wide range of varieties you can try, and you can't always base your selection on the plants that are only used in the lower South. I would advise those who try to handle some of the southern material to start out with small plants. I would further advise spring planting rather than a fall planting. If you do receive a plant in the fall, either hold it in a cold frame or greenhouse over the winter and then give it a test for a full growing season before you try to do any evaluation.

I think, too, a lot of us could benefit from the sort of philosophy, Cliff Runyon, of Spring Grove Cemetery had on bringing southern plants up North. A lot of us didn't have the patience to listen to him and didn't think we had the time to carry out his suggestions Briefly, Mr Runyon's idea was to select the most northern specimen of holly or *Magnolia grandiflora,* collect seed, move the seed up 50 to 100 miles, grow it, and when you have some fruiting plants of that established, again take seeds and move it up another 50 to 100 miles. Gradually you would get the plant acclimated over a wide area. This, naturally, is a slow process since it may take 10 years for plants to bear seed. I suggest that it may be possible to take big steps attempting to move plants 400 or 500 miles. You may lose them all, but again you may not lose any.

Ilex rotunda is one of the very southernmost forms of holly that we have. In our particular area it generally winter-kills, yet we now have four seedlings out of 50 that have gone through two winters of 10 degrees. We are not interested in what happened to the 46, they are dead We do have four that we think have possibilities If we can do it with a very tender plant that is known to grow in Florida, I think you can do it with some of the other plants that are growing in more northern latitudes.

I will mention a few of the materials we are interested in, and as you will see there is great emphasis placed on the broad-leafed evergreens. For example, we are particularly interested in a selection of *Pyracantha crenulata serrulata*. The plant I am sure is not hardy over wide areas but the possibility of seedlings from these plants or the hybrids between this and your common *P coccinea.* varieties do offer possibilities. There is some confusion in the species since sometimes it is listed as *Pyracantha crenato-serrata.*

There are a lot of magnolias coming up North every year. When I visited in Ohio I saw many of these little plants in local landscape plantings. Some were protected with burlap and straw People are interested in this plant and, for that reason someone should start with seed in order to really get some good selections. It will be tender, the first several years, but usually after that it will hold up on its own

We have a problem with some of our southern hollies which are not hardy, even though a good many of the named varieties came out of North Carolina and Tennessee. And again, we have selected good fruiters, having good green foliage and which have been exposed to 25 degrees Another good holly is Foster Number 2, one of the Foster hybrids of which there are five numbered varieties I think the Chinese holly is much more satisfactory than Burford to try, and yet, I heard that the supermarkets in Cincinnati are selling Burford hollies Another possibility for southern material I think is the use of *Ilex crenata helleri* as a small plant for modified container culture. It could be grown as a house plant in the winter and then moved out to the terrace in the summertime. I have had a plant such as this in the house for four years It has never been taken out of the house and has been growing in a four-inch pot.

That, briefly, covers the topics of propagation trends in the South and broadleaf evergreens which are semi-hardy in the North. Unless we try new materials I think we are going to hurt our business People want new things. They want the new cars, and new TV sets, yet do we give them new plants? We give them a plant with a new name, but often it has very little different charcteristics than the old material from which it was selected.

Now, the next man on our program is Jim Wells, who will talk to us on the subject of holly propagation.

Mr. James S Wells took the chair.

MR. JIM WELLS: I would like to begin by thoroughly endorsing Fred Galle's request for the development of interesting new plant material. Anyone who has tried to encourage the use of a new plant realizes the many problems that are associated with it I have always felt that the burden was directly upon the local nurserymen, the local retail nurserymen, if you like, to educate the people who come through their doors in the use of something a little better and a little different. I don't think that the job can be handed to anyone else or, in fact, should be handed to anyone else. However, it is up to the propagator to supply these plants So I commend his remarks to you in all earnestness and suggest that we might perhaps diverge from our pattern of meetings to consider more thoroughly at a later meeting new plant material of one kind or another It might well form a theme for a future annual meeting.

Mr. Wells presented his paper on "A Propagation Program for Hollies." (Applause)

A PROPAGATION PROGRAM FOR HOLLIES

JAMES S. WELLS
Wells Nursery
Red Bank, New Jersey

In company with many other plants, the propagation of hollies has undergone a quiet revolution during recent years. I mean by this, that the methods of propagation and culture employed by the average grower have changed radically. The groundwork for this change was laid much earlier and in reviewing the somewhat meagre literature available to me, I was astonished to find how long it takes to put an idea over, as well as how difficult it is to change a pattern once it has been established

Although it is now generally accepted that the propagation of most species and varieties of *Ilex* is best accomplished by rooting cuttings, the acceptance of this method is comparatively recent. I recall that in 1946 most growers were maintaining production by grafting, as I understand they still do in England. It is perhaps significant that the first reference to the propagation of *Ilex* in the Proceedings of our Society was a review by Gleason Matoon, published in 1952, titled "Vegetative Propagation of Holly by Grafting" (6). Reading the literature, I found that Burbridge (1), in 1877 stated that the propagation of both *Ilex opaca* and *Ilex aquifolium* from cuttings is comparatively easy. This has been substantiated by work at a later date, yet two most excellent books on propagation, one published in England in 1948 (11), and one in this country this year (9) make no reference to the rooting of *Ilex* cuttings.

In October 1933, Zimmerman and Hitchcock (16) described almost all of the important factors associated with the successful propagation of *Ilex* by cuttings. The only point which they omit is reference to the value of wounding, but this aspect is very adequately dealt with by Stuart and Marth (12), who reported in 1937 the effect on *Ilex opaca* cuttings of various treatments with indolebutyric acid. They also clearly show the increased rooting which occurs when the cuttings are wounded. Following these two pioneer papers, we have quite a number of references to successful rooting. Kirkpatrick (7), reporting work done at the Boyce Thompson Institute in 1940, records the value of both that the burden was directly upon the local nurserymen, the local retail nurserymen, if you like, to educate the people who come through their doors in the use of something a little better and a little different. I don't think that the job can be handed to anyone else or, in fact, should be handed to anyone else. However, it is up to the propagator to supply these plants So I commend his remarks to you in all earnestness and suggest that we might perhaps diverge from our pattern of meetings to consider more thoroughly at a later meeting new plant material of one kind or another It might well form a theme for a future annual meeting.

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In reading through all of these references, it becomes clear that there is hardly a variety of *Ilex* which cannot be successfully rooted from cuttings if comparatively simple procedures are understood and followed It is my purpose, therefore, to digest these references and, in conjunction with our own experiences, present to you now in a brief and condensed form the methods which I believe experiment and experience have shown to be successful.

TIMING

This used to be considered a critical matter, but is no longer. Boskoop (4) reports excellent rooting in June, Chadwick (2) reports equally good rooting in November; Coggeshall (3) in January, and we have made cuttings at all times from late June until late February. If care is taken in the selection of the wood, rooting usually follows without difficulty. To some extent the use of old wood at the base of the cutting can overcome the broad limitations of timing. For instance, shoots which may be completing a surge of active growth would not be considered fit to use as a cutting. Yet such shoots, if taken with a small piece of older wood at the base can often be handled successfully. There does seem to be a general consensus of opinion that the best time is from late July until the end of January, with an optimum period from late August to early October. However, the use of hormones and, in particular, the use of some form of misting has practically eliminated the necessity for critical attention to timing.

THE TYPE OF CUTTING

Chadwick (2) reported a series of tests in which it appeared that the use of a cutting with a heel, that is to say a small piece of two-year old wood at the base of the cutting, produced superior rooting We have found that the larger the cutting the better it roots, the more vigorous is the root system, and the greater the speed of rooting Now, of course, there is an obvious economic limit to the size of the cutting; a limitation of space, of propagating wood and so on, although I am bound to say that there does not seem to be any actual limitation to the size of the cutting that can be successfully rooted. I am convinced, from tests which we have made, that we can take a much larger cutting than we are accustomed to do and thereby obtain a better plant in less time. The type of cutting which we used to take was a terminal shoot (although it could be on a side branch) from four to six inches long, of current season's growth, mature, firm, and of a size approximately half pencil thickness. Such cuttings root very well indeed, but if you take a similar growth, further down into the stock plant, retaining the first set of branches, then such a cutting, maintained under healthy conditions in a greenhouse or frame under a mist system, will root with ease and vigor. The size of the cutting and the type of wood retained at the base also has a direct bearing upon wounding and hormone treatments. I mention these aids to successful propagation here because the three are interdependent, and we have to consider them together in order to achieve a proper balanced judgement. The cutting which has stout wood, perhaps two-years old at its base can, and will respond to a double heavy wound and to strong hormone treatments which would perhaps be lethal to a younger and smaller cutting.

WOUNDING

Stuart and Marth (12) clearly indicate the value of wounding on the successful rooting of *Ilex opaca,* and Coggeshall (3) follows this up with some excellent controlled tests which indicate the value of wounding on its own, without the addition of hormone treatments, a factor which has been recorded on other plants. The wound which is generally used on cuttings of this kind is called a heavy wound. A slice is removed with the knife from the base of the stem as the cuttings are made, being a strip from one to one and a half inches long which cuts through the outer bark and cortex to reveal the firm central woody tissues. Stuart and Marth (12) report that two such cuts were made on either side of the cuttings with excellent results. Coggeshall (3) used only one cut, and this produced a vigorous but obviously one-sided root system.

HORMONE TREATMENTS

Practically all people reporting work on *Ilex* state that treatment with indolebutyric acid produces superior results. Although it must be admitted that many varieties of holly can be successfully rooted without treatment, for normal production on a nursey it is well worthwhile to treat all cuttings, and thus to ensure a high percentage of heavily rooted plants We treat most varieties of *Ilex aquifolium* (English Holly) with Hormodin #3 powder, which contains indolebutyric acid at 8 milligrams to the gram in talc. This same strength is used for large cuttings of all the *Ilex crenata* (Japanese Holly) and types, and also for the *Ilex cornuta* (Chinese Holly) types For small cuttings of *Ilex crenata,* Hormodin #2 containing mg/g of indolebutyric acid is used.

Ilex opaca (American Holly) requires a stronger treatment, and for all varieties we use a powder containing 20 mg/g of indolebutyric acid. As mentioned earlier, there is a definite interdependence between the type of cutting, the severity of the wound, and the hormone treatment. For instance, an *Ilex opaca* cutting of average size which has been double wounded will respond quite well to Hormodin #3, whereas the same cutting, receiving only one wound, will respond about the same if treated with 2% indolebutyric acid. Where large cuttings are made with fairly heavy two-year old wood at the base, a double wound plus treatment with 2% indolebutyric acid may be necessary to achieve optimum results In 1953 the possible value of treating such cuttings with 1% 2-4-5 TP (Trichlorophenoxypropionic acid) was recorded (14), but we have since found that while this extremely strong hormone is successful on many varieties, if the condition of the wood is not exactly right it can be too strong. We have obtained such steady and obviously adequate rooting with the use of the 2% indolebutyric acid that this somewhat less vigorous treatment has become standard. We are presently testing another mixture of hormones which gives promise of being better on certain varities, yet not so vicious as the 1%, 2-4-5 TP. This mixture is made up of one part by bulk of 2% indolebutyric acid, one part of 1%, 2-4-5 TP, one part of .4% napthaleneacetic acid, and one part of the fungicide, Phygon.

One other point here which I think is of value. The normal procedure when we are making a batch of holly or rhododendron cuttings is to have at least three strengths of hormone powder in front of the person making the cuttings. The cuttings are trimmed, wounded, and immediately dipped into what seems to be the best hormone powder, depending upon the operator's judgment of the condition of that particular cutting. Now I realize that is getting down to rather fine details, but we find that by doing that we can give thicker and stronger cuttings which have older wood at the base, a little stronger treatment and lighter cuttings, a less concentrated treatment. By wounding and immediately treating, we have the cut surfaces of the wound still moist, so that a modest amount of powder adheres to that cut surface. I think that this point is quite important. If you have your cutting really wet or moist as a result of sprinkling them down, you tend to get too much powder. If they are dry, you generally do not get enough.

ROOTING MEDIUM

Our standard rooting medium has been a 50-50 mixture of sharp sand and acid type, Dutch peat However, Mr. Germain, of the Buckingham Nurseries near Philadelphia has reported excellent rooting on *Ilex opaca,* using a hormone mixture similar to that described above, and a medium of 80% acid peat and 20% perlite. We are testing this for the first time this year on both rhododendrons and hollies, and it looks good. The rooting is rapid and vigorous, and the condition of the root system is excellent on both plants. However, most varieties of *Ilex* do not seem to be critical as to their requirements in the rooting medium One has only to get into a disccussion in any corner of this room to discover that someone is rooting holly in almost everything, from sawdust to sifted ashes, fly ash, perlite, vermiculite, sand, and so on For the rooting of all types, that is, English, American, Chinese, but excepting only the Japanese holly (*Ilex crenata* and varieties), we recommend the 50-50 peat and sand mixture, with the suggestion that the perlite and peat mixture should be tested as a possibly superior substitute. For *Ilex crenata* and varieties, plain sharp sand is to be preferred. In all mediums, first-class drainage is required, because the maintenance of a high humidity, either manually or by the use of a mist system, is essential, and entails the use of much water.

HIGH HUMIDITY AND THE USE OF MIST

Many references are made to this in the literature and practically everyone is unanimous that a high level of humidity is essential for opimum results. Zimmerman and Hitchcock (16) in 1933 mention this emphatically. Stuart and Marth (12) inserted the cuttings under a double glass and maintained them under conditions of high humidity. Lindberg (8), reporting in Ohio Nursery Notes, September 1952, states that excellent rooting can be had at temperatures of from 95 to 100 degrees Fahrenheit if the humidity is also maintained at 100%. He also states that under these conditions the use of hormones is unnecessary. Coggeshall (3) reported that his tests were carried out under high humidity conditions maintained by polyethylene film, and Pease (10) emphasized that 100% humidity was essential. There should be no question in any growers mind that the application of considerable quantities of water in one form or another is essential to the rooting of *Ilex*. That it can be applied manually from a hose, (Hancock method), or automatically (Templeton method) from a mist nozzle, matters not. The essential thing is to realize that from the moment the cutting is removed from the parent plant the material should be very carefully maintained under conditions of high humidity and ample moisture. Never must the cutting material be allowed to dry out, for if the wood becomes even slightly shrivelled, successful rooting is highly improbable. But giving careful attention to this most vital point, particularly by the use of a mist system, the maintenance of highly humid and moist conditions in a well-drained medium can produce roots on a holly cutting in a remarkably short time. Cuttings which are on display here have been rooted in six weeks, and other growers report vigorous rooting in various times ranging from four to eight weeks.

BOTTOM HEAT

Most types of holly seem to respond to quite high temperatures, and a bottom heat of from 75 to 85 degrees would be preferable to one from 60 to 70 degrees. Rapid and vigorous rooting is certainly encouraged at the higher temperatures, but only when these are combined with conditions of high humidity. As the bench temperature drops below 75 degrees, the speed and the vigor of rooting decreases rapidly. The higher range of bench temperatures are clearly indicated, but only if the need for adequate moisture and humidity is understood and it is provided.

PROPAGATION IN FRAMES

This method must be mentioned because it is important, particularly for some of the varieties which do not root readily, such as *Ilex pedunculosa*. We ran a series of tests last winter using a well-constructed cinder block frame, electric cables as a source of bottom heat, and a medium of 50-50 peat and sand. A line of Florida jets was installed down the center of the frame controlled by a percentage timer, which applied 24 seconds of mist every six minutes during the hours of daylight. This mist line was used for about six weeks after the cuttings were set in mid November, and then only intermittently as conditions indicated the necessity. A number of varieties were set in the frame and remained undisturbed until late spring. The combination of mist, the right medium, treatment with 2% indolebutyric acid and finally a fair length of time, (in all, about five months), resulted in excellent rooting on some varieties which are considered somewhat difficult. A small episode occurred on one variety of holly in this group which may be of interest. This occurred with *Ilex aquifolium pyramidalis compacta*. Cuttings were gathered about the middle of November, made immediately, treated with Hormodin #3, and inserted in the frames. They began to callus, well and one or two commenced to root. Then, almost without warning, the cuttings began to drop their leaves. The dead leaves were removed as they fell, but within two months, all the cuttings were completely defoliated, and it was considered that this batch of exactly 1,000 cuttings would be a total loss. In the spring, when the frames were opened up, nothing was done to them. They remained in the frame, and when we began to lift varieties on either side which were well-rooted, these were left undisturbed. As the weather began to warm up, new growth could be seen breaking on the tops of all the completely defoliated sticks, and by the middle of May the cuttings were once more properly supplied with foliage. As soon as the new leaves were reasonably mature, rooting commenced and within quite a short time practically all the cuttings were well-rooted. The development of the leaves at the top of the cutting coincided with the development of a good root system beneath, and we were finally able to lift and plant out about the end of June, 940 cuttings from the 1,000 which were set in November. I believe that by leaving these cuttings completely undisturbed we finally ended with a reasonable percentage, but had they been moved or disturbed in any way while they were defoliated, then I am sure we would have raised none of them.

The purpose of this discussion is to consider plants of the broad-leaved evergreen type which may possibly be of value in northern areas, and it is my belief that if interested growers will take the time and trouble to look for varieties, already in existence, which are exceptionally hardy, the areas in which plants of this kind can be grown will be greatly increased As a case in point, the cuttings which I have displayed are of a variety of *Ilex opaca,* called, Johnson. These cuttings were obtained from Mr. Joseph Gable at Stewartstown, Pennsylvania. Mr. Gable told me that during the early spring of 1935, he made a survey of the countryside around him to see if there were any plants of native *Ilex opaca* which were undamaged by the extreme cold of the winter of 1934. Only one plant was found which was not damaged at all, and this was growing in an exposed situation on a farm belonging to a Mr. Johnson Mr. Gable propagated a few cuttings, and has a tree in his nursery. But as far as I know, no one is propagating or offering this variety now. It is plants such as these, which have to be searched for diligently, that can perhaps extend the beauty and grace of the native American holly to areas where it is at present unknown

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CHAIRMAN GALLE: We will hold all the questions until after the last speaker. We will now go on to our next speaker who will discuss "Propagation of Other Broadleafs on 'The Edge of the North'", Mr Don Hillenmeyer.

Mr. Hillenmeyer presented his paper. (Applause)

PROPAGATION OF OTHER BROADLEAVES ON THE EDGE OF THE NORTH

DONALD J. HILLENMEYER
Hillenmeyer Nurseries
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It is certainly an honor and a pleasure to come before this fine organization to present what little I can which might be of interest to fellow members. From attendance at former meetings, I have been

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CHAIRMAN GALLE: We will hold all the questions until after the last speaker. We will now go on to our next speaker who will discuss "Propagation of Other Broadleafs on 'The Edge of the North' ", Mr Don Hillenmeyer.

Mr. Hillenmeyer presented his paper. (Applause)

PROPAGATION OF OTHER BROADLEAVES ON THE EDGE OF THE NORTH

DONALD J. HILLENMEYER
Hillenmeyer Nurseries
Lexington, Kentucky

It is certainly an honor and a pleasure to come before this fine organization to present what little I can which might be of interest to fellow members. From attendance at former meetings, I have been highly impressed at the great amount of technical knowledge presented on these programs. Before going into the actual propagation of the so-called borderline broadleaves, I would like to say something about these plants and their hardiness. There are many plants that have been treated on a "hands off" basis by northern nurserymen (those north of the Ohio River) because of rumors and sad experiences in freeze damage in former years. I find in my experiences that many of these plants have never been tried under the best of conditions, and consequently, your customers have been denied a wider use of plant materials. I am not suggesting that everybody in the North go out and spend a large sum of money on liners of these questionable plants, because there is a limit to how much they will take before freezing.

I am basing my statements on the subject matter to be discussed primarily on experiences in Lexington, Kentucky, and some other Kentucky cities where the weather is comparable to that of Lexington. In the winter of 1950-51, we had a very good test for the plants in Lexington with a cold snap in November that many of you will well remember We had a temperature of 65°F. on Thursday morning and a low of 5°F. by Friday night In January and February, we had temperatures several times that were -15°F. or below, the coldest being 20 degrees below zero. With this situation, we had the following plants come through the winter unharmed, when many of the so called hardy plants were damaged: *Magnolia grandiflora, Ilex cornuta burfordi, Prunus laurocerasus, Prunus l. Zabeliana, Buxus spp.*, and *Osmanthus americanus.* Many nurserymen have tried purchasing full grown tender plants from the South, and reselling this material. Unfortunately my experience too often has been costly and discouraging However, these trials have been beneficial, because strains have been selected which permit us a wider use of material in this area.

Now, in reference to the actual propagation of this material, I would like to preface my talk with the statement that I am somewhat new in handling these plants due to the newness in our area, and that I am sure there are better or cheaper ways of propagating these items. However, experience and necessity have shown that some of these methods, even though different than southern ones, have proved beneficial and successful

MAGNOLIA GRANDIFLORA

In Lexington, we have many magnolias that are twelve inches in diameter which have been through many a severe winter apparently undamaged. I know of a Kentucky nurseryman that had some home grown seedling 4/5′ that were planted next to some southern purchased seedlings. The southern types were frozen, the home grown plants showed no damage whatsoever. How much cold will they take? I do not know, but it is proof that there are strains that will take it better than the plain *Magnolia grandiflora.*

Magnolia grandiflora is commonly raised from seed. We gather the cones when they are ripe, spread them out on a floor or bench at room temperature, and the seed will continue to come out of the cone until they can be very easily picked off. The seed should then be cleaned. I have heard, and had only fair success myself, of using uncleaned seed. The oily coating on the unclean seed is supposed to slow down or prevent germination. They can be cleaned cheaply and easily by soaking in water for several days and then rubbing lightly over a wire mesh. Sow immediately in a mixture of half sand and half peat and place the flats in the greenhouse. Germination, once it starts, is fairly regular and usually by the 15th of February you can count on them being mostly germinated. Pot them or transplant them at your convenience, but generally the sooner the better. This is the way found to be most successful in our area. You can sow them directly in beds if you prefer bed grown magnolias. I do not If you do this, there are some necessary precautions. Mice love them, so be sure to take precautionary steps to protect the seedlings. The other consideration lies in the fact that they can not be allowed to freeze, and therefore the bed must be protected to prevent this. The seed can be held until spring and sown in beds if preferred. However, it must be stratified to prevent drying out, and they must be stored in a cool place to prevent germination from taking place in the stratification medium.

ILEX CORNUTA BURFORDI

The propagation of this plant is readily accomplished by any methods by which you propagate your other hollies, a subject already ably covered by Mr. Wells. I would like to say a few words about its hardiness. For years nurserymen in Kentucky did not grow the plant because every time they brought up some from the South as finished plants they were damaged. However, there was one brave nurseryman in Lexington who planted some small liners four years previous to this time. In April he called me and showed me these plants There was no damage whatsoever. They are now being planted with regularity in Kentucky. It appears that when the plant is grown in the locality it can stand the winters much better

PRUNUS LAUROCERASUS CAROLINIANA

Cherry laurel is a plant that will suffer damage in a severe winter, although I have hopes that this will be remedied in time. I had the pleasure of cutting six foot plants back in the spring of 1951, but still the plant is grown, planted in protected places, and called for by the customers. Growth is rapid each year and the customers are using the foliage for winter decorations in the house. Many do not complain if it freezes, because of the enjoyment they have received from decorative uses. I found one plant last year, whose trunk is 18" in diameter, that the owner says was undamaged in the 20 degree below temperature of 1951. Maybe these plants will prove hardier than the normal seedling Cherry laurel. I have only seen the plant one winter and this was a mild one

Cherry laurel is primarily propagated by seed, and I am sure that there are others that can give a better description of seedling production than I can. However, I do not know that if it is fall sown in the seed bed, the winters in Kentucky are cold enough to prepare the seed for spring germination. The plants can also be propagated with relative ease by cuttings. The reason I bring this in is the hope that hardier varieties may soon be found, and also, because I understand that in the

Nashville, Tennessee area, there have been some strains selected for better leaf quality and generally better plant quality. My experience is that softwood cuttings taken in June, placed under intermittent mist, were rooted somewhere between 85 and 90% by late August. Maybe with a little closer attention to details I can increase the percentage, since I merely stuck them to see if they could be rooted. I presume that any method that you use to produce softwood cuttings would succeed in this case.

PRUNUS LAUROCERASUS ZABELIANA AND *SCHIPKAENSIS*

I am placing these two plants together because the results in propagating them have been almost identical. The former plant came through the winter of 1951 in excellent shape, although the latter was damaged. The latter is being grown because it has not damaged since then, and it sells well in our area I have had constant rooting of 90 to 98% when placed under intermittent mist the first of July, and removed the last of August. Also, one year they were rooted very satisfactorily in the greenhouse when placed in the bench in December. Either method seems to be satisfactory.

