For the benefit of the guests, I should like to say that we have three classifications of members: Junior members, Commercial Members, and Non-commercial members. One requires for full membership a minimum of five years of practical experience, research or association with the science and art of plant propagation. The provisions of junior membership are liberal in that the applicant is credited with any portion of the five years' experience which he has when he applies and we, therefore, have a system whereby a person might be a junior for an entire five years; on the other hand, he might be a junior only one year, depending upon the judgment of the Membership Committee.

It is customary for persons to be invited as guests so that they may, if they so desire, communicate with members of the Membership Committee and secure the signatures of three members on their applications.

To welcome the members and guests to the Annual Meeting is a very graceful way for the previous year's president to retire, so I shall now retire and thereby allow President Scanlon to proceed with the Sixth Annual Meeting. (Applause).

PRESIDENT SCANLON: Thank you, Dick, for starting our meeting. The first speaker this morning is Mr. Aart Vuyk of Musser Forest, Inc., Indiana, Pennsylvania. His subject is "Mass Production of Forest Tree Seedlings"

MR. VUYK: Mr. President and members and guests, it is pleasure to be here again at an annual meeting of the Society and to be able to talk to you

Mr. Vuyk presented his paper entitled "Mass Production of Forest Tree Seedlings." (Applause).

## MASS PRODUCTION OF FOREST TREE SEEDLINGS

AART VUYK
*Musser Forest, Inc ,*
*Indiana, Pennsylvania*

SOURCE OF THE SEED: Good seed is one of the most important factors in producing a good seedling Special attention should be given to elevation, climate, and characteristics of the parent trees. Years ago growers didn't care too much where the seeds came from, but we have learned that the source of seeds is of most vital importance, and cannot be overlooked by the serious grower who wants to sell a good product.

We, at Musser's, try to buy or gather the seeds in locations comparable to our own general conditions of climate and elevation. When the harvest is good, we buy seeds for years ahead and keep them under refrigeration. To give you an idea of the importance of good seed, let us take a look at one of the best selling pines in the trade, the Scotch pine. As most of you know, there are few races of Scotch pine, and if you start out with seeds from a race not well adapted to your own location, the results can be disastrous. Irregular and reduced growth, crooked stems, and even late spring frost damage may occur when the seeds come from a location with earlier spring and warmer summer conditions than you have.

This also applies to Norway Spruce. We discovered a very well adapted Norway Spruce. Two-year seedlings graded 5-10 inches, whereas the regular Norway Spruce seedlings never graded over 3-6 inches

Canadian Hemlock is also very sensitive, especially as a one-year seedling, when seeds are obtained from the wrong source. One must pay particular attention to the source in buying or collecting seeds of all forest trees.

STORAGE. We store the cones on racks and put them in a gas heated room, at a temperature approximately of 120°F After the cones open, extraction is effected by a tumbler, preferably on a day with low humidity. Many varieties of pines and spruces may be stored for several years without losing much viability. The opposite is true for the firs, which lose a high percentage of their viability in one or two years, usually about 50% after two years storage.

We store the seeds in five gallon jugs and label for species, year of seed crop, origin, etc. We maintain a temperature of about 35 to 40°F, and make sure that the moisture content is low when seeds are put into the jars.

AMOUNT OF SEED PER 400 SQUARE FEET: To determine the amount of seed used per bed, we use two seed tests, one made by one of the State Universities, and one made by our foreman in the nursery. We count exactly one hundred seeds for each test, and determine the amount of seed according to the outcome. As a rule, the tests don't vary much and we go by the better one.

Two years ago we had some seed of Nordman fir (*Abies Nordmanniana*). The test from the University showed zero, and our foreman got four out of a hundred. We decided after a cut test to sow the seeds anyway, and got a fairly good stand. So don't throw your seeds out the window before you try twice.

Some Examples of the Amount of Seed to be Used Per 400 sq. ft. are:

| | |
|---|---|
| Scotch Pine | 1½ - 2 lbs. |
| White Pine | 1¾ - 2 lbs |
| Austrian Pine | 2 - 2½ lbs. |
| Am. Red Pine | 1¼ - 1½ lbs. |
| Mugho Pine | 1½ lbs. |
| Norway Spruce | 1½ - 2 lbs. |
| White Spruce | 1 lb |
| Colorado Blue Spruce | 1 - 1¼ lbs. |
| Canadian Hemlock | 1 - 1¼ lbs. |
| Balsam Fir | 2 - 3 lbs. |
| Douglas Fir | 2½ - 3 lbs. |
| Concolor Fir | 4 lbs. (Old seed 6lbs. at 40%) |
| Cedrus atlantica | 5 - 6 lbs. (+5600 Per Lb.) |
| Japanese Larch | 2 lbs |
| Tulip Poplar | 10 - 12 lbs. (Mostly only 7-8% viability) |

The Oak varieties and Chestnut are hand planted, and the maple varieties are sown on sight.