BUXUS SEMPERVIRENS

Boxwood is a plant that is sold with words of caution to the buyers of nursery stock in Kentucky. Many of the people in this area had ancestors from Virginia and they think that boxwood has to be planted just as grandmother did back in Virginia. Consequently, there have been many planted over the years and many have proven hardy. Of course, there are many strains of boxwood that are hardy, so what I have to say might prove interesting to you It is not a difficult plant to root. I take my cuttings in the first part of July, place them under mist in sand and get excellent results. When I take the cuttings, I merely strip the leaves and stick them in the sand They root so easily and so well that I find no need for hormone treatment or any other special preparation.

OSMANTHUS AMERICANA

This plant may not be known too well, and among those who do know it, there are varied opinions as to its acceptability. It has done well in Kentucky in growth and in sales, when grown properly It survived the winter of 1951 in fine style. It can be raised from seed or reproduced by grafting. The seed is gathered in November and cleaned in the usual manner. You can sow immediately outside in beds or stratify and place outside for six weeks of cold weather They can then brought in the greenhouse and given an earlier start, if this is preferred. As soon as they can be handled, they should be potted.

Grafting is often practiced in Kentucky on this plant because of the seedling variation and because of the longer time required to produce a salable plant. Unfortunately, the larger, glossier, leaved plants appear to be more sensitive to cold weather than the narrow-leaved types. A side graft is used for this procedure in the same way you would propagate a juniper. One nurseryman I know says that they can be grafted any time of the year that you prefer, but because of time available and storage space afterwards, I prefer to do it in August. Ibolium privet is used as an understock. Pot the privet in the winter when you are not too busy, and place them outside in a cold frame until ready for use the following August. Graft them and then place in a shaded greenhouse, treating them in the same manner that you would junipers. When you remove the last of the top of the privet, you can move them outside in a cold frame for the winter

Propagation by cuttings has given varied results. It seems that the more undesirable plants are the ones that are more easily rooted than the good ones I have had 10 to 90% rooting of these plants under many conditions and methods, but there has been no consistency in the results from one year to the next. Therefore, I feel that it is a waste of time to tell you how not to propagate this plant by cuttings. I would now like to mention a couple of plants that are not going to go through many winters in Lexington, but you would have to classify them as borderline.

ABELIA GRANDIFLORA

Abelia is propagated generally by cuttings. Softwood cuttings placed under mist are rooted very easily when placed in the mist in June and can be removed in five or six weeks. When grown by this method, they are better off if grown in a bed for a year before moving to the field. They are also readily rooted from hardwood cuttings, or at least so I have heard. My experience has been disappointing in this regard, as a 10 to 15% rooting was all that I was ever able to obtain, and many times I had a big zero in the rooted column Maybe it was the condition of the wood or the way in which it was being stored that was giving the trouble. I do not know why I did not succeed when all the other hardwoods I was making were rooting fine. If in doubt, or unsuccessful in rooting hardwoods, then you should be able to root them easily from softwoods.

NANDINA DOMESTICA

This plant is very readily propagated by seed. Gather the seed when ripe and clean them. Sow the cleaned seeds outside in beds and you should have no trouble getting the seed to germinate in the spring. I have seen seedlings that came up in a bed of peat moss where they had fallen off the mother plant during the winter. Therefore, you do not have to clean the seed, although we have found out from experience that they germinated much faster in the spring when they are cleaned

There are many other borderline broadleaves that I could talk about, but time is limited and there are many more nurserymen that should have the opportunity to present some of this material to you. I have just covered the highlights of propagating these plants as I do them. There are many of the discussions that could be more detailed, but I do not think this is the time to do so. Generally, the cuttings are treated as any good propagator would, and the grafting procedures are the same as any good grafter would use. There is no need of going into seed bed construction, since methods are more or less standardized The cuttings were generally as large as I could take them under existing conditions. The hormones used were generally Hormodin #2 and in some cases, the other strengths, as the season and condition of the wood demanded.

I will be glad to enlarge on any part of these procedures during the question period to follow. I hope you do ask questions if there is any doubt, as I can readily picture what I am doing as I say these things, where you may not get the same impression Thank you for the privilege of appearing before you and for the kind attention you have given.

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CHAIRMAN GALLE: That concludes our formal presentations and we now are open for questions from the floor.

MR. LOWENFELS: I would like to ask Mr. Wells where he gets the hormones he has mentioned in his talk. Are they available commercially?

MR. WELLS: You really put me right slap on the spot here, Al, because I am forced to say that you can get them from me.

MR. STEAVENSON: Mr. Wells, while you are up here, I would like to ask a question In your cold frame propagation of hollies, is there any benefit from hormone treatments where you stick in the fall and rooting will not occur until the following spring?

MR. WELLS. No, I doubt it. However, in the cold frame method that I described we used heat supplied from an electric cable. The temperature was between 65 and 70 degrees and therefore you would expect benefit from hormone treatments.

MR. MARTIN VAN HOF: I would like to ask Jim Wells if he considers a mixture of peat and vermiculite to be beneficial for the rooting of cuttings?

MR. WELLS: I don't particularly like vermiculite, although I might be prejudiced. I think it produces a long watery root, and for that reason I don't like it. I do like perlite. The texture of medium which is made up from peat and perlite is quite different from that of a vermiculite-peat mixture. It drains much more readily and it feels gritty. I like that, and therefore I am bearing down on it's use quite a lot. I think it has considerable possibilities, and I would go further and say it might be an advantage to add some of chopped styrofoam to make it even lighter and more porous. I believe many of the problems associated with poor rooting are to be found in poor aeration of the rooting medium. The old-fashioned method of hammering down the rooting medium and hammering in the cuttings was, I believe, induced by a necessity to have the base of the cutting closely in contact with the rooting medium so it could perhaps get a little water and thereby keep in a turgid condition. With the advent of mist, that necessity no longer exists.

PRESIDENT VANDERBROOK: Jim, I know that you have been doing quite a bit with mist propagation. The question I would like to ask is whether you have tried any of the polyethylene structures and what results have you had in the past?

MR. WELLS. Yes, I have tried polyethylene, but not as a structure. I tried it as a covering for the bench, as Harvey Gray showed us yesterday, and I think that idea was first promulgated by Mr Lem in Oregon. My results have not been as good as other people have reported. I believe that we are all after the same thing, which is the control of water and the economy of water in a cutting, while it is re-establishing itself and reorganizing its tissues at the base in order to get a new root system The polyethylene tent which reduces water loss and maintains a high relative humidity in the atmosphere is one effort, the use of misting is another and the use of Mr. Hancock's syringing is another We should look at all these ideas and methods with that one idea in mind, the economy of the water reserve in the unrooted cutting.

I prefer an open greenhouse or frame with a mist system added, because I have found that there is less trouble with fungus diseases under that system. I think the use of mist by everyone has shown a great reduction in the incidence of fungus trouble, and the one time that I tried covering my bench right up with polyethylene, fungus came in or got in and became rampid and swept through there like wildfire.

PRESIDENT VANDERBROOK: Have you ever submerged your entire cutting in Orthocide, at the rate of two pounds to 100 gallons of water to prevent the fungus development?

MR. WELLS: Yes, I have tried it, but not for cuttings stuck under polyethylene. I did try this procedure under normal misting conditions, although it didn't seem to do any good or harm. I didn't get any less or any more fungus, since the mist itself seems to be as good control as anything for fungus diseases.

MR. ROLLER (Verhalen Nursery Co., Scottsville, Texas): I would like to ask Fred Galle if he doesn't know a half dozen varieties of camellias that will take 5 to 10 degrees below zero. I understand there are some that will take these temperatures.

CHAIRMAN GALLE: You are talking about the varieties that will flower under these conditions, since I think all of them are hardy at these temperatures Reporting on Zimmerman's paper, which was in the 1955, Camellia Year Book, he listed the varieties Lady Clare, Debutante, and things that even in the mid-south are not considered satisfactory. Apparently what these plants were doing was remaining dormant and flowering in the spring rather than coming in mid-season as we normally think. I think there are a good number of varieties, including those of *C. sasanqua*. They are qualifying and I think are even more satisfactory in some cases than the *C. japonica varieties.*

MR. JOHN VERMEULEN: Talking about borderline plants and temperatures of 20 degrees below zero, I would like to ask Hillenmeyer how many nights of 20 degrees below did he have?

MR HILLENMEYER: Just one night of 20 degrees below zero. We had 5 or 6 nights running that were 10 below zero, in the winter of 1951. I think five times during that winter in January and February, the temperatures were 15 degrees below zero

MR. VERMEULEN: On the question of borderline plants, many times they can be brought up from the South and can be used in certain sections. We could theoretically use most of the plants you have mentioned in New Jersey, since we very seldom get 20 degree below temperatures. However, all the plants you mentioned are generally killed by the wind in February, not by the extremely low temperatures.

MR. HILLENMEYER: You are correct in noting that low temperatures are not the only factors contributing to the hardiness of these plants.

MR CARL GRANT WILSON: I would like to ask the Chairman about the open field propagation of junipers in the Huntsville area. I have had some of the cutting material propagated in this area and I find they are stuck 8 to 12 inches deep. Can you explain why?

CHAIRMAN GALLE: I think the original deep sticking was necessitated by the lack of irrigation. I think now that they are using irrigation they are sticking their cuttings shallower. I know that there has been quite an objection to that long shank.

MR. RICHARD VAN HEININGEN (Van Heiningen Nurseries, Deep River, Conn.): I would like to direct this question to Mr. Wells We do a considerable amount of propagation using frames equipped with heating cables. We have had some trouble with fungus in years past. This winter we were rather successful, with no difficulties. However, we felt that our operation was a little bit expensive because we were rather fearful of using a cover over the glass on these frames at night We were concerned about the immense amount of condensation which collected on the inside of the glass when we used reed mats. It was just dripping in the morning and the cuttings were soaked. We felt that might be just the right condition for fungus to begin. Would you think that would be anything to worry about?

MR. WELLS: No, I don't. I say not worry about it, but any prudent operator keeps his eyes open and looks for trouble which will occur from time to time. We are using three frames, each with ten standard sash and they are heated by electric cables. The cost of heating the frames each month is $25. The frames are covered with mats.

MR VAN HEININGEN: How long are these frames?

MR. WELLS: These frames of ten sash are 30 feet 9 inches long, with the dividers. Each strip of ten sash would hold about 10,000 holly cuttings. We cover them each night with reed mats and roll the reed mats up in the morning. If it is a mild day we will give them a little air In addition to that, we have a line of Florida jets running down the center of the frame, operating at a pressure of about 80 pounds If I think the day is going to be bright and clear and it is likely to get a little warm, I will put on the mist system and let it run throughout the day, which means that there is a lot of water in that frame

MR JACK SIEBENTHALER: I have no question but a few comments, one directed to Mr. Wells, and the other directed to Fred Galle

First, I would like in a friendly way to score Jim Wells for his expression of the common fallacy in the nursery industry today that it is the job primarily of the retailer to educate the public To me, that is in direct contrast, in fact, diametrically opposite to the established basic principles of selling in the United States. The only example that you have to look to is the automobile industry or if you want to look further you can look at the television or refrigerator people, where the manufacturer, whom we could compare to the wholesaler in this particular industry of ours, does the primary and basic advertising. He comes out with new models or new plants. He promotes those models if he thinks they are good enough and establishes a desire in the minds of the public to come to the retailer and demand that particular product or model Now that is a basic method of merchandising in this country. I don't think we are so different, Jim We are not a different breed of horses from the automobile manufacturers. We may be lighter and slower but we can overcome that in a short period of time. I think before we make any further commitments about our ignorance we ought to look at the basic problem of merchandising. This is not a merchandising session so we won't carry it any further. Let's not blame the retailer any more than we blame the wholesaler who sits behind his desk, and produces the same old plant material. Let him come up with new material and a well planned promotion scheme, as for example, the All-America Rose. This is probably one of the best examples Let him come out with his promotion and create a desire in the minds of the public. Then the retailer and smaller growers will follow along and everybody will enjoy a healthy business climate.

The other comment I would like to make is simply to stir up interest for a future program. In line with what we have heard this morning, I think we can find a great deal of interest in this group on a discussion of so-called reversed hardiness. I think there can be a further development of a study along the line of trading some of the more desirable Northern plants to the South. I am genuinely serious in hoping sometime in the near future of hearing a discussion on what Northern plants not grown in the South might have possibilities in the warmer climate.

MR. QUINN (Ashland, Ohio): Mr. Hillenmeyer, in regard to after-hardiness of plants that you bring in from the deep South, have you had any records in regard to the different seasons or months of the year that you received the plants?

MR. HILLENMEYER. No, I haven't any results for the different seasons. We have lost them when we brought them in the fall, and we have lost them in the spring If we receive them not too late in the fall, at a time when perhaps they are still a little tender, we might get a cold snap and that, I think, does the damage In the spring, if we get them too late, they usually have begun to green up and a late cold snap does the damage. After they have been planted out a year, we notice no difference in their hardiness from the ones grown in our locality. If they get through the first summer all right, they generally do quite well.

MR. QUINN. The reason I brought this question up, was that I have observed a nursery in North Central Ohio, that has been regularly bringing salable plants up from the deep South. I wondered why they would bring three to four or four to five foot plants and put out into their field in the Spring. I expected all the plants to be dead, but believe it or not, all those plants came through the first winter without any damage whatsoever. I finally found the secret of their moving these particular plants. They brought them in January, at a time of the year when the plants should be completely dormant. They brought them into cellars or cold barns and kept the plant completely dormant until clear up into April They were then brought out into their sales beds or put directly in the nursery

MR. LESLIE HANCOCK: Mr Wells, I would like to know what temperature the Johnson variety of *Ilex opaca* went through in 1934.

MR. WELLS. I do not know. Mr Gable lives in Stewartstown, Pennsylvania, which is in the southern part of the state near the Maryland line. It is relatively high up, about 900 feet up in a very exposed place.

MR. VERMEULEN: I believe that this plant has withstood temperatures below zero, without injury.

MR ART VUYK: I would like to add a little to what John Vermeulen was saying about the temperatures in Pennsylvania Fifteen to twenty below zero is quite common in Indiana, Pennsylvania If these temperatures occur in January I am not worried about them, but I am worried about a temperature of ten above in March Under these conditions we get damage to several of these more tender plants

Now I have a question to ask Mr. Wells. I would like to go a little further than even two years' wood at the base of holly cuttings. I am convinced that you can even use five or six year old wood just as easy as the two year However, I am a commercial grower and I would like to know where I can obtain 15,000 cuttings at a reasonable price?

MR. WELLS: Well, this does bring up a point which I think every propagator faces and that is the need of having a good stock block. I wonder how many of you that have stock blocks give them as much care as your salable plants. They should have better care

CHAIRMAN GALLE: That is all the time we have for questions. I want to thank the members of the panel and thank you for your interest. (Applause)

PRESIDENT VANDERBROOK: We are traveling along pretty much on time, and as scheduled, our next subject will be on the mulch bed method of producing seedlings It is now my pleasure to introduce Mr. William C. Sherman, who will discuss this subject for us.

MR WILLIAM CARL SHERMAN (Forrest Keeling Nursery, Elsberry, Missouri): Thank you, Mr. President. I am very happy to be here this morning and present this topic to you. I am two and a half years young in this business, and I am sure that I do not have all the answers for you.

Mr. William Sherman read his paper, entitled "The Mulch Bed Method of Seedling Production" (Applause)

MULCH BED METHOD OF SEEDLING PRODUCTION

W. C. SHERMAN[1] AND R. E. SHERMAN[2]
Elsberry, Missouri

INTRODUCTION

The mulch bed method of seedling production has been used at the Elsberry Plant Materials Center since its establishment by the U.S. Department of Agriculture, Soil Conservation Service in 1934. Neighboring, Forrest Keeling Nursery has adopted the method because it fits in with weather and soil conditions of the area. Having shared experience for several years, we are presenting this subject jointly.

MULCH MATERIAL

The mulch material used is "header-tow," a by-product of local saw mills making barrel heads The type of material most sought is the long, stringy, saw scurf which results from sawing of the barrel head, hence the name "header-tow." Among the principle advantages of this material are: (1) moisture conservation, (2) prevention of crust and compaction of our fine, silty loam soils, (3) erosion control, (4) temperature control, and (5) suppression of weeds. The most economical and practical way of spreading the mulch material is by means of a manure spreader. It is important to cover the seed beds immediately after seeding to prevent drying and exposure of the seed. The applied depth is from one to two inches, which settles to a depth of from one half to one inch at the time of seedling emergence. The material can cover seed beds several times deeper than the amount of soil covering the seed since it is very porous and light. As a general rule, it is applied deeper on large seeded species, and shallower on the species of plants having smaller sized seeds.

SEEDLING BEDS

Raised seedling beds are used at both the Forrest Keeling Nursery and the Elsberry Plant Materials Center. Because of the adaptability of other equipment, Forrest Keeling Nursery beds are made three feet wide, while those at the Plant Materials Center are four feet in width Height ranges from three to five inches above the two-foot wide pathways. Advantages of raised seedling beds are: (1) good drainage, (2) aeration, and (3) ease of digging seedlings. On flat bottomland there is the problem of cross drainage.

Forrest Keeling Nursery uses a Larchmont bed former. In forming beds with this machine, two or three trips are made over previously tilled soil to achieve the desired raised bed. A five foot wide, mounted, cultipacker is used to firm the soil prior to seeding. The narrow, two inch corrugations of this machine pulverizes and forms the soil into one-inch deep indentations, ideal for seed coverage. After seeding, another trip with the cultipacker covers the seed with soil.

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[1]Forrest Keeling Nursery, Elsberry, Missouri

[2]Elsberry Plant Materials Center, Soil Conservation Service, Elsberry, Missouri

SEEDING

For most seeding at Forrest Keeling Nursery, seed distribution is accomplished by a three foot Gandy seeder. This can be used with seed of almost any size, that is, from seed of the *Lonicera* species to that of most of the *Prunus* species. A shallow metal pan, one foot square, is used to check the seed sowing rate. In cases where stratified seed is not separated from the medium, or where small lots of seed are involved, seed is broadcast by hand. Seed is immediately covered with soil by means of a cultipacker, and the mulch is applied without delay. Density of stand is very important for the following reasons: (1) size and caliper of stock desired, and (2) mutual protection of seedlings such as shading and wind movement effects.

Seed sowing data sheets are maintained on all seed collected or purchased. Data contained includes, accession number, scientific and common name, source, amount, seed per pound, cutting test, estimated emergence, estimated plants per pound, production quota, amount to sow, density desired, square feet of bed space, estimated production, preplanting treatment, days stratified, depth to cover, method of seeding, date to plant, mulch, disease and insect control, emergence notes and digging count

SHADING

Shading is very important on certain species from emergence through the first year. Sometimes it is needed through the second year. However, most deciduous species are grown without shade The chief values of shade are. (1) protection from sunlight, (2) cooling effect, (3) moisture conservation, (4) winter protection, and (5) protection from wind. Lath, or picket fencing is the material used for providing partial shade over seed beds.

SOIL AMENDMENTS AND PREPARATION

In general, fertilizer applications are made in accordance with soil tests. Any deficient element is added to the extent necessary to bring that element to a high level of fertility. It is considered essential to meet the fertility needs of the soil because there are so many other limiting factors in seedling production. The basic soil amendment is applied ahead of the formation of the seed beds, of course. Supplemental fertilization, mainly nitrogen, is applied several times, during the growing season, through the irrigaton system.

Our loessal soils (pH 6.0) are not acid enough to require changing the pH to grow most woody seedlings. However, conifer seedling beds are treated with acid forming agents such as sulfur, ammonium sulfate or aluminum sulfate. Since the soils of both Forrest Keeling Nursery and the U.S. Plant Materials Center are of loessal (wind blown) origin, seedling beds are located on either upland or river bottomland The upland areas are located along the first row of river hills above the Mississippi river, where the loessal deposit is deepest. The bottomland seedling areas are located on restricted sites of "made" soil, which is nothing more or less than the locss mantle washed down and deposited near creek mouths on the bottomland during the 100 years since the hills have been farmed.

The loessal (or recent alluvial) soils have excellent characteristics such as good drainage, resistance to compaction, moisture retention, good buffering qualities, good mineral supply and are generally satisfactory for seedling production. They are low in organic matter and there is a need for constant nitrogen nutrition to insure maximum growth. To maintain or build up organic matter in the soil, actual additions of organic materials are needed. The Plant Materials Center has available agronomic seed crop aftermath which is chopped with a forage harvester and worked into their seedling production areas to maintain soil organic matter. An attempt is made, at Forrest Keeling Nursery, to prepare the soil by a preceeding perennial sod crop Any good, fibrous rooted grass-legume combination such as bromegrass-alfalfa or perennial fescueladino, is satisfactory. The fertility level is brought up to optimum during this grass period by whatever fertilizer additions soil tests indicate. The land is grazed but no grass clippings are removed for hay. These perennial sod crops, heavily fertilized, bring the organic matter to a high level and, more important, provide a fibrous residue that will persist in the soil much longer than that provided by an annual green manure crop. The land remains in the sod crop for at least two, and probably three or four years. A very heavy application of nitrogen is in order when the sod is turned under, to provide for a quick breakdown of the heavy grass and maintain a satisfactory carbon-nitrogen ratio.

THE WEED — PATHOGEN COMPLEX

From time to time, at the Forrest Keeling Nursery and the Plant Materials Center, the gamut of selected herbicides have been tried for weed control in seedling beds. Oils (Stoddard solvent, etc.) are excellent in conifer beds, but we are convinced that, for the wide range of seedling material produced, post-emergence control of weeds is essentially the wrong approach. We are convinced that the proper concept is the elimination of weed seeds, together with pathogenic fungi, nematodes and other soil insects, prior to seeding. Ideally, this should be accomplished after the beds are finished and immediately prior to seeding Practically, this time is not always possible as it may be necessary or desirable to seed in cold weather when soil treatments may be ineffectual. We are not completely satisfied with any soil sanitation treatment presently available.

The Plant Materials Center uses methyl-bromide which is extremely effective as a herbicide, somewhat less satisfactory against soil fungi, and excellent against insects. Methyl-bromide is expensive to use and most laborious where several acres are to be treated. At present, at Forrest Keeling Nursery, we believe allyl alcohol to be the most satisfactory soil treatment. It is readily applied through the portable irrigation system and several acres can be treated per day. Even at a very heavy rate of application (75 gal per acre) cost is one-half that of methyl bromide. Actually, we have realized quite good weed control at the 25 gal. per acre rate. The fungicidal and nematicidal qualities of allyl alcohol are not well established, but we believe they can be important. Probably combinations of allyl alcohol and nematicides such as D.D. (a mixture of dichloropropane and dichloropropene) would enhance the general effectiveness of this treatment. There is definite need for a system to sanitize seed-bed areas with an effectiveness similar to what the florist can accomplish by steaming his greenhouse benches.

SEED HANDLING AND PRE-TREATMENT

This is a topic in itself and was most adequately covered last year by Miss Lela Barton, of the Boyce Thompson Institute. Suffice this to say that any seedling growers will do well to have the complete Boyce Thompson library of bulletins on woody plant seed studies. Another "must" is the U.S. Forest Service "Woody-Plant Seed Manual," Misc. Pub. No. 654. Among recent seed studies, Coggeshall's reports are some of the more helpful in ascertaining pre-treatment needed for a number of relatively rare species.

For 20 years we have vacillated between fall seeding vs stratification and spring seeding. There are hazards either way. About the time we adopt fall seeding, a series of late spring freezes which decimate resulting stands will make stratificaton and mid-spring sowing look mighty good. Then, when it never stops raining in April and May, as happened this year, you kick yourself for not fall seeding If you don't have controlled cold storage, you will find stratified seed can 'blow up in your face" while you are waiting for the rain to stop. We find it possible to standardize our pre-treatment practices to a large measure. For example, all seed after-ripening is satisfied by either fall seeding (which may mean summer or spring seeding, depending upon species) or warm or cold stratification for required periods. All scarification, where an impermeable seed coat is a problem, is handled by an appropriate bath in commercial sulphuric acid.

SEED PROCUREMENT

While most conifer seeds are satisfactorily available on the commercial market, this is not true with many or most deciduous species. Seedling nurserymen are well aware that it is well nigh impossible to order many deciduous varieties from commercial sources and expect delivery in time for necessary stratification or other pre-treatment. Often too, seed arrives in a condition of questionable viability.

For many, if not most, deciduous species the answer lies in local seed sources. To supplement local sources in parks, private gardens, botanical gardens, and native trees, shrubs and vines, we have for several years been in the process of establishing hedge rows and plantings of trees, and shrubs that fruit early in life and are generally difficult to come by. Already these "seed orchards" are providing much of our seed needs.

While the above practices and procedures have proved effective for us, we are still seeking newer and more efficient means of production. It is probable that the swiftly changing field of chemistry will contribute technological advances that will alter our whole production program in the near future

Table 1.—Seed treatment, date of planting and stands of ornamental plants.

Species	Preplanting Treatment	Date Planted	Days Stratified	Live Plants per square ft (11/1/'57)
Albizzia julibrissin	Sulfuric Acid — 30 min.	5-13-57		40
Ampelopsis tricuspidata	Stratify[1]	5- 9-57	120	20
Crataegus crus-galli	Planted dry; 1 year seed	8-29-56		43
Elaeagnus augustifolia	Soaked 48 hrs, froze 18 hrs	5-14-57	8	6
Hamamelis vernalis	Planted dry; 1 year seed	8-29-56		47
Ligustrum amurense	Stratify	5- 1-57	78	19
Lonicera maacki podocarpa	Planted dry	10-31-56		10
Mahonia aquifolium	Stratify	4- 0-56	112	18
Malus, Bob-White	Stratify	5- 1-57	39	36
Malus baccata mandshurica	Stratify	5- 1-57	39	20
Malus baccata Rosybloom	Stratify	5- 1-57	39	25
Phellodendron amurense	Planted dry	11- 1-56		42
Pinus echinata	Stratify	5 -1-57	58	44
Pinus nigra	Stratify	5- 1-57	38	18
Pinus sylvestris — Jennings	Stratify	5- 1-57	38	38
Pinus sylvestris Nye Branch	Stratify	5- 1-57	38	36
Pinus sylvestris Boonville	Stratify	5- 1-57	38	70
Prunus yedoensis	Stratify	5-14-57	130	6
Prunus mahaleb	Stratify	5-14-57	114	6
Pseudotsuga douglasi glauca	Stratify	5- 1-57	50	44
Rosa multiflora	Planted dry	12- 6-56		28
Rosa wichuriana	Planted dry	12- 6-56		22
Syringa amurensis	Planted dry	10-16-56		12
Syringa pekinensis	Planted dry	10-16-56		27
Ulmus pumila	Planted dry — fresh seed	6-10-57		28
Ulmus parvifolia	Stratify	5-14-57	125	15

[1] Stratify in a mixture of sand and peat at a temperature of 40°F

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(Editor's note). Mr. Roger E. Sherman of the Plant Materials Center, Elsberry, Missouri, supplemented this discussion with a series of color slides depicting salient features brought out in the preceding talk.

PRESIDENT VANDERBROOK: Before I call for questions I would like to announce that one of our members, Mr. Don Vanderbrook, employed by C. W. Stuart Nursery Co, Newark, New York, has had an acute appendicitis operation, is doing fine, and that flowers have been sent by the Society.

There is one thing I notice, particularly in so many of these talks, and that is, the construction of supports for shade on beds. I notice so many are using ground stakes and going through the laborious process of putting on wire. We used to do that for a long time, but since have adopted a newer arrangement. The method we use now is simple, quick and doesn't make use of stakes which rot in the ground and require replacement. We now use a 14-foot strip of 2″ x 3″ timber, in which we drill a half or three quarters inch hole half-way through it, about 18 inches from the end. This is repeated on the other end, and once more in the middle of the strip of timber We then go to the junk yard and pick up all the one-half or three-quarter inch galvanized pipe they have and cut this into lengths with a pipe cutter or acetylene torch It is easy to drive the stakes in the ground with a sledgehammer, position your 14-foot drilled strip, and then roll on your lath.

Are there any questions you would like to ask either one of these speakers?

MR. HOOGENDOORN: I would like to ask Mr. Roger Sherman if he covers his seed with soil and if the seed is pressed in?

MR. ROGER SHERMAN: The seed is covered with the Cultipacker running over the bed for the second time. It is then pressed in.

MR. HANS HESS: I'd like to ask Mr. Sherman whether the smaller seedling conifers, such as the spruce and pine, are grown also with this mulch cover

MR. ROGER SHERMAN: Yes, we do mulch these seedbeds. However, with those small seeds we don't have quite an inch of mulch on them by the time they germinate. By spring, at emergence time, it has settled down to maybe a quarter of an inch. It is important not to get it too thick on those seeds.

MR HESS: One more thing Is there a greater danger from fungus infection with the type of mulch covering you are using? We have always used sand to cover the seed and a hay cover over that which we remove at the time of germination. Isn't there a very large potential danger of fungus damage?

MR. ROGER SHERMAN: By using methyl bromide prior to seeding, as well as a soil drench of Fermate, Captan, and DDT at the time of emergence, we have had no stand reduction.

MR. HAROLD BARNES (Barnes Roses, Inc., Huron, Ohio): I would like to ask Mr. Sherman a question about the hammermill. Is that a standard hammermill which is used for cleaning seed or do you have to modify the commercial unit?

MR. ROGER SHERMAN: That is a Forrest Keeling Hammermill in which the hammers are stationary.

MR. VAN HOF: I would like to ask Bill Sherman how he cleans the seeds out of a vermiculite and peat stratification medium.

MR. WILLIAM SHERMAN. This is a very good question. We dry the seed slightly on a seed-drying screen, just enough so that the vermiculite becomes lighter, and then run the seed through a fanning mill, blowing out the vermiculite. Then by the use of screens you may separate your seed from the vermiculite.

MR. STEAVENSON: I think one comment that I would like to make is in order. The Soil Conservation Service has gotten out of the nursery business. Their production at the Plant Materials Center is restricted, as you observed, to those experimental plots of material which they are trying out, in an attempt to provide better material for use on farms in erosion control. The Soil Conservation Service has been outstanding in getting out of the nursery business. I only wish we could say the same of the state and other federal agencies.

PRESIDENT VANDERBROOK: We stand adjourned until 1:30 P.M. I want to compliment you fellows in the audience, as well as our panel for a very lively and interesting meeting

The session recessed at 12·15 o'clock.

FRIDAY AFTERNOON SESSION

November 22, 1957

The session was convened at 1:30 o'clock, President Vanderbrook presiding.

PRESIDENT VANDERBROOK: The first subject, which is going to be discussed by Dr. A. E Hitchcock, is one in which I am sure the entire membership is going to be very deeply interested. We are all looking for new methods, chemical or otherwise, to cut the production cost of our plants. So at this time it gives me pleasure to introduce Dr. A. E. Hitchcock, of the Boyce Thompson Institute for Plant Research, who will talk on, "The Synthetic Aids to Propagation. A review of hormones and other chemicals in cutting propagation," Dr. Hitchcock.

DR. A. E. HITCHCOCK (Boyce Thompson Institute, Yonkers, New York): Thank you, Mr. Chairman. You know, I am not sure that I should be here today. This is the first time I have given a talk which will not be based on recent experimental results, and as you will note from the title, this is really an assignment

My discussion will be mainly a summary of the work which has been done at the Institute since the time root-inducing substances were used back about 1935.

Dr. Hitchcock discussed the subject of the use of hormones and other chemicals in cutting propagation. (Applause)

THE SYNTHETIC AIDS TO PROPAGATION: A REVIEW OF HORMONES AND OTHER CHEMICALS IN CUTTING PROPAGATION

A. E. Hitchcock
Boyce Thompson Institute
Yonkers, New York

Last year you heard from Dr Henry Kirkpatrick whose specific subject was concerned with the rooting of lilac cuttings. As a result of this interesting discussion there are probably many questions in regard to what might be the prospects for the development of new root-inducing chemicals, what is the present status of rooting compounds, and what are the specific uses for these chemicals. As far as I am concerned I think that there is always a use for root-inducing substances in cutting propagation It is true that they will not work on all species of plants, and therefore cannot be considered a cure-all. As for the possible development of a chemical which will produce roots on all species of plants, I doubt very much whether such a chemical will ever be developed. There is a possibility that one might be formulated, or discovered, but I think that it is quite unlikely.

One of the first so-called hormones used to stimulate root production on cuttings was indoleacetic acid However, as other chemicals, closely related to this naturally occurring growth substance were discovered, it was clear that indoleacetic acid was not the best chemical which could be used to induce roots on cuttings. As a chemical it was relatively unstable, and although it could be used to root many cuttings, a higher concentration of the chemical was required than was necessary of other, more commonly used chemicals. One of these highly effective, synthetic root-inducing chemicals is indolebutyric acid. This chemical, in relatively small concentrations was very effective in inducing roots on cuttings and, what is more, it had a fairly wide range over which, you might say, it was safe to use.

As techniques for application were developed, we shifted from the 16-24 hour soak, to talc carrying rooting substances, the latter better known as powders. Again, the usefulness of indolebutyric acid was demonstrated by its relative effectiveness over a fairly wide range without causing injury to the cutting, even though roots were often produced from the uninjured tissues higher up. It was also possible to retard root induction by too high a concentration of certain substances tested. We also noted on rose cuttings for instance, that if we induced 25 roots or more, bud break would be delayed. This is perhaps true, to a lesser degree, with cuttings of other plant species.

As more became known about these root-inducing substances there was a gradual shift from the use of indoleacetic acid to indolebutyric, and naphthaleneacetic acids, and finally to a combination of the latter two chemicals. In general, naphthaleneacetic acid proved to be rather exceptional in inducing the rooting of certain evergreen species. However, as has already been brought out it had a narrow range of effective concentration as compared to indolebutyric acid. Mixtures of chemicals were generally more effective on cuttings than any of the individual substances. In many cases a greater than additive effect was obtained.

As experimentation at Boyce Thompson Institute continued, the relative effectiveness of the various derivatives of a particular synthetic compound was developed. The volatility of the ester forms was pointed out, the insolubility of the amide and ester forms in water was noted, and so forth. At the same time, we synthesized 2,4-dichlorophenoxyacetic acid (2,4-D) in our laboratory and found that it was very active, in dilute concentrations for inducing cell elongaton. Of course, as you all know, this chemical is one of our most potent herbicides, causing considerable foliage modifications in weeds and other plants. In the course of these studies we tested some 60 substituted phenoxy and benzoic acid compounds. We found out that 2,4-dichlorophenoxy-propionic and butyric derivatives were quite active in inducing cell elongation and curvature, but they, unlike the acetic form did not have a formative effect on new organs which developed after the plant was treated. Also, it was evident that 2,4,5-trichlorophenoxypropionic and butyric derivatives acted in a similar manner, but were considerably more effective Although they were effective in only fractions of the amount of indolebutyric acid required to produce a desired result, they had a rather narrow range in which they could be used without causing injury.

Mr. J. S. Wells, formerly of Koster Nurseries was very interested in the idea that some of the substituted phenoxy compounds might prove useful for the rooting of rhododendron cuttings I believe he tested some 37 different compounds in this general group and concluded that 2,4,5-trichlorophenoxypropionic acid was one of the best This was quite an usual undertaking for a commercial nurseryman, and one which yielded valuable information on optimum concentrations and the rooting of some of the more difficult red varieties of rhododendrons.

If one studies the literature closely he might be puzzled to find that there are often two or more concentrations of a rooting substance recommended for a particular type of cutting I know we have often been criticized by growers and practical people because we have not worked out sufficient practical recommendations for a specific rooting compound. Actually this was not our objective, since we were primarily interested in establishing the relationships between chemical structure and some measurement of physiological activity, or in this case, rooting For many of these tests we worked with privet cuttings, a plant which is considered to be fairly easily rooted. This plant was selected because of the ease of selecting cuttings, which not only are fairly uniform from season to season, but also from year to year. Because of the use of this plant you may ask what use or application do the results have for the more difficult varieties. May I note that regardless of the material, basic responses can be identified and correlated into some type of pattern. From these patterns further experimentation could easily establish the practical aspects of these studies. On occasion we have been influenced to extend these basic studies to find a practical application. One such case was with *Ilex opaca* in which we not only worked out optimum concentrations of root-inducing chemicals, but investigated subsequent rate of growth, after effects of chemical treatment, and growth comparisons between own-rooted and grafted plants. After treated cuttings of this plant have been rooted, transplanted, and finally lined out in the field they make a very bushy and unusual type of growth at first. These can be pruned severely. They will then form leaders and grow rather fast to form a really good specimen

What is the value of root-inducing substances? This is a common question frequently asked of us. Speaking mainly of woody plants, I would say that on certain species you get more and larger roots in any given length of time Practically it permits you to get the rooted cuttings to the transplant bed, pot, band, or field in a shorter time, and often with less loss For example, many times rhododendron cuttings which have not been treated with a root-inducing substance produce a root system that has a single point of attachment You might have a great ball of roots, but unless the operator was particularly careful in handling, the root system would be entirely lost. Treatment, then, on rhododendrons is valuable because more than one or two points of attachment between the root system and the cutting generally results.

Root inducing substances should be looked upon as aids to the rooting of cuttings, not as cure-alls. There are many propagators nowadays who can root cuttings without these substances. However, by knowing how rooting compounds influence propagation, they can be used effectively and integrated into the regular program. Indolebutyric acid, for example, works well on most yews, broadleaf and small-leaf hollies require less dosage and are not a problem as a rule One must learn when and how to use root inducing substances if they are to be used to best advantage.

It is generally recognized that there are a number of variables that enter into the propagation of plants by cuttings As season of collecting softwood cuttings influences rooting response, so does the concentration of the root-inducing substance. Although certain concentrations have been established for certain classes of cuttings, there will be differences in response from year to year. For example, between 1937 and 1942 we rooted a number of commercial varieties of apples by means of leaf bud cuttings. We tried to duplicate these results in 1945, but were not as successful as we had been earlier. Lack of disease control in the orchard at the later date was believed to be the principle reason for the poorer results.

From what we have seen at Boyce Thompson, it appears that perhaps misting almost substitutes for the use of growth substances in most cases. The fact that it is possible to keep cuttings in good shape until such a time as they are rooted has offset the advantage of slightly reduced intervals required to root a specific type of cutting. I would say, from the commercial aspect, that there are many species of plants on which you almost had to use root-inducing substances. Now, with mist, it would not be quite so important. Most of what I have said applies to leafy cuttings.

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DR. HITCHCOCK· To discuss the use of root inducing substances on leafless, hardwood cuttings I would like to ask Dr. Chadwick, of Ohio State University to come to the speakers stand

DR. L C. CHADWICK (Department of Horticulture, Ohio State University) : I have only very brief comments to make as far as the use of synthetic growth substances on leafless hardwood cuttings is concerned. I think a good many of you probably have watched the literature closely enough to know what is available relative to this subject. Probably there are some of you that have tried synthetic growth substances from a practical standpoint on leafless cuttings

The information that is in the literature, some of which I reported in the Proceedings of the Third annual meeting when we covered the subject of hardwood cuttings, would not indicate very favorable results There have been a few reports which would indicate considerable stimulation from indolebutyric acid and some of the other synthetic materials on leafless cuttings There are also a good many reports which would indicate no response whatsoever A good many of the favorable reports, which actually are few in number, I would say were with cuttings of plants that are compartively easy to root. Dr. Pearse of England, for instance, reported using indolebutyric acid on willow cuttings Cuttings of this plant usually do not give us very much difficulty but he reported considerable stimulation on cuttings of that type. There have been several other reports out of England, primarily from the East Malling Experiment Station on the use of root inducing substances for hardwood cuttings of plums; particularly those which are used there for understocks. They have also tried them on hardwood cuttings of the Malling, dwarfing understocks and almost without exception these reports would indicate no response from the synthetic growth substances.

There have been several reports, one by Johnston of Michigan, and another by Myhre in Washington, where synthetic growth materials have been used on hardwood cuttings of several varieties of blueberries. Again these reports would indicate very little, if any, response from synthetic materials on these types of cuttings. Bringing Russia into the picture, there was a report by a man by the name of Denza who obtained excellent results with 0.01 percent heteroauxin on hardwood cuttings of the weeping mulberry. He made no great elaboration of his results in the report although he indicated there was a response at least on cuttings of this particular type of plant. I think several of you are probably familiar with the work that Dr Doren of Massachusetts reported on using *Franklinia* and *Magnolia virginiana* cuttings treated with indolebutyric acid along with Phygon XL. His results were very striking as far as stimulating effects are concerned using a combination of the two ingredients A mixture of the two materials gave much better results than did either used alone.

Now, getting down a little bit more to the commercial aspects of this problem, I have talked with a good many propagators in various sections of the country who have tried to use synthetic materials on deciduous hardwood cuttings. I would say the great majority have reported no beneficial results. I think by and large, results would indicate that root-inducing substances have been used to greater advantage on leafy cuttings than on leafless hardwood materials. Those are about all the comments I have to make. Thank you.

PRESIDENT VANDERBROOK: Are there any questions?

MR HOOGENDOORN: I would like to ask Dr Hitchcock a question. This summer was the first time we ran an experiment on misting in an open frame. We tried different rooting powders and different types of plant materals. The normally easy ones were easy to root and the hard ones were still difficult. When we stuck a number of *Philadelphia coronarius* cuttings treated with Hormodin No 2 and No. 3 in ten days the leaves gradually started to turn black and drop off. What did I do wrong or what was the cause of this?

DR HITCHCOCK: Well, I would guess you probably used too high a concentration of root-inducing substance for this species. I would guess that you should use not more than the No 1 powder

MR. HARVEY TEMPLETON: I would like to ask Dr Hitchcock about the comparative effectiveness of the potassium salt, sodium salt and acid forms of indolebutyric acid

DR. HITCHCOCK: The salts were more effective than the acids from two standpoints. One, the salts generally are less critical with any given concentration and we get better results than with the acid. We explained that on the basis mainly of solubility. In other words, the salts are more soluble in water and for any given concentration you probably would get a little more in your cutting as compared to the acid.

MR. TEMPLETON: Is the salt any more unstable than the acid?

DR. HITCHCOCK: Fully as stable, if not more so.

MR. JACK HILL: Tell me, Dr. Hitchcock, has there been any work, to your knowledge, done along the line of enabling commercial producers to predetermine, on the basis of tissue analysis or otherwise, the optimum concentration of auxin to use for a given plant under a given set of conditions? As you stated earlier, we all know one variety or species of plant will respond differently to root-inducing substances from year to year. Is there any test which will tell us to use two milligrams of indolebutyric acid or to use five, ten or twenty?

DR HITCHCOCK: Not so far as I know. Testing has been done mainly with the carbohydrates or starches and sugars. As far as I know, this has never been actually correlated with the dosage of rooting powder which would be beneficial to use.

MR. VAN HOF: I would like to comment on some experiments I saw at the horticultural gardens in Boskoop, Holland, this past summer. They had displayed some of the hard-to-root cuttings of plants which had been treated wth indolebutyric acid for 12 to 24 hours, stored and stuck out in the spring They had non-treated check plots and treated ones, and really it was marvelous to see the stand they had as a result of treatment.

DR. CHADWICK: What plants?

MR. MARTIN VAN HOF. For instance, they had the Red-leafed plum, *Prunus cistena* and some of the viburnums rooted from hardwood cuttings. I think they had a 75 per cent stand.

PRESIDENT VANDERBROOK: Gentlemen, we will move on to the topic of the propagation and culture of container stock At this time it gives me pleasure to welcome the moderator for this panel, Mr. Frank Turner.

MODERATOR TURNER: I thank you for the privilege of making a few brief remarks before this Society, before bringing on the other two gentlemen who will cover the subject of growing ornamental plants to usable or salable size in metal containers. As our discussions continue, you will notice that there will be a great difference in our levels of experience. The discussions following will be given by men who have accomplished high levels of production in the culture of many and varied plant subjects They have been doing it for a long enough time that their answers to production and marketing of their materials have come from the vital, near unimpeachable field of experience. My own remarks are not derived from a background so well tested

Mr. Turner presented his talk on container culture in the North. (Applause)

OUTLOOK FOR CONTAINER CULTURE IN THE NORTH

FRANK TURNER
Berryhill Nursery Co
Springfield, Ohio

At the outset, I ask your indulgence for a few side issues that are not concerned directly with propagation and culture. However, unless these issues are justified by common sense they would have little merit before a Society of our kind Instead of posing the question, why grow plants in cans, I would like to submit the widely considered proposition that its practice is a method that promises a large degree of industrialization to the nursery industry. This aspect of industrialization, is drawing the interest of numerous mid-America, ornamental growers. It is viewed, after all factors of the equation are thrown in, as a tempting, less painful direction for expansion.

We had a number of questions in mind three growing seasons back, at our home nursery, in Central Ohio There, we consider our operation to be on the glaciated edge of corn-belt soils, in a quite typical, reasonably severe plains climate. The plants we grow there are mostly listed for Rehder's Zone IV. We are situated on limestone soils. The culture of ericaceous material is precluded from three aspects, namely climate, soil, and water This is an example of the broad picture anyone should take of his advantages or disadvantages in regard to doing something about growing. In a new venture it is a good thing to set up a proposal or statement of what you hope to do. Our proposal was to learn how to adapt a good and successful growing method for the moderate and warm temperature zones to a colder temperature zone. We still think today that is still the foundation statement for our effort and learning.

Almost immediately after our modest start had been made, we found that we would be required to learn not only the cultural adaptations of our stated purpose but also about several other sets of factors. Today, we are attempting to find out how to grow the crop, how to balance this container line with the accepted and required lines of plant materials, and how to educate our clients on the several aspects of superiority we think we have in our finished product. Taking these elements of experience in inverse order, the last one is clearly related to sales. I list it here because it is the eventual sale that regulates the size of the container to set out to produce the plant in. It also regulates the size that the plant shall be grown to, the amount of trimming necessary and the finish desired. Sale also calls for the application of every modern merchandising device. Some of the simpler ones are eye appeal of the product, picture-labeling in some instances, and many other factors.

The development or "make up" of an inventory has for a goal, the possession of the right plant at the right time There are the assumptions that the producer can do the growing job on the item required, at a profit, and that there will be a call for it when it is ready for sale.

With the limited experience we have on the balancing up of a line of container plants it permits me to give you only our ideas of what should constitute an inventory This inventory is based on what we believe is suitable for us under our conditions of climate, market, production ability, and all other conceivable factors. We find that we need about 20 per cent of our plants with high color and with novelty attraction. For example, when we think of yellow we think of golden privet. For red we might use *Prunus cistena*, or the red barberry. In conifers, the golden biotas and some of the other off color forms could be considered These would constitute the first 20 per cent. The second 20 per cent of the inventory would be composed of plants that we call ideally adapted to the canning process. The leading and outstanding example of this is represented by the *Pyracantha*. It could possibly be said that some varieties of cotoneasters could also be more satisfactorily grown in a container than any other way There are many more plants that could be thought of that naturally fit into this category. Forty per cent should be composed of standard conifers I know no particular reason for doing this except that we are primarily in the conifer business. Since we seem to have the market for them as well as the facilities for producing them, this seems about right for our situation. The last 20 per cent we are reserving for plants in the larger container such as the 30-pound egg can or the 5-gallon container that doesn't contain 5 gallons. For this category we are under way with a line of flowering crabapples, hawthorns, flowering cherries and selected shade trees

Now the aspect of the actual growing of a finished crop of plants in metal containers immediately presents a two-sided picture Facilities, equipment, organization, and efficiency are on one side The actual cultural procedures of producing liners, potting, handling, fertilizing, watering, and trimming, are on the other. Among the facilities you should have are first, a good location, with an ample water supply. Then there is plumbing and drainage. Specialized equipment will be required to apply water, fertilizer, and insecticides Your physical plant will most certainly require buildings to do the work in. You will need mixing and conveying equipment for the growing medium, as well as equipment for soil sterilization For a mechanized operation you will need something under the general heading of a canning machine.

Now, from our experience, it appears that the type and amount of equipment you should have will be governed by the size of the crop you are producing We have observed that 100,000 plants in containers will not go far in paying and providing for equipment, but 100,000 plants will show you what equipment and mechanization you need. The degree of mechanization will certainly be governed by the individual concern. For example, a canning machine can be rigged at the end of a wheelbarrow and used for a few hundred plants or it can be a fully engineered machine of the type used in the West for turning out multiples of thousands of containers per day. All of the foregoing, be it thorough or sketchy, brings you down to the place where you are ready to pick up the plant, place it in the container and carry through to the finished product.

Let us do some thinking about the plant itself. It needs to be at a certain stage of development in order to keep pace with a timetable for growth. We break our timetable to run in increments of months, as for example, 14, 18 or 24 months. Others find that shorter intervals fit their needs better With us, the plants must be the best material out of lots of a chosen age. If there can be advantages gained in their structural development by pre-trimming, that should be done. As people interested in getting a start, we have been using plants grown to two and three years of age, in beds, for canning. These plants require root and top pruning at processing time, they pot or can slowly, and they take time to reestablish. We are simply building up our line with these with the hope of also gaining experience with general growing procedures.