STRATIFICATION. Through the years we have made quite a number of tests, and gone throuh a lot of books and advice from different seed dealers as to cold treatments, hot treatments, etc. Now we are back to mother nature and some old fashioned stratification methods, and we are satisfied with the results.

The hard-coated seeds like taxus, *Ilex*, etc., are stratified in peat and sand in boxes in a cool place or sometimes in the seedbed. Many items like dogwood, maple, barberry, oak, chestnut, birch, poplar, locust, elm, linden, and some pines, are sown in the fall as soon as the seeds are collected or received. Due to the tremendous amount of work in the spring, it's a relief that this fall seeding gives us good results. Three years ago, we decided to grow Chinese chestnuts. We got advice from our seed-dealer as to how to stratify in cold storage, checked every two weeks for mold, and turned them over in containers. A lot of work and complete failure was experienced. Last year, the day after we got the seeds in, they were sown The result was a 97% stand. The way it looks now, we are going to stay old-fashioned, as far as stratification is concerned.

PROCESS OF SEEDLING: After plowing the field, we make up the beds with a Gravely Garden Tractor ( a bedmaker doesn't work in our tough soil), and then rake them out by hand The size of the bed is 100 ft. by 4 ft. We use mushroom manure or cow manure which ever is available, bonemeal and a 6-10-4 fertilizer. In order to distribute the seeds evenly over the bed, we use a 10 by 4 ft. square with the amount of seed divided in 10 equal, parts. All seeds are coated with red lead for protection against rodents. The seeds are covered with a sand-shaker which straddles the beds. They are then covered with salt hay, and shad-racks are placed on top to prevent the salt hay from being blown away by the wind. The sand coverage is determined by the size of the seed. As soon as the seeds start to germinate, the salt hay is taken away, and the shade is raised to 18 inches. For the evergreen seedlings, shade remains until about the second week of September. On all hardwood seedlings, however, shade is taken away as soon as the danger of frost is past. Also, there are some varieties which require no shade at all.

MAINTENANCE: All the seedbeds are under irrigation during the summer months. We use a portable overhead sprinkler system. At Nursery No. 3, the water is supplied by a man-made lake of 29½ acres, and at Nursery No 2 there are two reserviors holding 4,000,000 gallons of water. The waterlines there are underground. Weeding is done by hand labor, and a program which employs weed-killers is now in progress on a large scale. The seedbeds are watched very closely for disease and a spraying program is maintained during the summer season.

In the Fall all one year evergreen seedlings are mulched with salt hay. This coat remains until about the 15th of March to prevent heaving. When the mulch is taken off, the shade racks are put back on, and stay there during the hottest part of the summer, and are permanently removed in early Fall.

By then, one should have a sturdy two-year seedling which can stand the weather. In early Fall, a considerable amount of transplanting is done in the beds, because we could not take care of all this work in the Spring All those transplants are mulched, as for one year evergreen seedlings. Additional transplanting is done in May when the busy shipping season is over.

Wherever possible, the seedbeds are lifted with a bedlifter, and the remaining beds are root-pruned. In the counting room little trees are graded over a conveyor-belt to find their way to the Christmas tree plantations, the transplant-beds, and our customers.

* * * * *

(Editor's note: Mr. Vuyk showed a series of beautiful slides illustrating various nursery operations, including the use of DDT for insect control, fly ash (a byproduct of coal mining) as a soil conditioner for clay soils, and special planting boards to facilitate the transplanting of small seedlings Many of the following questions were discussed while these slides were being shown.)

MR. FILLMORE: How deep do you plant the seeds?

MR. VUYK: We cover the seeds according to the size of the seed. If they are small, we use a very light cover, no thicker than the seed. Larger size seed are covered accordingly. We put more sand on top of the coarse seed than we do the fine seed.

MR. MARTIN VAN HOF (Rodhe Island Nurseries, Newport, R.I.). How many seedlings can be planted per day with the planting boards?