In the future we intend to establish plants in clay pots or plant bands. We believe that good attention to the development of lining-out stock for container growing would go back to the selection of the cutting itself, and to the spacing afforded them in the propagation bench. While we have not had any experience, there are growers working on a trial basis, with the direct canning of unrooted hardwood cuttings and with rooted cuttings directly from the propagation bench The thing sought here is less loss of time during reestablishment period. Still the most important thing to say about the plant used is that they must be first-run stock, probably produced especially for the job. The reason for using that kind of stock is that they are going to go into an extensive and costly process of maintenance

A growing medium has to be provided. It has to contain the factors of fertility, aeration, moisture holding capacity and drainage. These are some of the essentials of what it has to have, irrespective of how it is made We have already had several excellent discussions on the preparation of container mixtures and for that reason I will give only our personal experience without further recommendations. In 1957 we used the 1-1-1 mixture of soil-peat-sand. In this mixture, the soil component only was sterilized with methyl bromide. We found our medium to be suitably sterilized as far as weed seeds were concerned For 1958, we are planninig to use a 1-2-2 mix. We are sterilizing the entire mixture with methyl bromide. Of course, there is much more that can be said on the subject of soil mixtures and their preparation.

In our nursery, plants are canned on a bench under a hopper that feeds down the soil mixture by gravity. Outside of a simple arrangement that drops the can down a hole and positions the rim to table level for filling, and the lifting of the filled can by a foot lever, there is no mechanization of the potting job The filled cans are moved to wagons by an unmotorized, roller conveyor. The wagons are tractor-drawn to the growing sites where the cans are placed in beds, 11 cans wide, 50 feet long, with 3½ foot aisles.

I will give our entire program for providing fertility at one time. Newly set plants are immediately supplied with 38 per cent nitro-form fertilizer applied by broadcasting. The rate of application is about one teaspoon per one gallon can. After this first fertilization, our plots are fed at 10-day intervals throughout the growing season with a soluble fertilizer having an analysis of 20-10-15. (This is applied at the rate of 1½ pounds per 400, one-gallon cans.) We have encountered need for adjustments to correct trace element deficiencies in the case of a few varieties. While watering is a matter of judgment, our plants are watered daily during periods of hot weather. For this we set up portable, aluminum irrigation piping with a riser at each of the four corners of the group of six beds. We then distribute the water with part-circle sprinklers directed inwardly from the four corners. Each sprinkler covers a quadrant of 90 degrees. I would like to say that we have been getting by quite satisfactorily with this type of watering system, although this does not preclude the fact that some of the plants will have to be watered by hand.

While it is possible to comment on the routine maintenance and handling of the crop and orders, I will pass on to the subject of winter protection. This is the one factor that will be most influential in determining the future of container growing in the colder climate of the United States. We have mostly wintered over our crop on top of the ground. There are many kinds of plants that have so far wintered with us under the fairly simple process of just banking soil around the exposed sides of the beds of cans after they have been placed together. There are other kinds of plants that require mulch. For this we have been using ground corncobs. I suspect we are going to have to find out many things, about winter protection, item by item and year by year

The outlook for large scale production of container grown plants in the cold temperate area is one which will have to undergo a slow, cautious period of development. One of our greatest advantages can come from a very discriminating survey of our list of plants. There is a good inventory of ornamental plants that will grow just as much in an Ohio summer as they will in a California or Texas summer We have subjects such as yews and spruces, that other areas do not attempt to grow. While large scale production may be a long time off, it will eventually come. Remember it may arrive by methods yet unrealized but I believe the midwest will give a good account of itself.

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MODERATOR TURNER: Now, as I mentioned earlier, we are endeavoring on this panel to present a picture of our container culture about the entire country. To present the next discussion, I would like to bring on the gentleman who is going to give us "The California Concept in Container Production." He is Mr Walter Lee of the Monrovia Nursery, Azusa, California.

Mr. Walter Lee presented his paper on the production of ornamentals in containers in California. (Applause)

THE CALIFORNIA CONCEPT OF CONTAINER PRODUCTION

WALTER LEE
Monrovia Nursery Co.
Azusa, California

The California concept of container production is to mass produce plants and offer them to the retail nurseryman at the lowest possible price. This has been brought about by the great demand for shrubs and trees for home beautification in California and the neighboring states.

Shrubs and trees are sold and planted in California twelve months of the year, and retail nurseries in California are open either 6 or 7 days a week. There are peak seasons occurring in the early spring and fall when the demand for plants is greater than in our summer or winter months. To meet these demands the wholesale growers in California have been forced to use mass and container production methods.

Another factor that has contributed to container growing in California is the high cost of land which in many cases amounts to thousands of dollars per acre Approximately 10 times field production may be realized by the use of container methods. For example, we can grow roughly about 96,000 containers on an acre, allowing for access roads, waterways, and space between beds.

Plants are sold in California by container size rather than by spread or height of the plant. The retail customer in California buys his plants by the gallon the same as most of you would buy oil

Due to our mild winters in Southern California, our growing season is greatly extended Plants break out of their dormancy by the latter part of February and remain in active growth until late in October or early November. This gives us a much longer growing period than most of you enjoy.

Container grown plants enjoy another advantage in that the root ball of the plant is intact, held in place by the walls of the container. There is no severance of roots as is the case of field grown stock. Therefore the container gives the plant an important advantage over balled and burlapped field stock, in that when it is planted out, the root system can readily absorb food and moisture without first having to make new feeder roots. Still another advantage of container grown plants is that they may be purchased and planted at the convenience of the retail customer. Container grown plants can be shipped long distances, arriving in excellent condition and ready of immediate sale.

With container grown plants, we are able to supply the retail nurseryman at an earlier date than is possible with field grown stock. We have had reports from some landscapers that they prefer to use container grown plants because the replacement problem is practically nil. While it is true that the container grown plants are smaller in size than field grown stock, they are as large as the field grown plants one year after planting out. It is also possible to offer the retail customer a more complete landscape job using container grown plants than it is when he must buy specimen sized, balled and burlapped stock. These are but a few of the advantages of supplying nursery stock in containers. Further thought and study on your part will bring to light many others.

It is a surprising fact to learn that fifteen percent of the ornamental shrubs grown in the United States are grown in California, and that six and nine-tenths percent of the nation s total are grown in Los Angeles County. These figures are taken from those compiled by the University of California and may be found in the book, "The U. C. System for Producing Healthy Container - Grown Plants," Manual #23.

We have long forseen the advantage of having selected, Mother plant, stock from which to take our cuttings and scion wood. The plants that are in our Mother plant field have been carefully selected for the most desirable characteristics of that particular variety Anytime a plant shows a tendency to revert to an undesirable form it is ruthlessly rouged out and replaced. It is from these selected plants that our trained cutting crews collect cuttings. From that point on, careful records are kept on the progress of that particular lot of cuttings until they reach the finished product stage.

After a cutting is rooted and potted, the training of that particular plant starts. It is fed at regular intervals so that a constant source of plant food is always available. It is pruned as is necessary, to keep it in the desired form. When a large enough root system has developed, the liner is then ready for canning. Some of the slower growing items are shifted into the next larger size pot and grown for a longer period before they are put into the gallon container We have six basic potting mixes. When plants are shifted, from pots to cans, they are placed into the soil mixture best suited for its continued growth and good health.

Soil for our canning operation is mixed in large quantities by a small clamshell and is then repiled so that a thorough mixing is accomplished. During the mixing operation water is sprayed over the pile so that the soil is neither too wet nor too dry. It is then ready to be used in the canning operation and is loaded by a skip loader into a bin located at one end of our canning machine. The soil mixture is put into the cans by hand, as we have not been able to find or devise a satisfactory machine for automatic filling of the containers. After the containers are filled to the proper level with the soil mixture, they are put on a roller conveyor that takes them to the canning machine.

The canning machine is a hydraulic press operated by compressed air that has a die slightly smaller in diameter than the one gallon container. The die packs the soil and at the same time punches a hole in the soil the proper size for either the two or three inch liner being canned. The liners are assembled in an area immediately adjacent to the canning machine. The liners are then tapped out of the pots by one man and dropped into the hole made by the die and hand firmed by another worker The container is then put on another conveyor that ends in an accumulating table. There the containers are put on a jeep drawn trailer that can handle two hundred, one gallon containers at a time The jeep hauls the trailer to the area in the nursery where the plants are to be grown. Each jeep has three trailers assigned to it, one being loaded at the canning machine, one that it is hauling and one that is being unloaded. Upon reaching the unloading area a jeep leaves the loaded trailer, picks up the unloaded trailer and returns to the canning machine where a loaded trailer is ready to be taken away. We find a canning crew of 10 people, including all of the above operations, can handle from 10,000 to 12,000 containers a day.

The two gallon, and five gallon or egg canning operations at our nursery are done by hand. The soil is put in the containers with shovels, compacted and the hole punched by a hand machine. In the meantime, a small crew has been removing plants from one gallon containers by inverting the can and tapping it against a solid object. If the soil in the one gallon container has been thoroughly watered it will come out of the container without any disturbance of the root ball. In some instances the can is cut away, especially when grafted plants are being canned into a larger size container. The same type of jeep drawn trailer is used in this operation as has been described for the one gallon canning operation.

The general conception of a finished plant in California is one that is bushy and well filled out rather than a plant that has been allowed to grow without much pruning By the time a one gallon container grown plant has reached the finished stage, we have pruned it at least ten times and this figure is almost doubled when it is grown on in the five gallon container..

The procedures of container production outlined in the foregoing are the procedures followed by the Monrovia Nursery Company. The other growers of nursery stock in California all have their own methods of growing their stock to the finished product. Also the Monrovia Nursery Company has a full time research director who keeps a very close check on all phases of production, from the cutting or seed to the finished product.

MODERATOR TURNER: Thank you, Mr. Lee. Since we should follow the procedure that has prevailed here, we will reserve ample time at the end of these discussions for questions. So without further loss of time, I would like to introduce Mr. Arthur Lancaster of the Coleman Nursery, Portsmouth, Virginia.

Mr. Lancaster presented his discussion on container culture in Maritime Zone 8. (Applause)

CONTAINER CULTURE IN MARITIME ZONE 8: ITS SIGNIFICANCE TO MORE NORTHERN LATITUDES

MR. A. J. LANCASTER, JR.
Coleman Nursery
Portsmouth, Virginia

Thank you, it is indeed a pleasure to be with you folks.

First I would like to spend a moment on the conditions that exist in our area where we are growing about 95 per cent of our stock in containers It is an area which has rainy weather, cold weather, warm weather, and hurricanes, except for this year. It is a land, as far as and one that is being unloaded. Upon reaching the unloading area a jeep leaves the loaded trailer, picks up the unloaded trailer and returns to the canning machine where a loaded trailer is ready to be taken away. We find a canning crew of 10 people, including all of the above operations, can handle from 10,000 to 12,000 containers a day.

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First I would like to spend a moment on the conditions that exist in our area where we are growing about 95 per cent of our stock in containers It is an area which has rainy weather, cold weather, warm weather, and hurricanes, except for this year. It is a land, as far as weather conditions are concerned, where a little bit of everything might be had. Starting in January of this year and on through until almost the middle of March, we had what we consider a hectic winter. It was rainy and cold, the low officially, about six above zero. For us this was considered cold. Then we had all of our rain in the spring, which was followed by the worst drought in over 50 years. When you are growing in cans and you have no rain, you have got to stay with it all the time. When I look at a plant I can't help but compare the plant to a human being. I don't know if any of you ever look at it that way, but that plant is something living, something you have got to take care of. When a drought comes, it must be nourished. When a plant gets hungry you have got to feed it. When the cold comes, you have to wrap it up. If we remember there is a comparison and think of it in these terms, I think we can grow a little better plant. We are constantly trying to find out more about container stock

This year we went to California, Dundee and Mobile, Alabama. After visiting all these outstanding nurseries we came back and tried to consolidate what we found and what we have learned through experience and put it into one place. There are two things I always like to keep in mind and one is that the minute we get ourselves set, the minute we think we know something, something backfires Never get too set in any one line of procedure. Be willing to change Be willing to roll as the stone rolls. Secondly, the grower must have confidence in what he is doing. He must have confidence in the plant he is trying to produce.

Now let's take a few minutes to look at some of the plants we grow in Virginia. We are located right off the coast of Virginia Beach, the Atlantic Ocean, Chesapeake Bay, in sort of a pocket. The Gulf Stream winds give us a little milder climate. We also have Indian summers in February and March, followed by sudden freezes. We grow many plants that are normally considered tender. For example, 20 years ago they wouldn't think of growing a camellia, although today, it is one of the biggest camellia-growing areas in the country. The camellia is one of the main plants As I left to come up to the convention, our fall-blooming camellias were beginning to bloom, along with crapemyrtle. Crapemyrtle is indeed one of the fine plants in that area, along with the gardenias and all the various exotics

I think the exotics grow as well as any class of plants in cans I can't think of any plant from *Ilex camelliaefolia* to *Ilex cornuta* that wouldn't grow exceptionally well in containers. *Ilex crenata convexa, I. c. variegata* and various other exotics also do very well. However, there is one plant, *Ilex rotunda,* that must be handled very carefully, as it will freeze in our area. *Ilex crenata convexa* is no doubt the hardiest of all pyramidals Crapemyrtle, which is considered very tender, overwinters without loss· (However, any plants we had in our retail yard were killed by a freeze of 25°F. if allowed to remain off the ground on a display table. Keep your plants where there is no air circulation under them.)

This year, for the first time, we rooted a number of plants under mist and were very successful. Cuttings are potted in 2¼" pots and put in cold frames which can be covered with sash during periods of dry weather. From a 2¼" pot everything goes to a one gallon can. Plants transferred to containers in April will be ready for sale in September, although a plant transferred to a container in June or July will not be ready until the following year. Stepping up from a one-gallon container to a larger can is done in November. We have square, 5-gallon cans, Although there will be no top growth on these plants, there will be a surprising amount of root growth by February or March and the plants are ready to grow as soon as the warm weather hits. These plants will be ready for sale the following fall.

Our potting mixture is composed of about 40 per cent soil, 30 per cent peat, and 30 per cent sand. Our soil is of a light, sandy nature and quite satisfactory, since aeration is one of the most important factors in container growing. If you have good aeration, you will also have a good vigorous root system.

We have been a little slow about changing over to mechanical overhead watering We have many of the various devices set up but still 90 per cent of our watering is done by hand. If a can is watered, the roots will stay in the can, but if the ground area is also watered they will root out into the ground. Summer care is very important. When the ground is dry, or during a drought, the container plant must be watered every day. Sprinklers can be set up as a supplementary measure, but they do not do a thorough job of watering. During dry spells when constant watering is necessary, we find frequent light fertilization best.

After losing 15,000 plants from a concentrated weed killer, we cut 6 to 10" of soil from the growing area and laid 1½ mil. black polyethylene Some of you have this material, I am sure. On top of this we put a thin quarter inch layer of sawdust to protect the polyethylene from light and then replaced our containers. This is an unsightly thing, but by eliminating weeding between cans we cut costs by 25 per cent.

* * * * *

(Editor's Note: Mr. Lancaster supplimented his talk with a set of well selected, colored slides. During this period a number of points were brought out which are included in this section)

QUESTION: What spacing do you use for your container beds?

MR. LANCASTER: All of our beds are marked into 15 foot wide areas, having 5 foot walks In one of our double beds we have 3,200 containers.

QUESTION: What kind of containers do you use?

MR. LANCASTER. We use only metal containers which we obtain from local sources and process ourselves. A number 10, or gallon can costs about three cents to process and an egg or square can about ten cents.

QUESTION: How do you get your plants from the salesyard to your customer's car?

MR. LANCASTER: We have boys who carry the plants to the customer's car, where they remove or cut the can. If the can is not cut or removed there is a chance that the customer would stick can and all into the ground and wonder why it didn't grow.

QUESTION: What do you charge for an item like privet, or a common variety of rose?

MR. LANCASTER: For a one gallon sized *Ligustrum lucidum* we get around $1.75. The minute we get it into a 5 gallon can the price jumps to $3.75 or $4.95. We put all our roses in 5 gallon containers in December or January. When they are sold around the first of May we get about a $1.95.

MODERATOR TURNER: Are there any further questions?

DR. CHARLES E. HESS (Hess Nursery, Mt. View, New Jersey): How much do those five -gallon cans weigh Mr Lancaster?

MR. LANCASTER: When the cans are wet they weigh in the neighborhood of 35 or 40 pounds. Styrofoam will cut the weight from 40 pounds to about 22 pounds, but it requires a lot of styrofoam.

DR. HESS: The year before last we had Dr. Matkin of California here and he gave us what he considered to be the composition of a good container medium I wonder if any of you gentlemen have used this medium of sand and peat and if so, what your experience has been with it.

MR. JACK HILL: Yes, we have used a sand-peat mix in Dundee for two years In fact, we are now using it exclusively throughout our whole operation, even for potting or banding rooted cuttings. So far, it seems to work out pretty well. There is some question right now as to whether or not its aeration qualities are sufficient for good and rapid establishment of yews, but for the general run of conifers, which tend to be tolerant of lower aeration, there is no difficulty at all. It is a good consistent mix, and most important of all, it can be standardized.

DR. HESS· What is the weight of this mixture in the one gallon container?

MR. HILL: A one-gallon can weighs about eight pounds including the finished plant.. The five-gallon can weighs 28 to 30 pounds.

DR. KEN REISCH: Mr Lancaster, what is the time schedule on your *Pyracantha,* from start to finish?

MR. LANCASTER. We try to make most of our cuttings in the summer The cuttings taken last July are already potted and will be canned by next April. These plants will not fruit until the second year.

MR. HILL: Mr. Lee, can you outline for this group what the California growers mean when they talk about a Pinto-tag nursery? What qualifications are prescribed for Pinto-tag authority?

MR. LEE: The Pinto-tag is a tag issued by the State Department of Agriculture. It is a nursery tag that is half pink and half green in color and it permits us to ship to any county in California (except Tulare and Ventura Counties) without reinspection of the plant. To qualify for Pinto-tags a nursery must be free of all injurious insects and diseases. There must be no insects that are not of normal, general distribution, in other words, no aphids or scale can be on any plant. Nurseries are periodically inspected by a crew of State Agricultural Inspectors who go through our fields; literally on their hands and knees, looking underneath the leaves of the plants to see that they are clean.

MR. HILL: Are you sterilizing any of your canning mixtures?

MR. LEE: Right now we are not.

MR. JOHN ROLLER: Mr. Lee, would you go through your steps for handling *Pyracantha?*

MR. LEE. We take our cuttings all through the year. The time period from the cutting to what we term a finished product in a gallon can runs approximately 14 to 16 months

MR. ROLLER: Do you have any problem of setting fruit on your *Pyracantha?*

MR LEE: None, other than they have to flower on the old wood.

MR. HARVEY GRAY: With your permission, Mr. Moderator, I would like the lights out so that I can project one slide. Here we see a different container than what has been in the subject of discussion this afternoon. This is a wire basket. It is not a new idea, but is old; old as containers and growing plants can be. This wire basket is handmade from 2″ x 4″ turkey wire. The liner is salvaged polyethylene film The mix is the U C. mix, prepared practically identical to the one described by Dr. Matkin here two years ago. The plant growing in the basket is *Cotoneaster horizontalis.* It is a two-year plant, one year in a two and a half inch pot and transferred to that container in the early spring of 1957. The basket has dimensions of 8″ x 8″ x 8″, and costs about 22 cents to make by hand

I am grateful to Bill Tish of New Jersey for this particular technique. When the plant is planted, the basket goes right in the ground. There is no taking away of any container The only thing that needs to be done is that you slash the plastic, in order to have the medium come in contact with your freshly prepared area. There are no wires to cut for the ultimate consumer and no problem as far as your watering program I am not saying the idea is original. I am not saying it will work in every situation, but it is something for your consideration.

MR. SIEBENTHALER: Has anyone had any experience with sub-irrigation with the idea of uniform watering and fertilization and elimination of hand labor?

MR. HILL: We have not had any actual experience with it, but I have talked to one or two people who tried it on a small scale. The ones who tried it seemed to think it was working all right, but I feel that there must be something wrong with it or they would have expanded their operation.

With containers there are problems with sub-irrigation. The number 1 problem is the cost of preparing a relatively shallow, water-tight container. You may use polyethylene there but it won't stand the wheelbarrow traffic. You have the problem of the spread of the disease organisms If you have one plant that is diseased it will thoroughly inoculate every other plant. Beyond that, in any area where you have moderate rainfall, sub-irrigation will tend to accumulate soluble salts. Any fertilization by the sub-irrigation method is never leached down from the top and would therefore tend to accumulate these salts.

DR J H TINGA (Department of Horticulture, V P.I., Blacksburg, Va): I would like to comment on sub-irrigation. We have a small sub-irrigation project with container stock that hasn't gone through the winter yet. For our setup we put polyethylene down and covered it with two inches of sand. We then set the gallon cans one inch into the sand. Then we bring the water level up to the bottom of the can. Our basin doesn't fill up because it has an overflow mechanism. If we have a hard rain it just goes over the edge. So far, without any watering, we have had better growth than we have had on cans handled in the ordinary way We are going to let them go through the winter right in the water to see how it looks before we say too much. One thing to remember with sub-irrigation is to keep the organic matter low. We use no compost or manure and only one-third peat in our potting mixture.

MR. JOHN McDONALD (McDonald Nurseries, Hampton, Virginia): I wonder why there has not been any concern demonstrated by the panel in regard to a plant producing too many roots in a container. It is not possible that a container can get so full of roots that it will be root-bound?

MR LEE: Some plants will produce a very heavy mass of roots, and if planted, without slightly disturbing that root ball, will express a choking-like condition, so to speak. If the plant seems to have a very heavy mass of roots, the root mass should be slightly disturbed before planting. Each variety of plant has a given time that it should be in a container. Some can actually be kept in a one gallon container for two or three years, without forming too heavy a mass of roots.

MODERATOR TURNER: Thank you, gentlemen. I will now turn the meeting back to our President.

PRESIDENT VANDERBROOK: Thank you, Frank, and your panel for a most interesting session.

The session recessed at 5:10 P.M.

PLANT PROPAGATION QUESTION BOX

FRIDAY EVENING SESSION

November 22, 1957

The Plant Propagation Quetion Box Session of the Seventh Annual Meeting convened at 8:00 p m. Dr. J. P. Mahlstede, Iowa State College, was the moderator for the evening.

The transcript of this session of the annual meeting is not included in these Proceedings.

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SATURDAY MORNING SESSION
November 23, 1957

The session convened at 9:25 o'clock, President Vanderbrook presiding. President Vanderbrook called the meeting to order At this time, we will have a discussion of "New Concepts in Propagating Structures." The man who will moderate the panel is Dr. Kenneth W. Reisch, Department of Horticulture, Ohio State University. Dr. Reisch.

MODERATOR REISCH: This panel will be concerned with factors and structures associated with the propagation of plants by vegetative means. A brief review of the use and development of these structures will introduce the discussion.

Dr. Reisch presented his paper entitled, "Plant Propagating Structures." (Applause)

PLANT PROPAGATING STRUCTURES

K W. Reisch
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Structures for growing plants under controlled conditions are known to have been in existence since 42 B.C. The doctor of Roman Emperor Tiberius Claudius Nero prescribed cucumbers for an ailment, so a translucent structure of slabs of talc or thin sheets of mica was constructed for their culture. The modern greenhouse probably had its inception with the use of forcing houses in northern Europe to grow such fruits as oranges and grapes. The growers then decided to heat the air inside the structure and used dung, stone stoves, or fireplaces. Oranges were grown in structures with an open framework in the summer and covered with wooden shutters and heated in the winter. One of these, built in Germany during the 17th Century, was 32 feet wide and 400 feet long. It wasn't until the early 18th Century that glass roofs were used and the first greenhouses in this country came into existence in the late 18th Century. They were narrow with a solid wall on the north and a glass roof sloping to the south. There is little evidence of the use of these structures for propagating plants. However, we know that practices in plant propagation date back to ancient times and can assume that much of it was carried out in various structures.

A propagating structure may be as complex as our modern greenhouses with light, temperature, and moisture controlled by electronic devices or as simple as an overturned mason jar. In either one of these structures the same physiological principles would apply to the propagating material regardless of the techniques used. In either situation, when a plant part is separated from the parent plant, conditions must be provided to maintain that part in a viable, active condition until it is self supporting by means of roots or a graft union The three environmental factors of light, temperature, and moisture, which can be controlled, are fundamentally important in the maintenance of propagating materials, and the means of controlling them are primarily dependent on the structure and its equipment.

It is common knowledge that light is necessary for food manufacture in a plant, and is essential to rooting and healing in propagation. *It makes little difference whether the light passes through Nero's mica, through glass, through plastic, through fiberglass, or is furnished by some artifical source, providing it is of the desirable quality or intensity* This indicates that the physiological importance of light has not been changed by the design or construction of new types of propagating structures. Of course, we have learned new concepts in the use and control of light and have adapted our structures to these by such techniques as variation in location, and use of shade.

We all know that temperature is very critical in plant propagation because of its effects on the metabolic factors associated with all phases of plant growth. Excessive temperatures without high levels of the other environmental factors, are usually undesirable because a depletion in food reserves may result due to acceleration of the process of respiration or by the promotion of lush top growth before rooting or union take place. Low temperature, on the other hand, may slow plant processes to a virtual standstill and result in little or no vegetative reproduction. We've learned the value of accurate temperature control and have utilized many valuable electronic devices to accomplish this end. The propagators of earlier years also knew the value of temperature, but had none of the devices or technical know-how of today. An article of 1824 discusses the techniques for heating glasshouses with fireplaces, and another illustrates the use of a piping system to prevent excessive heat build-up in a hot bed heated with dung. In the same year two authors discussed devices for opening glasshouse ventilators, automatically, for improved temperature control. These consisted of a black copper cylinder with water in the base. When the air in the cylinder became heated due to sunlight or increased outside air temperature, it forced the water down, which, by means of a float connected to a weight, caused a wheel to turn and open the ventilators. Today, 133 years later, we also have automatic ventilator controls in greenhouses which can be activated by timeclocks, changes in light intensity, changes in temperature, or rain. This is a great advance in temperature control, but again, the plant part has not changed because of its use. The same principles apply.

The somewhat spectacular results of successfully propagating some previously hard or impossible to root plants by use of high humidity or constant mist has indicated the value of moisture in propagating plants Over 50% of the fresh weight of a plant is water and water is absolutely essential to all life processes. In the case of a plant part which has been severed from the parent plant, water is of critical importance. We know that in order to maintain the plant part in an optimum condition it is necessary to maintain a humid condition around the surfaces of the plant. A worker of 1824 also realized this and discussed the use of double glass on hot beds to decrease the effect of cold surfaces which result in condensation and reduction in relative humidity. In relation to this he also commented on the possible value of heating air and passing it through a wet surface before it reached the greenhouse. The value of syringing greenhouse walks to raise humidity was also noted.

The Wardian case, sealed grafting cases, closed hot beds or cold frames, bell jars, the simple overturned mason jar or the overturned Dixie cup described by Jack Hill, all create the same effect of maintaining an area of high humidity around the propagating material. Through our technical advances and an increased understanding of the moisture factor, techniques for providing optimum moisture conditions have been developed. These include the high humidity system controlled by an humidistat, and intermittent or constant mist controlled by the same device, time clocks, electronic leaf, or other similar devices. Through the use of these systems we have reduced the all important limiting factors such as light and temperature which have resulted in improved propagating results. This advance has actualy reduced the need for enclosed structures by enabling the propagator to carry out his work in the open air under full sunlight. With this factor, as with those of light and temperature, we have not changed the physiology but have simply provided new and better means of control. The environmental factor of oxygen has not been mentioned because in most cases the structure does not affect its availability. There is evidence that oxygen may become limiting in the media in a closed propagating case if ventilation is not provided Oxygen would definitely be limiting when a poorly drained propagating medium resulted from faulty bench construction.

The members of our panel will tell you about new concepts in propagating structures and the control of environmental factors in these structures Again, you will note that the knowledge of past experience and the advancements in technical fields have enabled us to bring about new methods of control over the same three fundamental factors of light, temperature, and moisture. The future holds promise of new discoveries and innovations in plant propagating structures. We will probably see new discoveries in the effect of light quality, intensity, and quantity on plant propagation. New advancements in temperature control will undoubtedly occur, and techniques for using moisture more effectively are sure to be developed However, unless some radical change occurs naturally in the materials we are propagating, or unless we find a means of bringing about a change in plants, we will continue to be concerned with the problems of the same physiological fundamentals that the propagators of past centuries recognized and attempted to solve. Even the most *ideal* structures in existence wont give 100% rooting. We know that the only way to do that is to have an expert propagator tell about his results. This indicates *that* regardless of the changes or improvements in propagating structures, the most important factor affecting successful plant propagation will continue to be you, the plant propagator.

MODERATOR REISCH: Those were my introductory remarks Our first speaker is a florist. Since Mr Miller was unable to be with us, he sent an able replacement, Mr. Paul Daum, who is a general troubleshooter and problem corrector with Yoder Brothers, which has one of the largest plant propagation departments in the world. He is stationed at their Barberton Section. They have done a lot of work in plastic structures and washed-air cooling and certainly, the same problems apply whether we are considering herbaceous or woody plants.

At this time, I would like to introduce Mr Daum.

MR. DAUM (Yoder Bros., Barberton, Ohio): Good morning, ladies and gentlemen. Mr. Miller was not able to come, although, before I left we had a discussion on what we thought might be pertinent and interesting to this group. He was of the opinion that it might be a good idea to briefly outline what we, as an organization, operate.

As a business, we operate about 50 acres of glass in the State of Ohio, a portion of it in Ashtabula, Ohio, some in Cleveland and a portion in Barberton. About ten per cent of this glass or about 11½ acres in Barberton is devoted to propagation. During the summer period of the year the whole area is used for propagation. During the winter months the demand for rooted chrysanthemum and carnation cuttings is not high, and we can devote some of the area to finished stock.

The organization as such is divided into various groups or departments. We have a propagation staff, a stock production staff, and a pathology staff This results in an exchange of ideas among the men in the organization, yet making particular departments with trained personnel responsible for their specific field

At the present time we have only experimented with greenhouse construction using Polyflex 230. We, like most other people, are interested in getting started in plastics as a supplement to our acreage, since it is necessary for us to lease some of our area. The plastic would be advantageous to us from the standpoint of cost and in regard to the possibility of decentralizing at some later date, once we had established that the operation could perform satisfactorily in a structure as low in cost of erection and maintenance as has been advertised. By the use of plastics we could also isolate the carnation and chrysanthemum programs, which operate under different temperatures. We have at present a little over a half acre of plastic. Some of this is in Ashtabula and some is in Barberton, Ohio In both cases they are devoted to propagation. At present, we are not growing stock in either one, except on an experimental basis. I might add that the stock we have growing on an experimental basis had been satisfactory.

We have the conventional greenhouse type of construction, with side and top ventilators which are operated by hand. We have also had structures with no ventilators, no wet pad air cooling, no heating underneath the bench, but heated simply by pulling air through huge radiators One advantage that we have found is that high humidity can be maintained, even in the plastic house, without washed air cooling. Another is the advantage of being able to heat a plastic house with less total energy. We have also used washed air cooling in our conventional greenhouse. I will make a comparison, between the washed air cooling in the plastic house. We have found that the washed air cooling in the plastic house is much more successful.

We originally went into air cooling for the reasons most people do. For example, Ashtabula is approximately 100 miles from our propagating operation, which necessitates storing cuttings until enough are gathered to transport These cuttings are stored at 31°F., or above. In order to overcome moisture loss and to increase rooting we installed a washed air cooling system with the idea of providing very high humidity for the cuttings after they are stuck. Previously heavy shading, cheesecloth, and the Skinner system were tried, but any light reduction seems to be detrimental to the production of good rooted cuttings. With washed air conditioning, high humidity and light conditions can be maintained at the same time. In other words, optimum conditions can be constantly maintained. Briefly, here are some of the reasons we tried washed air cooling: (1) a constant level of humidity can be maintained with no reduction of light, (2) shading greenhouses for a large operation is extremely costly, (it entails broken glass, labor, cost of material and, I might add, it cost us $400 a year for the hydrochloric acid to remove the shading compound), (3) it is possible, with washed air cooling, to increase quality immensely, (4) the cuttings are cool when they are packed for shipment and, we have found, ship better The reasons being that there is less respiration during shipment and fewer disease problems. I might add here, that some shading is still necessary although less shading is required.

Further, we found that the air movement of the fans, even without the moisture pad, greatly increased quality and decreased disease incidence. After 5 or 6 days we often reduce the moisture and just operate the fans, alternating wet and dry air.

One plastic house was built with no top ventilators and the money saved was used to purchase air conditioning equipment. This has been very successful since it has increased both quality and rooting over the other houses. The labor required for propagating a unit of material has decreased, diseases were decreased and the operation as a whole has been more consistent. Growers all over the country have found growth under plastic is definitely superior to growth under glass. This may possibly be because glass sifts out the ultra-violet radiation and plastic doesn't.

Polyflex 230 does pose some problems. Most growers, including Yoder Brothers, have noted deterioration of Polyflex that has been in use less than one full year. It consistently blows out under winds of 60 miles per hour or more and constant flexing of Polyflex greatly weakens it. This may be overcome by stretching the plastic as tight as possible when it is installed and placing a bowed stick under the center of each panel so that it pushes the plastic out which tightens the panel so that flexing is impossible.

CHAIRMAN REISCH: Thank you Mr. Daum The next man on our program is Mr. Tom Kyle, Jr, from the Spring Hill Nurseries of Tipp City, Ohio They are wholesalers, retailers, and mail order nurserymen. Mr. Kyle will discuss the subject of greenhouse cooling as it is related to woody plant propagation.

MR. TOM KYLE, JR. (Spring Hill Nurseries, Tipp City, Ohio): Thank you, Ken. Ladies, gentlemen and guests of the Plant Propagators Society.

We have used washed air cooling for about two years. It has been a wonderful thing for the florist, since it allows them to grow a crop in the summer, which they were not able to do before, because of the terrific heat which was generated.

Our system is really a forced air cooling system, because we have coupled this with an intermittent mist system similar to the systems which have been described here at the meetings.

Mr. Kyle discussed the subject of greenhouse cooling as it influences propagation of woody plants. (Applause)

THE USE OF WASHED-AIR COOLING IN WOODY PLANT PROPAGATING HOUSES

TOM KYLE, JR.
Spring Hill Nurseries
Tipp City, Ohio

The system of washed air cooling is accomplished by equipping the greenhouses with large volume exhaust fans mounted on one side, or end, and wet fiberous pads on the opposite side of the house Air drawn through the pads by the fans is cooled by evaporation and drawn through the house. We try to build ours up to the point where a complete removal of our air is accomplished every minute, throughout the house The propagation house which we equipped was 16 feet by 100 feet. On the end of the greenhouse where we have our work rooms we put in a 42 inch bladed fan operated by a three-quarter horsepower motor. This fan is rated to exhaust 14,000 cubic feet of air per minute. At the opposite end of the greenhouse we were forced to construct our pads on a rafter. They were five feet high, 16 feet wide, or a total of 80 square feet of pad which is required to provide the right amount of cooling. Above the rafter we placed an ordinary galvanized gutter, similar to the type you use to drain water off your roof at home. This drip conductor, as we call it, had 1/16″ holes drilled at six inch intervals along the gutter. The drip conductor must be kept covered to exclude dust and debris from the pads Water flows through this conductor, through the holes, down through the aspen wood pads and is caught below by another gutter. There is a circulating pump placed in a sump at the base which in turn brings the water back to the top and lets it flow through the pads again. The water is re-used and according to the information we have there is only about two per cent of the water used by evaporation through the pads. The fan in our propagating house is started when the inside temperature reaches 80 degrees This year the fan was manipulated by hand. We are contemplating hooking a thermostat to turn on the fan.

We have intermittent mist installed in the house and it is a similar system to what has been described at these meetings. We use a Florida type nozzle with a time switch clock. In our system the mist is on for two seconds out of every minute. We have no problems as a result of

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We have intermittent mist installed in the house and it is a similar system to what has been described at these meetings. We use a Florida type nozzle with a time switch clock. In our system the mist is on for two seconds out of every minute. We have no problems as a result of putting on this much water since we use solid, well drained, concrete benches and a coarse sand medium Another reason we don't have any trouble is that the fan continually pulls the mist out of the house and it doesn't drop right down on the cuttings.

With this intermittent mist system and forced air cooling, we were able to hold the average temperature in our house in the summer between 80 and 83 degrees, even on the hottest days, with a minimum amount of shade. As the growing season progressed, in mid-August, we began to run into a problem of the temperature being between 56 and 60 degrees in the morning. This was undesirable because it retarded plant or cutting growth and also depleted the relative humidity within the house. Next August we will put our glass and door back on the end of the house and remove the wet pads earlier in August Another solution we have talked about is using a rolled canvass cover on the back of the house which could be rolled up during the day, to allow the fans to put the separated air through the house, and rolled down at night to keep this cold air out of the house.

We purchased the aspen wood pads, the fans, racks, and the circulating pump from a supply house in Kansas City. We did the installation with our own labor and I found our cost was approximately 25 cents per square foot of floor space in the greenhouse. That is pretty high and it is higher than I have read in most of the literature which has been put out by the florist trade for the construction of this type of system.

Some of the woody plants propagated in this house include: *Cornus mas elegantissima, Viburnum carlesii, V chenaultii, V burkwoodii, Euonymus alatus compacta, Cotoneaster apiculata, Ligustrum ibota vicari* and several others, I think we had phenomenal success.

I will give you some of the advantages of the forced air cooling. One of the advantages is that we were able to lower the temperature in our greenhouse from 30 to 40 degrees, even during the hottest day in the summer. We eliminated stagnant air by replacing it with filtered, moist air which is ideal for propagation. Another thing we did, we were able to lower our incidence of fungus diseases. Another thing is that shading can be entirely eliminated except for light control. Last year we used a small amount of shading compound on our house and next year we plan not to use any shading compound at all, but will handle it the same as we do our outside mist propagation This system also eliminates the manipulation of ventilators and keeps out dirt and insects Another thing some people told me to be sure to mention is that the cooler greenhouse makes for nicer working conditions

In conclusion, I might say that forced air cooling has been a real boon for the florist trade because it gives them a chance for summer income by producing another crop, which they ordinarily couldn't handle. However, I don't know whether it is the answer for the plant propagator and nurseryman or not. We are doing some outdoor misting. This summer, in August, we constructed a bed outdoors on concrete blocks It is seven feet wide, 100 feet long, and we used hardware cloth on the bottom with coal on top of the hardware cloth. Like John Ravestein, the reason we used coal, is that the coal bin was next door and we didn't have gravel. Above the coal, we put some vermiculite We propagated many of the same woody plants outside in the mist bed that we carried inside our forced air cooled house, and we had equally great success with them. Some of the roots weren't as tough as the plants that were produced indoors because of the vermiculite and the watering, but they all seemed to grow alright We were well pleased with our outdoor misting and we plan to do more with that

Another thing that could be done to cool propagating houses would be to put water pressure pumps on your intermittent misting system. We used 65 or 85 pounds pressure or whatever we get from our city water. With a pump that would bring the water pressure to 400 or 500 pounds per square inch, you could possibly atomize the water going through nozzles and you would get a lot more cooling.

That is about all I have Thank you.

MODERATOR REISCH: I thank you for this very thorough presentation The next man on our panel will lead off on the topic of the use of plastics for propagating houses It is a pleasure to introduce Mr. Zophar Warner.

Mr. Warner presented his paper entitled, "The Use of Plastic Film in Propagating Houses." (Applause)

THE USE OF PLASTIC FILM IN PROPAGATING HOUSES

MR ZOPHAR WARNER
Warner Nursery
Willoughby, Ohio

We are in an era of very rapid development and change. This applies not only to space travel and sputniks but also to the propagating profession. In a meeting of this kind anything presented on the third day may have become obsolete during the discussions of the first and second days.

The uses of plastic film in propagating houses are so extensive and varied that I have made no attempt to compile their uses, many of which are common knowledge. I will confine my remarks to the uses we have already made of plastic film and what part we expect it to play in our future operations. A few years ago we started using polyethylene film to line the inside of a sash house. Since the sash were removed yearly it was difficult to keep it tight without use of the film. The following things resulted from using the film. (1) heat loss was substantially reduced, (2) constant humidity and soil moisture were easier to maintain, (3) the air space between the film and the glass acted as an insulator against sudden heat variations caused on partially cloudy days, and (4) the film acted as a slight shade. We have since used polyethylene film to line the inside of two 10 x 50 foot propagating houses This is very easy to do as there are no inside braces, only ribs. We merely start at the ridge and run the film the long way of the house. Any ordinary, heavy duty stapler is used to staple it to the ribs. I would like to emphasize here the desirability of placing the film on the inside of the house. If placed on the outside the film is subjected to the wind and door and we didn't have gravel. Above the coal, we put some vermiculite We propagated many of the same woody plants outside in the mist bed that we carried inside our forced air cooled house, and we had equally great success with them. Some of the roots weren't as tough as the plants that were produced indoors because of the vermiculite and the watering, but they all seemed to grow alright We were well pleased with our outdoor misting and we plan to do more with that

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Many plants can be rooted in closed frames or in frames under mist and be well rooted before cold weather There is a wide range of deciduous and broadleaf plants that do not properly mature until August and September, too late to root in the frames but too early to stand the heat of the greenhouse. This year, we started sticking azalea cuttings in the plastic lined house early in September. The ventilators were covered over and even with some shade it became too hot on sunny days. An additional sheet of polyethylene film was rolled over the benches on top of the cuttings and left on for a week at a time The film was removed weekly for inspection and to remove any condensed water. We have used the same procedure on rhododendron cuttings and results have been satisfactory. I believe the very limited air space under the film is a good feature, however, I would not argue with anyone who wished to build a framework to make a more conventional type sweatbox If it is undesirable, due to loss of light or ultra violet rays, to have the cuttings under a layer of glass and two layers of polyethylene these disadvantages are offset by being able to maintain the proper humidity. Where the proper humidity is maintained, it is best to use a dryer, looser, rooting medium and if the common practice of drenching the cuttings is avoided, more effective use of concentrated hormone solutions can be made.

It has been the custom of many propagators to fill the greenhouse during the late fall with an assortment of cuttings that had varying requirements and by subjecting them to average conditions, a fairly good stand could be realized by spring. Those items that are rooted and actually deteriorating by growing in the rooting medium should be potted or flatted and removed to another greenhouse. By using all the aids available to propagators, it is now possible to root many hitherto difficult items in a matter of a few weeks. While this is very desirable, the problem of caring for the increased production of plants once they are rooted becomes acute To solve this problem, we have been looking, for several years, for a growing-on facility that could be used all times of the year that was better than a cold frame but more economical to build than a conventional type greenhouse.

Last year Dr. Wendell H. Camp devoted a portion of his address to plastic-covered propagation units. His enthusiasum over the new material Polyflex 230 encouraged us to build a 15 x 65 foot house last winter. We used a low concrete block foundation, bolted a wooden plate onto it and used 2 x 4's, 20 inches on centers to make proper use of the 42 inch Polyflex. Ten mil. Polyflex was used on the outside and 5 mil. was used on the inside of the 2 x 4's Shortly after erection we had an 18 inch snow with no damage to the plastic There are no ventilators but an exhaust fan has been installed in one end and humidity could be introduced at the other end Since construction was late last year, we are just now putting this house to real use.

I have the following reservations about the material Polyflex 230: (1) the house must be built in a wind-free location, if the material does not suffer from fatigue, the workers will, from the cracking noises caused by the wind, (2) after one year, the Polyflex has shattered in two or three places from bitternuts dropping from an overhanging tree and therefore I believe the material has deteriorated a little in the one year that it has been up. Nevertheless, I am confident that a suitable material will be available shortly. When this happens, it will be possible to enclose larger areas at low cost.

There are instances both here and abroad of moving greenhouses in order to rehabilitate the soil. Other favorable results from moving a greenhouse that occur to me are: (1) increased control over the growth and dormancy of plants, (2) expensive handling of plants could be eliminated in many cases by simply moving the house, and (3) planting operations could be carried on continuously regardless of weather. The development of plastic films for use on rigid or semi-rigid structures, stationary or movable, will continue to have interesting applications to our profession

MODERATOR REISCH: Thank you, Mr. Warner, for your comments on the use of plastic for propagation structures. The structure we will be talking about now is the Nearing Propagating Frame. Mr. David Leach is quite a rhododendron fancier and a book written by him was published in 1955. Mr. Leach.

MR DAVID LEACH (Brooksville, Pennsylvania): The Nearing Propagating Frame was developed by Guy Nearing of New Jersey, after some years of work, and was perfected in 1928. It was patented in 1932. Mr. Nearing tells me the reason he patented the frame is that it appeared someone would come in and copy the design and prevent him from using it himself. In any case, the patents have now run out and the frame can be built by anyone.

The largest commercial installation I know anything about is in New Jersey, and consists of 60 of these structures. There is one in New York composed of 40 structures. There is another one in Pennsylvania which has about 12 units. I have sent blueprints to New Zealand, The Netherlands, England, Germany and to almost every part of the United States and Canada.

The advantages of the frame are many. It consistently produces the successful rooting of cuttings which are notorious for their difficult propagation. It eliminates expensive greenhouse space and greenhouse maintenance. It produces plants of superior vigor. I have kept records of plants propagated in this frame and the propagation percentage is better than 99 per cent. Post-rooting losses of rhododendrons are less than one per cent compared with a regular mortality of 15 per cent. There is a great reduction of labor cost and disease problems are minimized as well I experimented for about eight years in devising a hormone treatment which was specifically adapted to this method of propagation. I contributed nothing whatever to the design of the frame and it all came about because Warren Bostwick, from New York State came up to my place and offered to build a frame if I would make a series of experiments on hormone treatments, which I did.

The device isn't quite as simple as it looks. The overhang is calculated according to the angle of declination of the sun. The amount of space at this point is calculated for a specific cubic foot flow of air as a ventilating medium. A wide variety of plants have been successfully propagated in the structure and includes the Japanese maples, boxwood, falsecypress, dogwood, cotoneaster, euonymus, English and American holly, magnolia, the tree peonies, pieris, yews, and hemlock. They have all been propagated on a commercial scale.

The most convenient construction makes use of corrugated aluminum sheets for the back, Celotex for the two ends and cypress or redwood for the wooden parts. The two frames which are oriented back to back make use of ordinary 3′ x 6′ sash covers As far as the site is concerned, it should have good drainage. The land immediately underneath the frame must be absolutely level to avoid later complications in watering and the site must be open to the north in order to insure maximum light. The most critical thing about the frame is its orientation to due north If you get it more than 5 or 6 degrees off due north the usefulness is seriously impaired. In order to get it exactly due north it should be oriented by someone who knows the deviations of the compass or if you are doing it yourself you can set up three sticks in line with Polaris, and the next day orient your frame, without a compass, exactly parallel to the three sticks.

The inside of the frame should be painted white for best results, since the whole purpose of it is to provide maximum light without any direct sun, in order to encourage photosynthesis which is necessary for the production of carbohydates. Furthermore, when the cuttings are watered the glass should be flushed clean to allow a maximum amount of light to reach the cutting.

Each of the two frames has a bottom in it. The purpose of the bottom is to retard the exit of the water when cuttings are watered but not to inhibit water run-off completely. If the floor is constructed correctly, water will run out between the cracks in the boards. The propagation medium in these frames is in three layers. The bottom one consists of four bushels of peat which acts as a sponge for water conduction I have tried various kinds of peat and feel nothing is equal to Premier brand peat. This bottom peat layer has to be level. If you don't level the different layers you will have an uneven distribution of water to the cuttings. The middle layer consists of either two bushels of coarse sand and one bushel of peat or one part coarse sand, one part of Premier peat, and one part Styrofoam. I am going to use the latter in the future rather than the sand and peat combination alone. The top layer consists of a quarter inch of pure sand The only purpose of this is to keep the peat moss from floating up and covering the leaves of the cutting. The sand must be coarse and non-alkaline In those cases where people have failed with the frame it has been because the people have used fine or alkaline sand. In order to pin that down, 100 per cent of the sand should pass through a 50-mesh screen. This whole frame is then watered until the three layers are saturated. It takes about ten minutes and is the most time-consuming operation of all. At no time is the rooting medium compressed.

The great time and labor saver is this home-made template which consists of nails arranged in two rows, each nail one and one-quarter inches apart in the row and rows one and one-quarter inches apart, each row with the same number of nails. These are just 12-penny nails with a handle screwed on top. You can go along the rooting medium and put the cuttings in very quickly. If you are propagating azaleas, use every hole, if you are propagating rhododendrons, use every second hole. I believe you could use close spacing in commercial practice Some put in about 750 rhododendrons or about 1400 azaleas per frame, in commercial practice All of my experimenting has been done with azaleas and rhododendrons and I have found that as far as my own experience is concerned, the cuttings should be rather short, that is not more than two and a quarter inches. By making the cutting this size and placing it in the medium it puts the rooting zone in the top of the medium where there is a better supply of oxygen. Another reason is that I suspect there is a greater concentration of the natural auxin in the short cutting. In any case, I have found after experimenting with cuttings of all rhododendrons that the optimum length is two and a quarter inches. There is a one-inch wound made along the side before the cutting is ready for insertion. The reasons for this are first, there is a mobilization of hormones and carbohydrates which accumulate in the region of the injury and secondly, in my experiments I have found a wounded cutting absorbs about three times more water than an unwounded one. The leaves are reduced to three. I think perhaps you might leave more on if you could The thing to keep in mind is that the idea is to leave as much leaf surface on as possible without causing excessive wilting. The larger the leaf area the greater the production of carbohydrates. The greater the amount of carbohydrates in relation to nitrogen the more vigorous the rooting

After the cuttings are prepared in this manner they are soaked for 18 hours in a 75 p p m. indolebutyric acid solution. This concentration is the result of my experiments extending over a period of eight years. The first thinig I determined, as far as rhododendrons are concerned, was that the aqueous soak is not just a little more effective than the powder, it is infinitely more effective. I suppose the magnitude would be in the neighborhood of 300 to 400 times more effective. Since 1950 this technique has yielded approximately 92 per cent rooting of 3,600 rhododendron cuttings, representing 84 different hybrids This also includes a great many which, just a few years ago, were considered completely impossible to root. Even yet, most of the plants on the market are grafted but each year the technique has improved until in 1956 I had an unprecedented 99.4 per cent successful rooting of 600 cuttings representing 58 different hybrids. I don't expect to ever repeat such near perfect results, but this happens to be a mathematical answer. My feeling is that any propagator should be able to average better than 92 per cent with rhododendrons in a Nearing Propagating Frame

Indolebutyric acid is purchased by the gram, from Eastman Organic Chemicals Wherever you purchase it, the easiest way is to take it to a druggist and have him put it up in capsules of 296 milligrams each.