MR. VUYK: I can't tell you about transplanting seedling since it is not my department. However, we transplant rooted cuttings from the greenhouse. Planting boards are not used however. By hand, two men plant approximately 260 rows of about 20 cuttings per row.

Question: Do you spray the pine seedlings?

MR. VUYK: Yes, we apply DDT about the time the pine shoot moth comes out. This treatment is to prevent the insect since we don't have them yet.

Question: How do you space Scotch pine for Christmas tree production?

MR VUYK. They are spaced five feet by five feet. These trees will remain six or seven years before they are cut. They will then be five to six foot trees.

Question: Is Scotch pine still your favorite for Christmas tree planting?

MR. VUYK: Yes, about 900 of a thousand will be Scotch Pine. Others include white, red, and Austrian pine.

Question: Do you have Balsam fir?

MR. VUYK: We have sold some Balsam fir, but needle drop is a problem. Because of needle drop we never start cutting spruce before December 6th or 7th. Cutting pine usually starts on December 1st, however, one year we started cutting as early as October 15th. If there are several rainy days, pines can be cut and placed in piles. We have never grown Douglas fir as a Christmas tree

Question: Do you plant Christmas trees by hand or by machine?

MR.VUYK: Machine planting is used whenever possible. If the hill is too steep, we plant by hand.

MR. RICHARD VAN HEININGEN (Van Heiningen Nurseries, Deep River, Conn.) Do you pick seed from your own plants?

MR. VUYK: Yes, we do, especially Scotch pine, Norway spruce, and hemlock. We allow the cones to dry and open in a heated room Sometimes we give the cones to a seed dealer to process for us.

MR. VAN HOF. What fungicide do you generally use?

MR VUYK: Mostly Fermate, but also Captan.

MR. VAN HOF: How much care is required?

MR. VUYK: Approximately 1800 trees can be planted to the acre if a five by five square is used. We start shearing the pines and spruces the fourth year. If we think a plant will be good in the seventh year we don't shear the sixth year.

Question: Do you spray for spruce gall?

MR. VUYK: No. It is not necessary if they are cut.

Quetion· Can pines be cut if they have pine shoot moth?

MR. VUYK: I am not sure, but I think you can't cut them.

Question: What was the black material you put in the soil?

MR. VUYK. It is fly ash, a product from coal mines It is used to condition our heavy clay soils

MR. JOHN VERMEULEN (John Vermeulen and Son, Neshanic Station, New Jersey): How do you use the red lead for rodents?

MR. VUYK: It is applied in dry, powdered form. We add some red lead powder to a bucket of seed and mix it until all seeds are coated

MR HANS HESS (Hess' Nurseries, Mountain View, New Jersey): What do you use to get the red lead to stick on the seeds?

MR. VUYK: If you stir the seeds or shake them in a box, they will become completely covered. It is not necessary to use anything

MR. HESS. It has been our experience that the red lead will not stick on smooth-coated seeds, such as pine and spruce, unless we add a very small quantity of linseed oil to coat the seed first and then apply the red lead. By this procedure the red lead sticks on long enough so that the birds will not eat the germinating seed in the spring.

MR. VUYK: Well, the birds are not a problem in our seedling at all, because our seeds are always covered with salt hay The birds can't touch them. After they germinate, as a rule, the birds don't bother the seed.

MR. HANS HESS: To discuss this thing a little further as far as birds are concerned, in our area we cannot grow a spruce, pine, hemlock or yew seedling without either treating with red lead or covering the bed with a fine mesh wire to keep out the sparrows. They will clean a bed of seedlings in a 24-hour period. They will absolutely destroy every seedling which has emerged, removing the seed head, leaving just the stem After eating the seedlings, they will proceed to scratch in the bed and eat whatever seeds are left. That has been a problem with us for the last ten years. I know there are more fellows who have that same problem. Before that time, we had no difficulty at all, and as each year progresses, the birds find more things that they will eat and destroy. For years they haven't bothered hemlock. Last year, they cleaned us out of hemlock seed.

MR. C. H. HENNING (Park Department, Niagara Falls, Ontario): What is salt hay?

MR. VUYK: Salt hay is a product of the swamps of New Jersey. It does not contain any kind of weed seeds

MR. LOUIS VANDERBROOK (Vanderbrook Nurseries, Manchester, Conn.): Why do you use DDT to certify your nursery?