You dissolve one capsule in a tablespoonful of ethyl alcohol, add it to one gallon of water, and your average concentration will be approximately 75 parts per million You can vary the concentration advantageously. I have used up to 600 parts per million. The more difficult cuttings may require a more powerful concentration. There isn't too much incentive to experiment with different concentrations when you are getting in excess of 92 per cent. I don't think it is worth while to vary the concentration of hormones.

Japanese maples and magnolias are inserted in early June, tree peonies in mid-June, dogwood in early July and rhododendrons in mid-September English and American hollies are rooted in mid-July and yews early in September. Incidentally, with dogwood, one of the important things is to leave them in the frame over winter. Hollies should be removed from the case after they are rooted. Yews are one plant which should have less water than the others. The rhododendron cuttings which are inserted in September do not root until in the following August. The only labor required throughout this long period is watering which should be done about once a week. By the end of October when the weather cools, the water is reduced to every two weeks until the medium freezes. After it thaws in the spring they are watered again every two weeks until early May and then weekly watering is resumed. This is not a case of using your judgment about watering, since they should be watered whether you think they need it or not At least, that has been my experience. With someone else it may be different.

After the rhododendron cuttings are taken out, in mid-August, they are put in flats; not into pots. Rhododendrons will grow better in the field if the root systems are not first confined in containers. The flats are put under glass in cold frames to protect them over winter, and are not ventilated until they are taken out the following August.

All propagation resolves itself pretty well to maintaining the right balance between aeration and moisture. I first heard about Styrofoam when I read some articles by Mr. Coggeshall of the Arnold Arboretum The rhododendrons, particularly, require oxygen, which apparently is a higher requirement than many other plants. Stryofoam seems to increase the aeration in the rooting medium and has a beneficial effect on the root masses.

Leaf bud cuttings root very well in the Nearing Propagating Frame. If you have a hybrid with a limited amount of propagating wood, just take the leaf with the leaf stem and dormant bud at the base of the petiole and it will root very well. There has been a lot of talk, I know, among rhododendron propagators that it doesn't produce a good plant. I have had excellent success with this type of cutting. Initially it is not as large, sturdy or as vigorous as the stem cutting but if you are working with rare material the results are still perfectly satisfactory, and my experience is that after the end of three years there is very little difference in the size between them.

Deciduous azaleas root very well in the Nearing Propagating Frame. There are two critical points in the propagation of the deciduous azaleas. One is, take them when they are very soft, around the latter part of May. The next important thing is to pinch out the terminal bud. If you pinch out the terminal bud at the time of inserting, they start to grow right away without any trouble at all.

In summarizing, then, while the fall-inserted cuttings are slow, after the first year you get a regular annual crop with this method. It is a much cheaper method of producing plants from cuttings and gives a much higher survival rate. It is consistently successful with many plants that are inconsistent in the greenhouse. I might say the Nearing Propagating Frame can be improved, but the experience of others has shown that changes are likely to be expensive. Those of you who are interested in trying the frame are urged to discard your prejudices and follow the directions explicitly. As soon as you begin to vary from the experience of others you are likely to run into trouble Mr. Nearing resolved the frame as a result of 10 or 15 years of work and Mr. Bostwick devised the rooting medium over a period of many years The hormone applications have been fairly accurately worked out. I believe that the procedure is adaptable to large commercial operations and is worthy of consideration by anyone who is thinking about the propagation of these woody ornamentals.

(Editor's Note. Mr. Leach supplemented his discussion with a series of well selected, colored slides.)

MODERATOR REISCH: Thank you, Mr. Leach, for your intereting comments on the Nearing Propagating Frame. We have about ten minutes for questions.

MR. ALBERT LOWENFELS: Mr Kyle, what is the benefit of this greenhouse cooling system? I don't go to Florida and leave my cuttings alone, but I am in another line of business and I go down to New York every day. I use the electronic leaf and Polyflex covering in a new greenhouse, and from lilac cuttings taken in May to holly cuttings taken right now I get at least 70 to 80 per cent rooting. What is the benefit of all this washed air?

MR. TOM KYLE: I don't know. If you come to one of these propagators meetings, you will find there are a multitude of new things being tried I think that the main reason is that the florists have had phenomenal success with this type of cooling. I think it can be adapted, much like they have at Yoder Bros, by using the mist in combination with the ventilation, and maybe eliminating this wet pad. I think moving the air in the mist has some advantage.

MR. LOWENFELS: My experience has been the hotter the greenhouse the better, in fact, my greenhouse got up to 120°F. I don't see the benefit of having it air cooled. You can get it as hot as possible, as long as you have enough mist.

DR. CHARLES E. HESS: I think we had the same experience in Ithaca. Our experience was that we had better success in the greenhouse during the summer than in the outdoor frame. I think it was because of our cold season. The average night temperature was around 55 degrees that year, and we felt the additional heat speeded up rooting and we also felt that in climates like Ithaca, it could be possible that the use of bottom heat would be more beneficial than an outdoor mist frame.

The thing I was going to ask Mr. Kyle was that on the basis of the comparison, would he feel that the investment in air washing is worth while? In other words, does he get enough increase in his percentage rooting using the air wash to make the investment worth while.

MR. KYLE: To tell you the truth, I was in Korea while most of this was going on. From what I understand from our propagator, we do not feel that there is a real advantage over the outside mist However, this was our first year in outdoor misting and we did have better results compared to outdoors frames. In our locality, controlling the temperature is quite advantageous. For conditions in New York or somewhere else, it might not be needed. During the middle of the summer we get extreme changes in temperature and this way, we don't have to worry about working our ventilators.

MODERATOR REISCH: Remember, forced air cooling is in its infancy in the nursery business while we have had mist a little bit longer.

MR. HANS HESS: You mentioned propagating clematis under the combination of double glass and mist. Would you elaborate on that just a little bit?

MR. KYLE: Well, to tell you the truth, that is sort of a fallacy. You can't very well put mist under a double glass. We did have clematis in the open bench mist, and later we cut the mist off because it was getting too wet. However, we had the cool, moist air. I will let Mr. Englemann answer your question.

MR. HERMAN ENGELMANN: I think clematis propagation is easy if you can keep the leaves healthy. Clematis leaves are very tender and rot easily. It is a little easier to keep the leaves in good condition under the double glass. You must keep the leaves good for about 40 days to get a good root system. I think with plenty of sunlight and under the double glass we possibly got 80% to 95%.

PRESIDENT VANDERBROOK: Thank you very much, gentlemen, for the excellent presentations. We will now have a talk which I know many of you have been looking forward to on dwarfing and hybridization techniques for the plant propagator. It gives me great pleasure to introduce Dr. Karl Sax.

Dr. Sax presented his paper entitled "Dwarf Ornamental and Fruit Trees." (Applause)

DWARF ORNAMENTAL AND FRUIT TREES

Dr. Karl Sax
Arnold Arboretum and Bussey Institution
Harvard University
Jamaica Plain, Massachusetts

The ranch type house and limited grounds demand smaller types of ornamental trees and shrubs for landscaping. The migration to the shrubs has also revived an interest in fruit trees. For such orchards, dwarf trees are essential to provide a variety of fruits in a limited space

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The ranch type house and limited grounds demand smaller types of ornamental trees and shrubs for landscaping. The migration to the shrubs has also revived an interest in fruit trees. For such orchards, dwarf trees are essential to provide a variety of fruits in a limited space and to facilitate pruning, spraying and harvesting. Even the commercial fruit growers are becoming interested in dwarf or semi-dwarf trees to reduce labor costs.

In our breeding work with ornamental trees and shrubs we have produced several small ornamental trees which have been named and released to nurserymen Perhaps the most outstanding example is the "Hally Jolivette" cherry, named after the author's wife. The French name Jolivette means "pretty little one," an appropriate name for the tree, as well as the wife. This tree grows to a height of eight to ten feet and bears semi-double, pink-centered flowers which are borne over a period of about 10 days.

Another small graceful tree is the "Blanche Ames" apple, named after the wife of Oakes Ames, former director of the Arnold Arboretum. It has semi-double white flowers on slender graceful branches. The Washington Arboretum at Seattle has classed it among the best of the 50 varieties tested.

Among the dwarf shrubs produced by hybridization the "Arnold Dwarf" forsythia has considerable merit, although it is slow to come into flower. The original plant was eight years old before it flowered, but cuttings from flowering plants should flower in four or five years. The mature plant is only several feet tall and the spreading branches root readily and form a good ground cover. Even without flowers it is an attractive plant.

Ornamental trees and shrubs can also be made to produce either smaller or larger plants by the use of appropriate rootstocks and by other methods. We have used *Prunus tomentosa* as a rootstock for *Prunus triloba multiplex* with considerable success. The first year, the *P triloba* whips reach a height of 5 or 6 feet and the second year they are a mass of bloom. At the end of ten years the trees are still vigorous and bloom heavily. The Nanking cherry is also an excellent dwarfing stock for ornamental peaches and plums

Many different genera can be budded on *Crataegus* rootstocks. Perhaps the most promising combination is cotoneaster on hawthorn. *Cotoneaster adpressa praecox* budded on *Crataegus phaenopyrum* made excellent growth the first year, and when budded at the height of 5 or 6 feet the spreading forms of cotoneaster produce a most effective ornamental.

Our experience with the Silver maple as a rootstock for Norway and Red maples has been very promising. Although *Acer saccharinum* is the fastest growing of all maples, it dwarfs "Crimson King," a variety of *Acer platanoides.* Such trees at the age of six years are only about 6 feet tall, even when grown in good nursery soil. *Acer rubrum* is also dwarfed when budded on Silver maple rootstocks, at least when it is budded 15-20 inches above ground level. Even when budded low on Silver rootstocks the Red maple flushes earlier in the spring and colors earlier and more brilliantly in the fall. Silver maple rootstocks might permit the Red maples to be grown more successfully in alkaline soils.

The common lilac budded on *Syringa amurensis japonica* is dwarfed, although the lilac is by far the largest of all lilacs The grafted plant is not long-lived, however, possibly due to borer infection in the main trunk.

It is also possible to get feeble seedlings to grow much better in some cases by budding them on other rootstocks We have been trying to get hybrids between *Syringa laciniata* and *S. vulgaris* in order to obtain new forms of *S. chinensis.* The cross is easily made and the seedlings grow well the first year, but at the end of four or five years practically all of the seedlings were dead. If, however, the young seedlings are budded on common lilac rootstocks, many of them survive and flower.

We grew about a hundred plum X peach hybrid seedlings, but almost all of them died the first year. If, however, they are budded on *P. tomentosa* they grow fairly well and budded on peach they make almost as much growth as peach on peach. Brock, of Australia has had a similar experience with apple X pear hybrids grown at the John Innes Horticultural Institute in England. Many feeble hybrid seedlings would probably survive if budded on a parental rootstock.

The dwarfing of fruit trees is an ancient art. European horticulturists have been producing dwarf apple and pear trees for hundreds of years. They found that certain apple seedlings, when used as rootstocks, would greatly reduce the growth of the scion variety and induce earlier fruiting. These selected rootstocks were propagated by stooling, and were originally known as French Paradise and Jaune de Metz. Eventually the clones became mixed, and in order to insure proper identity the East Malling Horticultural Station, in England, began test plantings nearly 50 years ago and later gave the clones numbers East Malling VIII and IX are the more extreme dwarfing clones, while East Malling VII is often used as a semi-dwarfing rootstock.

Mature apple trees thirty to forty years old, budded on Malling IX rootstocks, grown at East Malling are only about seven feet tall and bear about a bushel of fruit each. These dwarf apple trees bear fruit which is fully as good, if not better, than fruit grown on standard trees.

Pear trees are usually dwarfed by budding or grafting them on quince rootstocks. Various degrees of dwarfing are attained by grafting them on clonal varieties of quince which are propagated by stooling. We have found *Photinia villosa* to be a very dwarfing rootstock for pears, although the bud compatibility is poor In some cases pear on *Photinia* have fruited the second year These trees are now six years old and bear heavily, but grow very slowly. Pears can also be budded on cotoneaster and hawthorn. Seckel pears on hawthorne roots, with a cotoneaster interstock, are less than six feet tall the sixth year and bear heavily.

The Europeans also dwarfed peach trees by budding them on St Julian plum, but smaller trees are obtained by budding the peach on *Prunus besseyi, Prunus tomentosa* or *Prunus triloba.* About 15 years ago Karl Brase at the New York Experiment Station budded peaches and plums on *P. besseyi.* This rootstock produces dwarf, productive peach and plum trees, but the trees in the nursery often tip on their side and *P. besseyi* suckers badly from the roots. During the past ten years we have been using *Prunus tomentosa* as a rootstock for peaches and plums with considerable success The Nanking Cherry is not as compatible with so many peach varieties as is the Western Sand cherry, but it stands up better in the nursery and has a much more fibrous root system.

Prunus triloba seems to be a compatible rootstock for peaches, plums, and apricots, but we have tested it for only a few years. It will also take sweet cherry occasionally, but there is some overgrowth of the scion variety. Sweet cherries can also be grown on *Prunus maritima* seedlings and we have Washington and Windsor sweet cherry on beach plum rootstocks. There is considerable overgrowth of the sweet cherry branches, but the tree is alive and fruiting at the end of ten years. Karl Brase has had promising results with *Prunus sufruticosa* as a rootstock for dwarfing sweet cherries.

It has long been known that many species, or even genera, can be grafted together. Mr. Burbridge in 1886 wrote that it was possible to "have on the same Thorn stock . . . Pear, Medlar, the Beam-tree, the Service-tree, the Mountain-Ash, the European and Japanese Quince... the Cotoneaster and the Pyracantha." It is also known that individual seedling rootstocks of the same species may vary greatly in their compatibility with a given scion variety We find that only about 10 percent of our seedling *Prunus tomentosa* are compatible with the Elberta peach, but other propagators report a good take of Elberta on *P. tomentosa*. We are now growing *P. tomentosa* seedings which are compatible with Elberta to see if their seedlings will have a high degree of compatibility In the search for seedling rootstocks, various species, varieties and ecotypes should be tested Unfortunately, such tests require a lot of time and land.

Clonal rootstocks are desirable because their compatibility and performance is known, but they have two disadvantages, first the cost of propagation, and second, the possible infection by virus which is transmitted by vegetative propagation For the past 15 years we have been testing certain apomictic apple varieties since they are genetically uniform and virus is not normally tranmitted through the seed. *Malus sargenti* seedlings grow too slowly and are not compatible with many apple varieties. *Malus hupehensis* and *M. toringoides* have also proved incompatible with many varieties. *Malus sargenti rosea* is more promising, but *Malus sikkimensis* has proved to be the best. The seedlings from old trees are almost all of the maternal type and are compatible with all varieties tested. Tests made at Long Ashton in England indicate that *M. sikkimensis* seedling rootstocks are less dwarfing than Malling VII, but at the New York Experiment Station Dr. Brase finds them to be more dwarfing. He also confirms our observations that the *M. sikkimensis* rootstock produces a more spreading tree. It appears to be a good semi-dwarfing, seedling rootstock for commercial growers. Unfortunately there are few trees in this country, seedlings do not produce fruit until 8-10 years old, and the young fruiting trees produce a large percentage of variants, apparently due to cross pollination of the flowers of the facultatively apomictic species, while young. Facultative apomixis does, however, permit hybridizing between apomictics and sexually reproducing species We have crossed *M. sargenti rosea* with

East Malling IX in an attempt to get an apomictic dwarfing rootstock variety. Apomixis is a dominant character and usually appears in the hybrids of *M. sargentii rosea.*

Because of the ease of propagation many nurserymen in this country are now using dwarfing interstocks instead of dwarfing rootstocks for producing dwarf apple trees This technique is not new. It was described by John Rea in 1665 as follows· "I have found out another expedient to help them forward, that is by grafting the Cyen of the Paradise apple in the Crab, or other Apple-Stock, close to the ground, with one graft, and when that is grown to the bigness of a finger, graft thereon about eight inches higher, the fruit desired, which will stop the luxurious growth of the Tree, almost as well as if it had been immediately grafted on the forementioned layers, and will cause the Trees to bear sooner, more and better fruits."

If the interstock is 5 or 6 inches or more in length a satisfactory dwarf tree is produced Another method now used by some nurserymen is to graft the dwarfing scion on a short nurse-root, bud the scion high and plant the graft deep so that the dwarfing interstock is 8-12 inches below the surface of the soil. The nurse-root will sustain the graft until the buried interstock strikes root. The nurse-root can be removed when the tree is set in the orchard or it can be retained as an anchor for the more feeble Malling VIII or IX root system.

Our experiments indicate that a greater dwarfing effect of Malling IX is attained if the dwarfing stem extends at least a foot above the ground, and for maximum dwarfing of the nurse-root interstock it may be advisable to have it extend nearly a foot below, and about a foot above, the ground level when set in the orchard

Interstocks can also be used as compatibility bridges to permit certain fruit varieties to be grown on a root system which is incompatible if grafted directly. The compatibility bridge has long been used in grafting pears on quince Some pear varieties, such as Bartlett and Bosc, are incompatible when grafted directly on quince rootstocks, so the quince is first grafted or budded with a compatible variety, such as Beurre Hardy, and the Beurre Hardy stem is then budded with Bartlett or Bosc.

The use of the compatibility bridge is an ancient art and was first described by John Parkinson in 1629 as follows: "The green and the yellow Nectorin will thrive best to be grafted immediately on a plumme stock, but the other two sorts of red Nectorin must not be immediately grafted on the plumme stock, the nature of these Nectorins being found by experience to be so contrary to the plumme stocks that it will starve it, and both dye within a year, two or three at most."

The compatibility bridge can be a useful technique in producing dwarf trees. We have used it to produce dwarf apricot trees and it may be of value in dwarfing pear trees. We have been unable to bud the apricot on *P. tomentosa,* but by using a peach or *P. triloba* interstock, the apricot can be grown on Nanking cherry rootstocks. The Stella apricot on *P. tomentosa* roots made a very dwarf tree less than four feet tall and flowered heavily at the age of three years. The variety Minn.

604 made much more growth, but it too flowered and fruited heavily at three years.

Perhaps the most versatile bridging interstock is *Pyronia veitchi*, a cross between *Cydonia* and *Pyrus*. It is compatible with apple, pear, hawthorn and probably with other genera of the *Pomoideae*. We have used *Pyronia* as an interstock to grow pears on apple rootstocks and apples on pear or hawthorn rootstocks. Pears can be budded on some apple rootstocks, but the graft union with *M. sikkimensis* seedlings was poor and, although the tree fruited early, the fruits were very small. If, however, the *Malus sikkimensis* seedling is budded with *Pyronia* and the *Pyronia* stem budded with pear, the pear, although dwarfed, produces normal fruit at an early age. We have budded East Malling IX rootstocks and interstocks with *Cydonia* to see if dwarfing apple rootstocks and interstocks can be used to dwarf pears

Other techniques for dwarfing trees and the induction of earlier fruiting have long been used. The earliest technique for promoting fruit development was the girdling of the bark of fruit trees and vines. This method was used by the early Romans, and in the case of the grape it dates back to about 2000 B.C. in Egypt. It was described by John Williams of England in 1820 as follows: "At the end of July and the beginning of August, I took annular excisions of bark from the trunk of several of my vines, and that the alburnum might be again covered with new bark by the end of autumn, the removed circles were made rather less than a quarter of an inch in width . . . In every case in which circles of bark were removed, I invariably found that the fruit not only ripened earlier, but the berries were considerably larger than usual, and more highly flavored." This technique is a common practice in the vineyards of southern Europe and California.

Girdling of the bark is also used to promote earlier fruiting of apple trees Usually, however, the exposed wood is immediately covered with tape so that a new bark will develop directly from the exposed surface of the wood, thus insuring the survival of the tree even though the girdle may be too wide to be covered by proliferation of the bark above and below the girdled stem. Another method of stimulating fruit production is "scoring" the bark of the trunk or branches of the young tree Both girdling and scoring should be done before the initiation of fruit buds for the following year, which in our area is late June to early July for apples. Girdling checks phloem transport for about a month, but scoring is effective for only about two weeks, so that the scoring technique has to be timed more closely. It is also advisable to girdle or score in a long spiral to reduce the weakening of the branch and possible breakage in high winds.

A more permanent method of dwarfing trees is bark inversion. This is a relatively new method which was first described by R. H. Roberts of Wisconsin in 1935. A complete ring of bark several inches long is removed from the branch or trunk of the young tree and replaced in an inverted position., It is then bound tightly with a rubber band until the inverted bark is united with the wood — a period of ten days to two weeks. Bark inversions on the trunks of young apple trees, when done in mid or late June, almost invariably result in flower and fruit production the following year. We have inverted bark of one and two years old apples and induced fruit production the second or third year.

It is better, however, to wait until the tree is three or four years old before inverting the bark so that the tree is large enough to carry the fruit. The later inversion also results in a more permanent effect. A new bark is formed from the underlying wood at the vertical seam and this bark is normally polarized. As a result organic nutrients pass down this new bark readily and it grows so rapidly that it soon offsets the effect of the inverted ring of bark on the younger tree, and the dwarfing effect is lost. On older trees the ratio of inverted bark is larger and the regenerated bark at the seam is not able to take over normal transport for several years In the meantime the induced heavy fruiting tends to check vegetative growth. But the effect is temporary and after a few years new inversions on the trunk or on the branches are needed to keep the tree dwarfed. Even a double inversion, with the vertical seams on opposite sides of the tree, is not permanent in its effect because the regeneration tissue between the inversions permits lateral diffusion followed by lateral orientation of phloem and xylem in this area. Other tricks are being tried to make the bark inversion technique more permanent.

Another method of dwarfing trees was used by the early horticulturists of Europe. They bent the branches in a horizontal plane, and tied knots in the branches to check growth and induce fruiting. Seven years ago we tied knots in the stems of young seedlings of *Malus sikkimensis*. These trees are now only half the size of the control seedlings which were not knotted, but knotting did not promote earlier fruiting. We also knotted *M. sikkimensis* seedlings and budded McIntosh above the knot. These trees were also dwarfed and fruited earlier than McIntosh budded on normal *M. sikkimensis* seedlings. The stem at the knot has grown together and the ultimate fate and performance of such trees is not known.

Why do dwarfing stocks, girdling, bark inversion and knotting of the trunk curtail vegetative growth and promote earlier flowering of fruit trees? Thomas Andrew Knight, for many years the president of the London Horticultural Society, had the answer in 1820, when he wrote as follows: "The true sap of trees is wholly generated in the leaves, from which it descends through their bark to the extremities of the roots, depositing in its course the matter which is successively added to the tree, whilst whatever portion of such sap is not thus expended sinks into the alburnum and joins the ascending current, to which it communicates powers not possessed by the recently absorbed fluid When the course of the descending sap is intercepted, that necessarily stagnates, and accumulates above the decorticated space, whence it is repulsed and carried upwards, to be expended in an increased production of blossoms and of fruit."

Knight had observed the swelling of the trunk above the girdle and the swelling of the dwarfing rootstock below the graft union. This swelling he attributed to the checking of the downward flow of the nutrient sap in the bark. His conclusion has been confirmed by the use of radioactive tracers. A solution of radioactive phosphorous was fed into the petiole of a leaf on the upper branch of an apple tree dwarfed by an East Malling interstock, and of an apple tree dwarfed by a double bark inversion In one case the radioactive concentration in the trunk of the tree was measured with a Geiger counter several days after treatment. In the other tree the radioactive concentration was measured by making autoradiographs of the sectioned trunk. In the bark inversion tree the radioactive phosphorous was concentrated at the upper end of the inversion and in the dwarfing interstock tree it was concentrated in the East Malling IV interstock In both cases the radioactive tracer was carried through the blocked region, but was diminished in amount below the inversion or the dwarfing interstock. This test was done by Alan Dickson and Ed Samuels, Harvard graduate students, financed by Stark Brothers Nurseries.

Another graduate student, Stanley Berg, confirmed Knight's conclusion that the accumulated sap is carried upward "to be expended in an increased production of blossoms and of fruit." Chemical tests made several weeks after a bark inversion showed that the leaves contained several times as much soluble carbohydrate as the leaves of the control trees.

That the reduced vegetative growth and the induction of earlier flowering is due to the accumulation of organic nutrients in the top of the tree, and not to the starvation of the root system, is proved by the fact that a bark inversion on a single branch will cause that branch to check its growth and produce fruit, while the untreated branches will continue to grow vigorously and remain unfruitful

The knotting of the stem also checks the downward flow of nutrient sap as is shown by radioactive tracer tests, but not as effectively as a dwarfing interstock or inverted ring of bark. The induction of fruiting by bending the branches in a horizontal position was attributed by Knight to the "stagnation" of the nutrient sap, but we have not yet been able to confirm this conclusion by radioactive tracer tests

The horticulturist does not need to be convinced that horticulture is both an art and a science, and that both are essential for future progress. Most horticulturists also realize the pleasures of working with living trees and would agree with Professor Sorokin, emeritus professor of sociology at Harvard University. In describing his azalea garden in a recent issue of *Horticulture,* he wrote: "I firmly believe that in our magolopolitan and super-industrial civilization, gardening is one of the noblest and most effective methods for moral and mental educaton, for keeping the equanimity and peace of mind, and for curing most of the physchoneuroses of modern man" But this idea is not new either William Langford in his book "The Practical Planter" published in England in 1681, wrote as follows: "When thou goest to work by these directions, then as a good Christian, observe the Characters of Divine Wisdom, Power, and Goodness, that thou shalt everywhere meet with in this ingenious and beneficial employment" and concluded with a quotation from Eccliastics 9: 7 — "Go thy way, eat thy bread with joy, and drink thy wine with a merry heart, for God now accepteth thy works."

PRESIDENT VANDERBROOK: Thank you, Dr. Sax, for your interesting talk and report on your most specialized work. If there are any questions the audience would like to ask Dr Sax, we will take a few minutes for them.

MR. WILLIAM BURTON (Burton's Hill Top Nurseries, Casstown, Ohio): Dr. Sax, would a bark inversion help initiate blooming on a wisteria?

DR. SAX: We tried that and it didn't work. I don't know just why. The wisteria bark is awfully thick and awfully tough. It doesn't seem to like to go back on too well, and is somewhat corrugated underneath.

MR. ENGELMANN: I would like to ask if plants which have been treated with Colchicine are more difficult to root. In Boskoop, Holland they tried to get a smaller sized flowering clematis with Colchicine. They got it but they can't propagate any more.

DR. SAX: The Arnold Giant, the original tetraploid is definitely more difficult to root than the diploid parent, but it isn't impossible to propagate The triploid is very easily rooted, but we have had a little trouble with this tetraploid.

MR. WILLIAM COLE: I just wondered how you can protect the bark inversions from drying out.

DR. SAX: We use a special rubber budding band about an inch wide. You bind it tight to cover all the exposed edges of the inversion so it won't dry out. After ten days, the bark heals on and one can remove the rubber band I think it might be well to leave it covered more loosely with some protective covering or painted with a mixture such as Chlordane in lanolin The borers seem to like this soft growth which develops following a bark inversion

MR. COLE: I thought you might be interested in knowing we used some of these inversions on a lot of Red maples and the graft union was so weak after the second or third year they blew off or fell off when you touched them.

DR SAX: That is likely to happen with a lot of these wide hybrids. There are all sorts of things that prevent good compatibility. One is the imperfect graft union Others are an interaction between the stock and scion and still others result from an excessive check on phloem transport. It isn't a simple problem at all. What the nurserymen do with *Prunus besseyi* or *tomentosa,* is treat them rough at digging time. If you treat them rough at digging time you are likely to weed out the weak sisters.

MR. C. H. HENNING (Niagara Falls, Ont.): I would like to ask Doctor Sax if he has used the bark inversions on mature trees at time of blooming. We have semi-circled flowering crabs and we removed strips of bark a quarter of an inch to half an inch wide, and did not cover them with tape We used a tree wound paint and completely covered the area. It took several years for the cambium to unite.

DR. SAX: In that method of girdling, the wound should heal-over before the end of that season, or you are likely to have trouble. That is a very old trick In England, they usually cover it with tape. Instead of covering with tape we just wipe it with lanolin. It is a good deal easier than putting the tape on it. The effect of this method is, I think, a little more temporary and it is possibly a little more dangerous than the bark inversion, but it is less work

What we are playing with now is simply scoring. If we score at the right time it is easy to make a diagonal cut, or spiral around the tree We had a little Burmese boy this summer who found that it takes two or three weeks to regenerate a new connecting tissue in the new bark following cutting with a knife. I suspect if that is done at the critical time before blossom bud initiation, which with us would be about the 15th or 20th of June, that it would throw the tree into bearing It is even more temporary than the narrow girdle. The Chinese have used that for a long, long time

One of my colleagues who is a bamboo expert, and has spent most of his life in China, said the Chinese commonly used to cut a spiral around the tree to get the thing to flower That would be a lot simpler than these other methods.

PRESIDENT VANDERBROOK: If there are no other questions for Dr Sax, Mr. Harvey Gray has some slides he would like to discuss a moment

(Editor's Note· Mr. Gray supplemented his discussion with a series of six color slides.)

MR. GRAY: I would like to mention a technique which might be related to the subject of structures for aiding the rooting of cuttings. In the rooting and growing of the Kurume azaleas, it is common in our section of the country, Long Island, to place the cuttings quite close together in the rooting bench Upon rooting, they are lifted and carried on through the winter in the greenhouse in order to get some top growth so the plant will come along at a more rapid rate. It occurred to me through the use of the plastic we could eliminate this moving and cut the costs of the whole operation.

The greenhouses in such a growing establishment are usually empty at this season of the year. With that thought in mind, the media that was selected was sphagnum moss peat. The bench was lined on the bottom and sides with plastic. Onto that plastic we placed the sphagnum peat moistened to the degree that it will lose only a few drops of water on the application of pressure. Then the cuttings are set at a spacing similar to that used in transplanting.

A "bird cage" made of wire netting is then set in position over the bench and the plastic is brought over the top and held securely in place with a water seal over the top When the cuttings are rooted the plastic is pulled back slowly and finally the wire cage is removed Remember the plastic is underneath and therefore they will need a little drainage now. They are not watered up to this point, other than the initial watering. Now that the bed is open to evaporation, water is required from time to time, and the plastic on the bottom of the bench must be cut away with a knife. We would cut down through to the bottom of the peat to sever the plastic in numerous places to accommodate seepage. The medium should be fertilized to encourage root and top growth.

PRESIDENT VANDERBROOK: Are there any questions you would like to ask Mr. Gray about this illustration? If not, we are adjourned.

The session recessed at 12:00 noon.

SATURDAY AFTERNOON SESSION
November 23, 1957

The final session convened at 1.45 o'clock, President Vanderbrook presiding.

PRESIDENT VANDERBROOK: Gentlemen, we will start the afternoon off with the panel on "The Propagation of Some Unusual Plants." The moderator will be Roger Coggeshall, of the Arnold Arboretum, Jamaica Plain, Massachusetts.

MODERATOR COGGESHALL (Arnold Arboretum, Jamaica Plain, Mass.): The program this afternoon will be concerned with the propagation of unusual plants It will be more or less a continuation of the talks which we have heard both yesterday morning on the propagation of the borderline evergreens and the talk this morning by Dr. Karl Sax.

The propagation of so-called unusual plants or newer plants in The Arnold Arboretum is going on constantly Some of them have no merit at all as far as commercial arboriculture is concerned, others we think, do.

I would like to show a series of slides which will certainly illustrate some of the material we have at the present time.

(Editor's Note: Mr. Coggeshall discussed the propagation of some of the more unusual plants from a series of slides. The following account has been edited for presentation in the Proceedings)

1. *Rhododendron mucronatum*, Cornell Pink:
   a) This plant was grown from seed at Cornell University by Dr. Skinner of the National Arboretum in Washington. It blooms at the same time the magenta or lavender rhododendron does, and we think it is a good plant. We find, however, it is not an easy one to propagate when you consider rhododendrons or azaleas in general. We have been successful only with softwood cuttings, taken in July. The cuttings were rooted in a mixture of sand and peat, mixed half and half by volume.

      We have only one plant. This plant is now three years old and from it we took 106 cuttings this past year. Out of those 106 cuttings we managed to root 79. That is by far the best percentage we have been able to obtain. Hardwood cuttings taken throughout the early fall months of October and November are very difficult to root, resulting in only about a 5 per cent stand.

2 *Viburnum tomentosum roseum*:
   a) There has been some confusion about this particular plant. When it first opens it is quite pale, but the longer it stays in bloom the darker it becomes. This remains in flower for at least three weeks and is quite a spectacle. Certainly, very conspicuous over the other viburnums. It is readily propagated from softwood cuttings treated with Hormodin No. 2
   b) This plant seems to lack vigor. The plant was obtained in 1928 and has grown approximately four feet.

3 *Stewartia koreana,* Korean stewartia:

a) This plant, *S koreana,* and *S. pseudocamellia* look alike at a distance. However, there is a difference in the size of the flower.

The bark of the Korean stewartia is certainly conspicuous. The plant blooms again the second or third week in June, in Jamaica Plain.

4. *Ilex yunnanensis*:

a) The propagation of holly has already been mentioned. This one is *Ilex yunnanensis.* It roots very readily from hardwood cuttings taken in the months of October and November, treated with Hormodin No. 2 and stuck in a sand and peat mix, half and half by volume.

5. *Mahonia aquisargentii*:

a) This is a cross between a mahonia and a barberry. The name is *Mahonia aquisargentii.* I have never seen it in flower or in fruit. We received a single plant of this variety from Sweden.

b) We have been propagating this plant very heavily and the plant really hasn't had a chance to flower. The foliage doesn't winter-burn badly. Any leaves which protruded above the snow line were hardy.

c) They root very well from hardwood cuttings, again taken in the fall months and treated with Hormodin No. 3 in sand and peat.

6. *Pinus bungeana*:

a) I have put this particular plant in so I could mention how it may be propagated. It is *Pinus bungeana.* It does not seed for us in Boston. However, it can be very easily propagated by grafting on plants of native white pine seedlings.

The next speaker on the program is Mr. Richard Fenicchia, from the Rochester Park System, Rochester, New York. Mr. Fenicchia!

MR. RICHARD FENICCHIA (Rochester Park Bur., Rochester, New York): Thank you, Roger. Fellow members, it is a great pleasure for me to be here. I will try to convey to you what little information I have regarding unusual plants and their propagation I maintain there is nothing new under the sun, but more testing must be given to some of the plants I will describe

I know that every nurseryman has plants hidden somewhere in his nursery, plants probably of an unusual character which he may be watching, or may have forgotten I believe there is a great deal of wonderful plant material growing unnoticed around in various nurseries.

Mr. Fenicchia preesnted his paper entitled, "Unusual Plants and Their Propagation." (Applause)

UNUSUAL PLANTS AND THEIR PROPAGATION

RICHARD A. FENICCHIA
Rochester Park Bureau
Rochester, New York

The coniferous, deciduous and broad-leaved plant collections of the Bureau of Parks, Rochester, N.Y., contain some plants of distinct and unusual habits of growth. The variations in these plants include forms of low, compact, dense, upright, pyramidal, spreading, pendulous, and color variations, not to mention many other characters and traits. The hardiness factor also enters into the picture in relation to hybrid rhododendrons and other plants of a tender nature. The development of hardier clones is a major goal.

The Park Department is interested in maintaining and adding to its fine collections of plant species and clones and is always on the look out for new forms of plant life. Some of these plants have found their way into the trade, others are only in arboretums and collections. The test of time and climate will determine the usefulness of this plant material.

I would like to say a little about the experimental work that is underway at the present time, as well as some of the techniques we have developed or are using for the propagation of specific types of plants. A program of hybridization is going on principally with lilacs, and clones and species of rhododendrons and viburnums About 150 *Rhododendron* and *Azalea* crosses have been made and are under observation The rooting of conifers and rhododendrons in unheated cold frames is also under test. The rooting of lilacs, *Viburnum carlesii* and the Japanese red maple from hardwood cuttings is under study. Also various methods have been used in the rooting of other difficult subjects.

We have found that in shield budding some maples the time of starting the budding operation is of the utmost importance and can mean a loss of 50% or more in the bud take. The propagator must determine the proper time to bud. To determine the proper budding time involves several factors, the first of which is the stage of development of your bud stick. The propagator must look for certain factors governing proper maturity of bud sticks and maturity of buds to be used. Leaf buds must have reached a stage close to maturity and wood must be about three-quarters of maturity. When budding *Acer platanoides erectum* and *Acer saccharum columnaris*, all well-matured buds on bud sticks can be used with good results, excluding the two lowest buds. All wood from the shield bud must be removed when budding maples. Also strict attention must be given to observe that the filament that feeds the leaf bud in the center of the eye is not removed when de-wooding, discard the bud if the filament has been removed. The understock must be in a turgid state and the bark must easily part from the cambium. Better results can be attained by inserting the bud below the full length of the T-shaped incision. *Acer nikoense* came through very well side grafted in the greenhouse on an *Acer saccharum* understock.

Evergreens to be used for understocks are potted in October in a soil mixture of equal parts soil, peat and sand. The pots are plunged two-thirds deep in sand on an open bench with 65°F. bottom heat. Several daily mistings make ideal conditions for the inducement of root action. Side grafting of most confers can take place when the understocks shows considerable root action. All grafts should be tied with rubber bands and (no waxing) placed on an open bench. Frequent mistings are required to maintain humidity. During winter periods, no shading is placed over grafts. Wedge grafts were used to graft some firs with very good results, eliminating the need for cutting the understock thereby resulting in a smoother and stronger union.

Cuttings of *Stewartia pseudocamellia* can be easily rooted during the winter months by bringing in cut branches and inserting them in water in a warm greenhouse. After the leaf buds start to grow and the stems have elongated, one half to two inches long, cuttings can be made of the soft tips. Insert the cuttings in a medium of 2 parts sand, 1 part peat moss Hormodin No. 3, or stronger, can be used to treat the cuttings. After rooting, the cuttings should be potted in a medium of 2 parts peat moss, and 1 part sand.

A fast and sure method of producing grafted, dormant lilacs is to pot the grafted plants into 3 inch rose pots with a medium of one part sharp sand and one part loam or well rotted compost. Grafting methods employed can be either the whip and tongue or the saddle (wedge) graft. Waxing of wounds is not necessary, but the grafts should be potted at least one inch below the soil so as to encourage scion rooting.

Two forms of Japanese flowering cherries have rooted very well from cuttings which were taken from balled and burlapped plants and forced in a cool greenhouse *Prunus serrulata Senriko* (*Ojochin*) and *P. s. Torano-o.* Soft cuttings were taken February 19, 1956 and inserted in a medium of 2 parts sand and 1 part peat moss; using Hormodin No. 3, under plastic and bottom heat of 70-75°F, ninety-eight per cent of the cuttings rooted and all had very strong root systems.

Franklinia alatamaha roots very well from very soft cuttings inserted in jars of pure water and shaded from the direct rays of the sun. After the cuttings are well rooted they should be potted in a medium of equal parts of sand and peat moss.

Metasequoia glyptostroboides propagated very well from strong, hardwood, defoliated cuttings, taken from mid-November to early December. Cuttings were made six to eight inches in length, wounded on both sides, dipped in Hormodin No. 3, and stuck in a medium of sharp sand. Bottom heat was beneficial. Moisture content of the medium was the deciding factor in the successful rooting of Dawn trees. Once watered, refrain from watering again until the surface of the medium is on the dry side, then water lightly and repeat this process until the cuttings are rooted.

(Editor's Note: Mr. Fenicchia concluded his talk with a series of slides which he discussed as they were shown. This discussion is included since valuable information on varieties, clones and propagation techniques were noted.)

1. *Acer ginnala.* Durand Dwarf
   a) The virtues of the Amur maple are well known. Therefore it seemed of interest to have a mutation occur in the Durand-

Eastman park planting which produced a dwarf form. Propagation of this has been an interesting problem.

2. *Acer grandidentatum* Western Sugar Maple
   a) This Western Sugar Maple, in fifty years, has made a thirty foot, broadly columnar tree. One characteristic is the gnarled enlargements at the union of the branches and trunk. It grows well from seeds, sown as soon as they are gathered.
3. *Acer griseum.* Paperbark Maple
   a) The Paperbark maple is becoming rather well known as a good, small tree It is probably a Zone 6 tree but its striking bark and autumnal wine-red leaves, call for extensive use. Seedlings grow well but the seeds have a double dormancy. Seeds must be stratified 12 months at temperatures between 32-45°F. After stratification, seeds are fall sown and will germinate in the spring.
4. *Acer nigrum ascendens.* Slavins Upright Maple
   a) It is the good fortune of this country to have native maples available, nearly everywhere, for ornamental use Mr. B. H. Slavin selected this upright form of Black maple, now a mature tree in Highland Park. There is some evidence that in calcareous soils, Black maple is the best street tree maple. We are not making as much use of this form as we should. It can be budded on sugar maple or Black maple understock.
5. *Acer platanoides erectum.* Mount Hope Norway Maple
   a) Over fifty years ago there was noted a slow-growing conical form of the Norway maple, in a row planted in Rochester's Mount Hope Cemetery. Considerable use has been made of this form for street tree planting as it withstands the rough conditions of city life It is easily budded on its own type or side grafted in an open bench.
6 *Acer platanoides variegatum.* Harlequin Maple
   a) Leaf color variegations of white or yellow are not too commonly seen in our area but this form with a green center and a wide white margin seems well worth more use. It apparently is the form introduced by an English nursery before 1903. It can be propagated by budding, but it is slow growing until it becomes well established
7. *Acer saccharum columnare.* Temples Upright Maple
   a) Temples Upright, first introduced in 1885 is the distinct form of Sugar maple in which all of the branches are ascending. It is easily budded on its own type.
8 *Acer senacaensis* (A. leucoderme x A. saccharum). Seneca Maple
   a) The Seneca maple originated as a chance seedling in 1919. It was selected from a seedling of the southern Chalk maple, some of which were fertilized by the Sugar maple. The resulting hybrid is typically intermediate in size and smaller in all respects than the Sugar maple. It may be grown by budding on Sugar maple or side grafting in greenhouse.
9. *Aesculus carnea brioti.* Ruby Horsechestnut
   a) This is recognized as the best of the hybrids between the common horsechestnut and Red buckeye. The Ruby horsechest-

nut will be 100 years old next year and it still commands attention. This can be propagated by side or veneer grafting on common horsechestnut understock.

10. *Aesculus parviflora.* Bottlebrush Buckeye
    a) Bottlebrush buckeye is the prime show of the July flowering shrubs. The variety *serotina* extends flowering a couple weeks later into August and seems to have even longer and showier panicles than the species. This may be propagated from root cuttings or division.
11. *Carpinus caroliniana* (Upright form). American Hornbeam
    a) As an addition to the strictly upright trees, this form of the native American hornbeam is one worthy of more attention. Propagation is by budding or side grafting in the greenhouse.
12. *Cercidiphyllum japonicum sinense.* Chinese Katsuratree
    a) The Chinese variety of Katsuratree differs in having but one trunk, whereas the Japanese type usually has several. In other respects it is the same useful, pest-free tree. Katsura grows very well from seed and is a fast and a strong grower.
13. *Chionanthus retusus.* Chinese Fringetree
    a) The Chinese fringetree is a really choice flowering shrub, too rarely seen. The male plant, especially, is a fountain of delicate white flowers. In habit it may become a small tree. It is easily side grafted on the native fringetree, *C. virginicus.*
14. *Elaeagnus umbellata.* Autumn Elaeagnus
    a) This plant's October fruit is very acceptable bird food. It has an unusual color variation in foliage. This is propagated by grafting on its own type.
15. *Euonymus oxyphyllus.* Japanese Euonymus
    a) The Japanese (or Korean) *Euonymus oxyphyllus* is one of the small, deciduous spindle-trees which are notable for the rich coloring of their fruits. This one comes in two shades of red. It may be propagated by seed sown as soon as it is gathered and cleaned, or by softwood cuttings.
16. *Fagus sylvatica* (Globe form). European Beech
    a) European beech has many forms and varieties but the globe shaped tree, which I have watched for many years, may be something new and worthwhile. It is easily propagated by side or veneer grafting in the greenhouse.
17. *Hamamelis mollis.* Chinese Witchhazel
    a) Chinese witchhazel is the most reliable winter-flowering shrub that we have. We have a variety with reddish flowers which we call *superbum.* It is easily propagated by budding on *Hamamelis virginiana* or from cuttings..
18. *Magnolia cordata.* Yellow Magnolia
    a) Yellow magnolia is thought to be a southern form of the Cucumber tree. In Rochester it stays as a low tree with a spreading crown. Flowering is usually abundant. This should be side grafted on *Magnolia kobus* seedlings.
19. *Magnolia fraseri.* Fraser Magnolia
    a) Recently described erroneously as having rosy-red flowers, the Fraser magnolia, with large creamy white flowers saves its red-

ness for the ripening fruits. Its leaves are conspicuously eared at the base. Seeds germinate well after stratification in a very sandy medium.

20. *Magnolia kobus borealis.* Hokkaido Magnolia
    a) The Hokkaido magnolia comes from the northern island in Japan. A Highland Park specimen has developed into a large tree. Every other year it is completely covered with flowers early in May. It can be grafted on *Magnolia kobus* seedlings or grown from seeds.
21. *Magnolia macrophylla.* Big Leaf Magnolia
    a) The Bigleaf magnolia requires a most sheltered spot to reach tree-size, in Rochester. However, there is one notable specimen in the former Ellwanger and Barry nursery grounds that reached an exceptional age and beauty. For propagating, stratify the seeds, as soon as they are cleaned, at temperatures of 35-45 degrees. Sow in the spring in a sandy medium.
22. *Magnolia sieboldi.* Oyama Magnolia
    a) Oyama Magnolia is the shrubby Japanese plant which extends the Magnolia flowering season into the summer. Side graft this on *Magnolia kobus* and it is also easily grown from stratified seeds.
23. *Magnolia Slavinii.* Slavins Snowy Magnolia
    a) Slavins Snowy is a hybrid, early-flowering type, from the seed of *Magnolia salicifolia.* A chromosome count has cast doubt on the published premise that *Magnolia soulangeana* is the other parent. Propagate this by cuttings or grafting on *Magnolia kobus* understock.
24. *Malus coronaria.* (Unnamed Variety)
    a) A new seedling in the *Malus coronaria* species, it has double pink flowers. It is easily budded or grown from whip grafts.
25. *Malus ioensis fimbriata.* Fringe Petal Crabapple
    a) The Fringe Petal crabapple is a strong-growing clone of the Prairie crabapple with double pink fragrant flowers and notched petals. It follows the Bechtel crabapple in order of flowering. Budding or tongue grafting produce fine plants.
26. *Malus Katherine.* Katherine Crabapple
    a) The Katherine crabapple produces long branches that are filled with double white flowers. The tree is as broad as it is high, which is about eighteen feet. Budding is the best method of propagation.
27. *Malus Species.* (Unnamed Red-fruited Variety)
    a) Another unnamed seedling was selected for its large fruits of a bright red color, hanging on long after most crabapples have dropped or been spoiled by freezing. The plant is of a dwarf nature with light pink flowers.
28. *Rhododendron* #6 (*Smirnovi* x *maximum* x *caractacus*). (Unnamed hybrid)
    a) There is considerable variation within this hybrid. Some good forms may later be selected. They are very hardy and strong growers.