MR. VUYK: We are not in a Japanese beetle area, but they are moving in closer and closer

Question: Do you think DDT is better than Aldrin?

MR. VUYK: We have used both. DDT handles better and is effective for a longer period of time

MR. VANDERBROOK: Where do you get sufficient labor for this enormous operation?

MR. VUYK All weeding of the seed beds is done by girls The boys take care of spraying and the more heavy work.

MR. FILLMORE: Do you practice the same root pruning procedure on deciduous seedligs, such as oaks and chestnuts, as you practice on the narrow-leaf evergreens?

MR. VUYK: We undercut pin oak and Norway spruce. The blade is set deeper than for the evergreens.

MR. HAROLD HICKS (The Cottage Gardens, Lansing, Michigan): What is the fertilization program for these seed beds?

MR. VUYK: It is not a big fertilization program. When we make the seed beds we use mushroom manure, or cow manure if we can get it. Just before seeding, we apply 6-10-4 at a rate of about twelve pounds per bed.

We make two applications of 20-20-20 to the two-year old seedlings. The first application is made late in May or early June and the second in July. We once made the mistake of continuing the fertilization program.

MR THOMAS PINNEY (Evergreen Nursery Co., Sturgeon Bay, Wisconsin): How do you control damping-off?

MR VUYK: In my opinion, when damping-off has started, it is hard to control. We spray all one year seedlings with Fermate or Captan whether or not they are diseased. We don't give the same application twice. If the first spray is with Fermate, then the second would be Captan.

MR. PINNEY: We have been coating the seed with Tersan or Semesan. Do you use wires to support the shades for the seed beds?

MR. VUYK: No. The shades are on pegs as cross pieces.

MR. LESLIE HANCOCK (Woodland Nurseries, Cooksville, Ontario): Dusting seeds with sulfur is as good for controlling damping-off as anything we have used. It is very cheap and equally as good as commercial materials. With Austrian pine, sulfur treated seeds gave nearly a 100 percent stand, whereas an untreated lot was almost a complete loss.

MR. C. S. INGELS (The Home Nursery, Lafayette, Ind.): How was the sulfur for control of birds?

MR HANCOCK: There isn't a single answer for everything. You have to use the red lead for control of the birds. Perhaps the two materials could be applied at the same time.

MR. D. D. QUINN (Willo' dell Nursery, Ashland, Ohio): When do you prune the pines?

MR. VUYK: The pines for Christmas trees are pruned just once a year. Our pruning operation starts about June 15th and continues until about July 15th. The spruce are pruned during July. We have never pruned pines during the winter.

PRESIDENT SCANLON: Because of the time it will be necessary to conclude this session. If there are further questions, I am sure that Aart Vuyk will be glad to answer them individually during the remainder of our meeting We thank you, Aart, for a very interesting and informative presentation. The afternoon session will convene at 1:30 p.m.

The session recessed at 11:55 a.m.

# THURSDAY AFTERNOON SESSION
## November 29, 1956

The second session of the Sixth Annual Meeting of the Plant Propagator Society convened at 1:30 p.m with President Scanlon presiding.

PRESIDENT SCANLON: The program this afternoon includes a discussion of the propagation of peonies and the Speaker-Exhibitor Symposium. It will be a full program but extremely interesting.

The first part of our program is a discussion of the propagation of tree peonies by Mr. Harold E. Hicks, The Cottage Gardens, Lansing, Michigan.

(*Editor's Note*: Mr. Hicks determined that few of those present had very much experience with tree peonies. He, therefore, prefaced his paper with a number of kodachrome slides illustrating various types of peonies)

Mr. Hicks presented his paper entitled "The Propagation of Tree Peonies." (Applause).

## THE PROPAGATION OF TREE PEONIES

HAROLD E. HICKS
*The Cottage Gardens*
· *Lansing, Michigan*

HISTORY. By way of introduction I would like to give a brief history of the tree peony. Its earliest existence has been traced to Asia, where is has been growing in the wild state, in mountainous country, references being made of it back as far as 536 A.D. It was known as "The King of Flowers" and was given the most prominent and sacred place in the gardens of the impèrial places.

The Dutch people were the first to write about the tree peonies of China but it was more than a 100 years later when English Explorers sent plants home and that a real interest was born From about the year 1860 Dutch, English and French nurserymen imported tree peonies, propagated them, and made selections.