29. *Rhododendron carolinianum album.* Carolina Rhododendron
   a) The White Carolina rhododendron is a natural variety of which there are several clones of varying ornamental value. Seedlings come fairly true to color.
30. *Rhododendron dauricum* x *Rhododendron carolinianum.* (Unnamed Hybrid)
   a) This is a strong grower which flowers early and roots well from cuttings.
31. *Rhododendron fortunei hybrida.* Fortune Rhododendron Hybrid
   a) The Fortune hybrids are contributing to our rhododendron flower displays now. The pink-flowered form is one of our better plants and is very hardy. It roots fairly well under plastic. The flowers have abortive stamens.
32. *Rhododendron maximum superbum.* Rosebay Rhododendron Hybrid
   a) *R. maximum superbum* is an old Parson's Nursery selection or possibly a hybrid of the native Rosebay. It commonly extends the flowering season past the middle of July. It roots well from cuttings, under plastic.
33. *Rhododendron racemosum* x *Rhododendron carolinianum.* (Unnamed Hybrid)
   a) This has fine foliage and is a strong grower. It roots fairly well from cuttings under plastic.
34. *Rhododendron roseum* x *Rhododendron japonicum.* (Unnamed Hybrid)
   a) This is best rooted from softwood cutting under plastic. It is a floriferous type.
35. *Rhododendron Smirnovi* x *Rhododendron maximum.* (Unnamed Hybrid)
   a) This is a very hardy hybrid which roots well from cuttings.
36. *Rhododendron yedoense poukhanense* x *Rhododendron japonica.* (Unnamed Hybrid)
   a) This is very hardy and a strong grower which roots from semi-hardwood cuttings.
37. *Sambucus canadensis rubra.* Redberried American Elder
   a) By virtue of its bright red fruit, the red American elderberry becomes a useful ornamental shrub especially for semi-silt or damp ground plantings. This should not be confused with the early fruiting native red-elder. It is grown from root cuttings or division.
38 *Styrax obassia.* Fragrant Styrax
   a) Fragrant styrax is a large-leaved, tall growing, shrub with pendant clusters of fragrant white flowers. It grows well from seeds after stratification.
39. *Syringa pekinensis.* Pekin Lilac
   a) One of the interesting characteristics of the tree-like, Pekin lilac is the cherry-like bark which is glossy, reddish brown, and peeling. It is a fast grower from seed and can be used as an understock for budding French lilacs. These plants are abundant annual bloomers, blooming late in June after the French lilacs.

40. *Syringa spp.* Edward J. Gardner
   a) The finest new American lilac is the double, pure pink Edward J. Gardner. Mr. Gardner, before his illness and death, was doing excellent work with lilacs at his Wisconsin nursery.
41. *Syringa spp.* Sensation
   a) The recently released Dutch lilac, Sensation is notable in having the first bicolor effect. The purple of the parent Hugo De Vries is edged with white. It appeared as a mutation in 1938. Propagation can be by cuttings or root grafting.
42. *Wisteria venusta.* Silky Wistaria
   a) The Silky wistaria has white flowers and is characterized by a silky hairiness, covering the leaves. It should be grafted on *W. sinensis* using the whip and tongue graft.

MODERATOR COGGESHALL: Thank you, Mr. Fenicchia. Now Mr. K. D. Holmes, Mt Arbor Nurseries, Shenandoah, Iowa will speak on the "Propagation of Some of the Stone Fruit Trees."

MR. K. D. HOLMES (Mount Arbor Nurseries, Shenandoah, Iowa): After listening to the sessions since arriving Thursday noon, I am convinced that either our methods are completely outmoded, or that the cycle is coming around to the point where our methods are about to become popular again. Be that as it may, my subject is quite different from those discussed so far in these meetings.

Mr. Holmes presented his paper entitled "Propagation of Some of the Stone Fruit Trees." (Applause)

PROPAGATION OF SOME OF THE STONE FRUIT TREES

K. D. HOLMES
Mount Arbor Nurseries
Shenandoah, Iowa

It has been suggested that I speak on the subject of "Propagation of Some of the Stone Fruits." I will attempt to tell you, rather briefly, of the methods used at Mount Arbor Nurseries. I might start by telling you of the type of record form we keep on all budding operations. We use a large columnar ruled pad, 17″ x 11″. This record is prepared in our main office and each page carries a main heading showing the type or species and the location, such as the farm number, the block number and section. A sub-heading carries the row number, the variety, budder, date budded, and the amount budded. There is also a space for brief comments and a column for the per cent of bud take that the budding foreman fills in as we re-bud. There is also space for the name of the re-budder, man hours and rate of pay. This column, if filled in as the budding season ends, will give very valuable cost information.

As concerns our actual methods of production I will start with comments on dwarf flowering and dwarf fruiting peach trees. We line out *Prunus besseyi* or *Prunus tomentosa* seedlings which are about $\frac{3}{16}$″ in caliper. We prefer to get these understocks planted in the fall and bud them the following August. Both *P. besseyi* and *P. tomentosa* are

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We believe that extremely hot weather has a very definite effect upon our bud stand and therefore, have a rule that we shall stop budding when the temperature reaches 95 degrees. Some seasons' we have experienced temperatures from 95 to 105 degrees for days. During extended "hot" periods, we have found it necessary to change our working hours for the budding gang. They start about 5.00 A M and bud until the temperature reaches 95 degrees, which was usually around 11.00 A.M. Our bud take varies, as it does with most nurseries. It is dependent upon many factors such as the individual budder, the winder, sometimes upon the specific variety and upon weather conditions Our bud take on dwarf peach this year ran from 78% to 91%. I consider this to be an excellent percentage for peach buds on *Prunus tomentosa* or dwarfing understocks

Our standard peach tree budding is carried on exactly as I have described for our dwarf budding operation, with the exception of the understocks, which for standard peaches are partly red leaf peach seedlings, partly Southern natural and California Lovells. We like to plant some of all three kinds as we sometimes have a germination failure with one of the types Generally speaking, our budwood is taken from our own stock block trees. Our *Prunus mahaleb* is, of course, the main understock used for the production of the sour cherry. Much work has been done on the *Prunus mahaleb* seedlings, particularly during the past six or seven years, in an effort to produce certified virus-free material for cherry understocks Dr W. F. Buchholtz, Head of the Plant Pathology section at Iowa State College started valuable work on this problem long before most of us realized that a great many of the trees being produced were carrying a virus disease that could seriously effect the production of sour cherries. Thousands of *Prunus mahaleb* were repeatedly indexed Many were found to be virus-free and were transplanted for use in the production of *Prunus mahaleb* seed We have one of the *Prunus mahaleb* seed producing plantings that already is providing us with just about enough seed, from indexed virus-free trees, for our seedling production. There are now several other seed producing plantings in the country This same virus indexing work was extended to the Sour cherry variety trees, to the end that a number of nurseries are now growing only virus-free indexed understocks and budwood

I wanted to mention this, primarily, to call your attention to some of the work that must be carried on indefinitely if we are to make a determined effort to furnish our customers and the general public with the best quality tree that can be produced. I would advise lining out *Prunus mahaleb* seedlings as early in the spring season as the weather conditions will permit. We often get them planted during February. Practically all of our understocks and other materials, for that matter, are planted with a two row John Deere planting machine, rather than by hand In our area we have to keep *Prunus mahaleb* seedlings and our stock block trees well sprayed to hold the foliage. We do not like to cut bud sticks that have lost any of their foliage, as we feel that the bud-eyes would be damaged. We usually do not start to bud cherry until after September 15th as cooler weather arrives, and as the understocks show indications of retarded growth

The only Dwarf Sour cherry we propagate is the Dwarfrich variety To me it is more of a novelty than a fruiting tree, but so far we have not produced enough any year to supply the demand. This variety, by the way, is budded on *Prunus mahaleb* the same as any other sour cherry variety

We grow only the American and Minnesota hybrid plums at Shenandoah They are budded on native plum seedlings that are fall planted Incidentally, plum is another of the stone fruits that is subject to a virus condition and a great deal of work has been completed making virus-free budwood available In our State, Dr. Buchholtz is now coming up with quite a few seedlings from virus indexed trees The seedlings will, in turn, be indexed and those that remian virus-free will be planted for seed producing blocks. We usually bud plum during August. There is quite a little controversy in the Mid-West regarding plum budding. Some nurseries like to bud earlier than we do and de-wood the buds. They claim that they cannot get a good stand unless they do use rather green bud sticks and remove the wood from the bud-eye. This practice does not seem to work in our immediate locality. We have gone back to budding plum using riper wood and slicing the bud-eye leaving the wood in. Our stand of buds on plum was better than average this year, as weather conditions were more favorable at budding time. Our bud take on the purple leaf plums (*P. cistena* and Thundercloud) averaged 85% and our entire plum budding averaged 80%. Most of our European varieties of plum are grown at our Yakima Valley, Washington, branch and are budded on Myrobolan plum seedlings.

Our budding operation at Shenandoah is small compared to some of the rose budding operations that I have observed in California, although we try to run a gang of 12 to 15 good budders. It usually takes two winders for each of the budders and two men to rake out the seedlings ahead of the budders, making a crew of 35 to 40 workers altogether

MODERATOR COGGESHALL· Thank you, Mr Holmes At this time the meeting is open to questions.

MR FLEMER I would like to ask what average budding costs amount to.

MR. HOLMES That can vary, but on an average, peach and apple, which bud much more rapidly than the stone fruits, would run around 15 cents by the time we are through, including sprouting.

MODERATOR COGGESHALL: Any further questions? If not, I turn the meeting back to President Louie Vanderbrook Thank you.

PRESIDENT VANDERBROOK: At this time I will turn the microphone over to Dr. John Mahlstede for the report of the Field Trials Committee

MODERATOR MAHLSTEDE: While the final reports are being distributed I would like to call attention and give due credit to those members who helped organize and carry out this year's project. The Field Trials Committee as listed in the 1956 Proceedings consisted of the following members Vincent K Bailey, Jean P Nitsch, Harvey M. Templeton, Jr, John Vermeulen and myself, as Chairman.

Moderator Mahlstede presented the Committees report, entitled "Photoperiod Studies and Gibberellic Acid Screening" (Applause)

PHOTOPERIOD STUDIES

After considerable discussion by the committee and your officers it was decided to continue and complete, if possible, the photoperiod studies initiated in 1955-56. A program similar to the one solicited in 1956 was distributed in March of this spring through the courtesy of Dr Snyder Later this fall a request was made in the NEWSLETTER for anyone cooperating in this venture to contact the Committee. Two such notices were received.

Much has been said about the influence of light on the growth of ornamental plants, and plants in general As a science and a field, the effects of radiation on the growth of plants is in its infancy. Scientists know that, for growth, light must be given in sufficient quantity. The term photoperiodism has been given to the length of the day or light period and the night as it affects physiological responses in plants. It is known also that temperature plays an important part in the photoperiodic reaction Plants in turn may be classified by their reaction to the length of the light and dark period, as for example: (1) short day plants (Chrysanthemum), (2) long day plants (China-aster), and (3) those indifferent (*Buddleia*). Plants listed as short day and long day plants must be given certain light and dark conditioning periods before they can be brought to flowering For example, the chrysanthemum, a typical short day plant must have long uninterrupted night periods (50°F. and above) of 12-16 hours duration, depending on the variety, before they can be brought into flower. Flowering can be retarded at will by subjecting the plants to extended light periods or interrupting the night period before flower buds have been formed.

Why plants respond to variations in the light and dark period is not quite clear One explanation might be that in certain plants the reactions necessary for the transformation of buds into flower buds require slow chemical reactions which take place during the dark period. These reactions start with products produced as the result of photosynthesis during the day and finish up during the extended night period.

OBJECTIVES

It was the objective of the project, to determine what ornamentals could be maintained in a continuous state of growth by interrupting the normal dark period by two hours of light. Also by positioning plants in rows radiating away from the primary light source, it was hoped that information could be gained on the effect of light intensity on the growth of these plants which might be affected by an interrupted night period.

RESULTS

Crapemyrtle and *Caryopteris* in 1956, and *Caryopteris* again in 1957 were noticeably affected by interrupting the dark period with 2 hours of light Although the blossom buds on *Caryopteris* were formed, during the period of night lighting, the flowers did not open for at least 2 weeks after the lights had been turned off

General responses of various plant materials in the light experiment are summarized in Table 1. It must be pointed out that although some of the plants responded in a similar manner both years, others responded differently. In part, this may be accounted for by normal growth habit after the plants have become established. However, there is also the influence of environmental conditions as they effect the growth of plants For example, it is known that *Caragana arborescens* is an extremely hardy plant, which has the ability to take hot, dry growing conditions. For this reason it has been used in the Plains States for shelterbelt plantings. During the first growing season, transplants in 1956 performed very well at high interrupted light intensities, poorer at intermediate and again better at lower light intensities. The year was hot and dry in the Midwest, conditions under which the plant ordinarily does well. In 1957 the same general response was obtained at the various light intensities but the percent growth increase was much lower. This can be explained in part by noting that the year was relatively wet and cool. The non-lighted control plants were similarly affected by season, i e., there was a 79% growth increase in 1956 as contrasted to only 26% in 1957.

It was also interesting to observe the rate of growth of various plant materials located in a position directly under the light source (Table 2). With the exception of Red pyracantha, all plant materials had put on most of their growth by July 23rd. In other words, after that date very little growth was made by these plants for the remainder of the season. How this compares to the normal growth cycle of non-lighted materials or plants growing in the field was not determined.

In summary, we believe that further screening of plant materials for their possible response to interrupted light would not be practical. The variation in the age of the plant placed under lights and its normal flowering habits in regard to when it comes into "bearing" greatly influences results One of the primary objectives of this study, was to determine if it would be possible to maintain a plant in the vegetative state by interrupting the night period. Of the plants tested, few economically important plants were responsive, as far as the study went. In order to determine if the majority of these plants could be influenced it would be necessary to carefully observe flowering characteristics over a relatively long period of time, and then grow only those plants which could be held in an active vegetative stage under this system.

Table 1.—Effect of various interrupted light intensities on the growth of woody ornamental plants

High Light* 120-320 fc**	Intermediate* 30-120 fc	Low* 2-30
Artemesia stelleriana (1)	*Abelia grandiflora* (1)	None
Kolkwitzia amabilis (2)	*Ilex cornuta burfordi* (2)	
Prunus laurocerasus (1)		
Rhus glabra (2)		
Symphoricarpos chenaulti (2)		
Viburnum burkwoodi (1)		
Weigela vaniceki (2)		

Increased Growth* At All Intensities	No Effect in Growth	Decreased Growth At All Intensities
Amorpha fruticosa (2)	*Acanthopanax Sieb* (2)	*Magnolia grandiflora* (1)
Caragana arborescens (2)	*Cornus alba sibirica* (2)	*Spiraea billiardi* (2)
Caryopteris Blue Mist (2)	*Gardenia fortunei* (1)	
Cercis canadensis (2)	*Lonicera claveyi nana* (1)	
Forsythia suspensa (2)	*Spiraea froebeli* (2)	
Fraxinus p lanceolata (2)		
Ligustrum lucidum (1)		
Prunus besseyi (2)		

* Growth at least doubled at the specific light intensity in comparison to non-lighted controls.

**—Foot candles

( ) Reference

Table 2.—Growth rate of various ornamentals*

Plant Material	Percent of Total Growth Made by July 23, 1957**
Abelia grandiflora	100%
Gardenia fortunei	84%
Ilex cornuta burfordi	100%
Ligustrum lucidum	97%
Lonicera conjugialis	100%
Magnolia grandiflora	100%
Prunus laurocerasus	89%
Pyracantha coccinea	45%
Viburnum burkwoodi	100%

* Reported by J B. Roller

** 320 fc position

PRELIMINARY SCREENING STUDIES WITH GIBBERELLIC ACID

Late in 1955 it was brought to the attention of many members of the various sciences, meeting in Storrs, Connecticut, that a new growth stimulating chemical was available for testing on a limited scale This chemical was tested by many of the colleges during 1956, principally in the vegetable field.

In the Spring of 1957 several large chemical companies started marketing the chemical under various trade names to any taker The results were generally discouraging. Most plants were responsive to the chemical. In general, increased stem length, earlier flowering, large blooms, increased flower stalk length, longer internodes, and occasionally more lateral branching was noted as the result of the application of the growth regulator.

Because of the interest in this product and the effect it might have on modifying propagation and growing methods, the Field Trials Committee and several selected cooperators were asked to run a preliminary screening test. A chemical containing Gibrel, was purchased from a company in Missouri. Samples of this product were then distributed to the cooperators with suggested concentrations, possible uses, and a warning about burning.

RESULTS

From a summary of the results from members who used this particular product it was clear that the carrier used in the formulation of this product caused considerable damage to almost all plants to which it was applied (in concentrations over 100 ppm). Genera and species were quite variable in their response to concentrations between 10 and 100 ppm (Table 1 — Ref. 3)

Samples of the pure chemical supplied primarily to Experiment Station personnel by Merck and Company and Eli Lilly & Co, have given better results, at least from the burning standpoint. Dr. S H Nelson (4) treated rooted cuttings of several ornamentals on May 8th, 1957 and transplanted them 2½ days later. The results are summarized in Table 2. It is interesting to note that little loss occurred in the transplanting operation and that the height of plants of *Spiraea media* treated with 100 ppm gibberellic acid almost doubled over that of the untreated control plants. Cuttings of *Philadelphus* Dame Blanche also made a "favorable" increase in height over the untreated controls. *Hydrangea, Lonicera,* and *Viburnum,* on the other hand, were unaffected, at best, and often stunted by the higher concentrations

Table I.—The effect of gibberellic acid on the growth (height) of various ornamentals. (R. L. Ticknor-3)

	Percentage Growth Increase			
		Concentration (ppm)		
Plant Material	CK	10	50	100
Malus spp **	548	533	506	358
Rhododendron Schlip *	21	19	14	23
*Pieris japonica**	78	83	61	63
*Cornus Kousa***	229	129	214	165
*Chamaecyparis obtusa***	265		160	0
*Rhododendron o arnold***	32	27	30	38
Syringa vulgaris "Congo"*	41	60	4	9
*Rhododendron poukhanense**	30	14	26	3
*Euonymus vegetus***	11	30	32	17
*Daphne creorum***	61	63	56	59

Chemical applied July 12, Evaluated October 14, 1957

* Bedded June, 1956

** Bedded, June, 1957

Table 2—Height (in cms) of ornamental shrubs after one growing season following gibberellic acid sprays prior to transplanting

Material	Treatment			
	Check	10 ppm	50 ppm	100 ppm
Spiraea media	26.45	26.95	26.60	40.30
Philadelphus Dame Blanche	26.70	28.70	27.90	33.10
Hydrangea arborescens	22.06	15.25	21.17	16.50
Lonicera Carelton	33.15	29.63	30.33	19.75
Viburnum lantana	12.94	13.58	9.63	11.88

Similar results were obtained by J. B Roller (1) using seedlings and cuttings transplanted into 2½ inch pots two weeks prior to treatment. Gibberellic acid at 100ppm was applied on June 6, 1957 and again on June 13. *Photinia,* and *Taxus* were the only plants which showed any height effects from treatment (Table 3).

Table 3.—Effect of gibberellic acid on the growth of transplants

Plant Material	Per cent Growth Increase of Non-treated Plants	Per cent Growth Increase of Treated Plants	Type of Plant
Taxus cupsidata	35%	48%	Cutting
Ilex perneyi	Dead	123%	Cutting
Ilex cornuta rotunda	63%	50%	Cutting
Ilex bullata	94%	63%	Cutting
Ilex vomitoria (df)	69%	38%	Cutting
Ilex cornuta burfordi	50%	25%	Cutting
Acer atropurpurea	289%	200%	Seedling
Scheffelera	300%	300%	Seedling
Photinia	100%	300%	Seedling

Vincent Bailey, (5) using the supplied formulation on *Syringa, Euonymus, Philadelphus, Ribes, Abies, Pinus, Juniperus* and a number of other plant materials, reported uniform, negative growth results which were accompanied by various degrees of leaf burning

In summary then, it appears that the use of gibberellic acid by nurserymen should be restricted to small scale testing When more is known about its physiological action in plants it may well be that it will have a definite place in speeding up growth of slow growing dwarf plants, in establishing rooted cuttings and liners, and in seed propagation. In this latter regard, the use of this chemical on the so-called two year seed has particular merit which deserves further testing.

The situation has been very accurately evaluated in the July-August Agricultural Leaders' Digest by the statement "Right now the gibberellic product is like the atom bomb — it's got a lot of power of some kind, but nobody knows how much."

PARTIAL LIST OF CONTRIBUTORS

Reference No.	Name	Firm and Address
1	J. B Roller	Verhalen Nursery Co Scottsville, Texas
2	J P. Mahlstede	Iowa State College Ames, Iowa
3	R L. Ticknor	Waltham Field Station University of Massachusetts
4	S. H. Nelson	Dept of Agriculture Ottawa, Canada
5	Vincent Bailey	J V. Bailey Nurseries Saint Paul, Minnesota

MODERATOR MAHLSTEDE: I would like to ask Dr. Nitsch to come forward and give us a few details of the work he is doing on photoperiodism Dr Nitsch.

DR JEAN P. NITSCH (Department of Ornamental Horticulture, Cornell University, Ithaca, New York) · It was suggested that we make a few remarks about our work at Cornell. First of all. I am sorry to say most of our experience has been in the greenhouse, although we did have a very limited test outdoors this summer. We came to the following conclusions·

1 For the most part, in the greenhouse, where the temperature is high, I think the commercial use of light would be feasible only in the South where the night temperature doesn't go below 55 degrees I think light has no effect at all below this temperature.

2 Light effects the facility with which some cuttings root The intensity of rooting of poplar cuttings changes greatly with changes in day length.

3. Norway spruce grown under short days, results in shorter stock If they were kept under continuous light, they continued to grow, and at this time, they are still growing. This is just to show you that this type of plant does respond to daylength You can get a Christmas tree in three of four years if you keep it under continuous light I am afraid this is not practicable commercially, because we have to do it in the greenhouse

Departing from the subject of photoperiodism I might add a comment on the subject of gibberellic acid. Certain plants do respond very dramatically to gibberellic acid Gibberellic acid was applied to maple with very noticeable results. We observed a very large increase in height, but the stem was very thin. You get a tall spindley plant which generally is not desirable.

MODERATOR MAHLSTEDE: Thank you, Dr. Nitsch. Mr. Wells has a few words he would like to say in regard to the use of gibberellic acid on ornamentals Mr. Wells.

MR. JAMES WELLS: Some of you have received some material from me this summer and I think, without exception, all of you had notice of it. We applied this material to about 80 different kinds of plants in all stages of growth. We had some results which appeared quite quickly but which were later submerged in the normal growth of the plant I should perhaps say that we made three treatments, (June 5, July 1, and August 5) and we applied three strengths, i e., 25, 50, and 100 parts per million An untreated check was also used for comparison.

I would just briefly mention one or two of the plants which responded to treatment. We estimated response in percentage of increase in growth against the check. *Viburnum tomentosum,* treated with 25 parts per million gibberellic acid solution increased its size 75 per cent over the check. The percentage increase with 50 parts per million was down to 50 per cent *Philadelphus virginalis* and *Spiraea vanhouttei* was essentially the same.

There was only one plant, *Biota orientalis,* that gave a response which I thought was good. The plants, which were one year old from seed, were set out in the spring and had rerooted and re-established themselves at the time of treatment. The 25 ppm treatment produced plants which were 120 per cent larger than the check, and the plants were normal, without elongated internodes.

There was one other feature which we noticed on a number of plants, and that was that quite a few of the treated plants appear to be more healthy than the untreated plants Under our exceptional summer this year they retained their leaves when in some instances the check was completely defoliated. The treated plants looked healthier. The leaves were darker green and in better condition.

Right at this time I don't think we have any information which would suggest that it should be used by anybody except on an experimental basis.

MR JOHN B. ROLLER. I tested a number of commercial preparations of gibberellic acid and obtained poor results. However, I procured 100 milligrams of the pure acid from Eli Lilly & Co This I dissolved in 1,000 cubic centimeters of distilled water The solution was applied to young seedlings, some of which gave some terrific responses. One outstanding example was *Magnolia grandiflora.* These plants were in pots two weeks before treatment and approximately an inch and a half in height I treated these with three treatments at four-day intervals. It became apparent I was over-treating, so I skipped a week, gave them another treatment, and then I skipped two or three months These plants were growing so fast that they were unable to stand up and consequently had to be supported. After a growing period of two months the treated plants were about eight to ten inches in height compared to an inch and a half to two inches for those which were not treated. These plants were then put out when it was warm enough out in the shade and periodic fertilization continued The treated plants absolutely stopped growing until today the untreated plants are as tall, with better foliage and generally much better plants in appearance.

I am against use of this chemical after seeing what happened to some of these plants one year later Thank you.

MODERATOR MAHLSTEDE: With that gentlemen, I now turn the meeting back to our illustrious President.

PRESIDENT VANDERBROOK: Thank you very much, gentlemen, for the presentations. This is more or less a labor of love The membership doesn't realize the work that is being done by you scientific men. Neither does it realize the amount of cooperation it takes to make a project of this type "go"

We will now proceed to our Annual Business Meeting. (See page 11).

SEVENTH ANNUAL BANQUET

The Past President, Mr. Louis Vanderbrook and the newly elected president, Mr. Hugh Steavenson, presided at the annual banquet.

Dr. William Snyder was justly recognized for his faithful service to the Society. Through his services and foresight the Society has grown to be recognized as one of the outstanding organizations of its kind in the world.

Following a period of entertainment, Past President Edward H. Scanlon discussed a number of select slides he took while "Sleuthing for Specimens from Moscow to the Mediterranean"

The Seventh Annual Meeting of the Plant Propagators Society adjourned *sine die* at 10:00 p.m.