I might say here that Mr. N. I. W. Kriek has imported many varieties of the Lutea hybrid types to this country, especially those from the famous "House of Lemoine" in France.

TYPES. There are three main types of tree peonies, namely, the European, the Lutea Hybrids and the Japanese.

Because of the greater activity of the European nurserymen, the European varieties, such as Banksi, Souv. de Ducher, Reine Elizabeth and Jules Pirlot, became the most wide spread in this country during the last 50 years. We are gradually discarding this type, however, in favor of the Lutea hybrids and the Japanese varieties because they are more floriferous and bloom at an earlier age

The Lutea Hybrids originated in France through the effort of the great hybridizers, Prof. Louis Henry and Victor and Emile Lemoine

This type is outstanding in having many pure yellow (there are no true yellow herbaceous peonies), oranges, and terra cotta colors A few varieties that should be mentioned are Souv de Maxime Cornu, a full double deep yellow, heavily shaded orange salmon, Alice Harding, a nearly pure lemon yellow, and Flambeau, Satin Rouge and Surprise, three beautiful full double varieties of yellow, heavily shaded with orange or red. The one draw-back to the Lutea types is the habit of the flowers drooping and hiding in the foliage. However, as the plant gets larger and older, 4-6 feet in height, this drawback becomes an asset in that flowers then can be seen at eye level from the side.

I must make mention of the work of the late Prof A P. Saunders, of Hamilton College, who developed a new group of tree peonies, mostly single and semi-double with a wide range of colors in nearly 75 varieties. Only a few, such as Argosy, a clear bright single yellow, are availabe now, but I am sure we will be seeing many of his varieties in the future.

The Japanese types are more graceful plants, their foliage is more beautiful, the flowers are single, semi-double and double, are born well above the foliage, and the colors are always vivid. One must see to appreciate such varieties as Yeso-no-mine, a pure double white with blossoms 8-10 inches across, Kuro-Botan, a semi-double dark velvet maroon and Adzumi Kagami, glowing deep carmine.

PROPAGATION Tree peonies can be propagated by several methods of which all but one will be only briefly mentioned.

Seedlings can be produced quitely easily and the resulting plants are sturdy and vigorous. However, only 10 to 15% will produce blooms of pleasing color, the great majority of the flower color being magneta. We have always felt it an injustice to sell a plant that would almost surely be a disappointment when it began to bloom 3 to 5 years later.

We have been experimenting with propagation by cuttings, however, results have been too poor to be of commercial value. We have succeeded in rooting 20 to 30% under summer mist and fully intend to continue our efforts on the theory that if one will root there must be a way to get two to root, etc.

The common method of propagation is by grafting in late July and August. We use herbaceous peony roots for the understock Best results are obtained by using Mons Jules Elie, Sarah Bernhardt and Felix Crousse The understock should be about 4 inches long and ½ to ¾ inches wide. We use scions from our own named varieties. Each scion is a stem about 1½ inches long with one leaf left attached and one bud in the leaf node. The understock is slit about 2 inches at the top end and along one side A good union is always assured because the herbaceous root is pliable. The graft is dipped in a ferbam solution, placed in a sweat box in a greenhous bench, in a medium of sand and peat. They remain here until about October 1st at which time the scion has easily knitted and new roots have formed on most of the understocks.

The grafts are then potted in 3-inch rose pots and plunged in cold frames, covering them with about two inches of sharp sand The only care is to keep them watered and the dead leaves picked out. We spray them three times in early spring with ferbam or a similar solution to keep any disease from entering.

The following Fall the plants are shifted to 5-inch pots and then plunged six inches deep in outside frames. This is done so that new roots will be formed above the graft union. The plants can be left in the 5-inch pot for a year or two and then planted to field rows, where again they should be planted deeply, 6 to 10 inches, under the surface to induce true own roots to form.

I might say here that some criticism has been made because the old herbaceous root tends to enlarge and it is felt that is not a good root for long life. However, if the plants are planted deeply, the union being from 6 to 10 inches below the surface, true roots will almost always develop and the herbaceous root becomes secondary.

I would like to warn the new propagator that all is not as simple as it sounds, mainly because of the difficulty in getting the plants to live until true tree peony roots are formed. The actual grafting is easy, and good results are obtained from the greenhouse bench. But the period while they are potted is the critical stage. Results obtained vary considerably with the variety. For example, with Yeso-no-mine, a beautiful Japanese double white, we expect 70 to 80%, but with Adzumi-kagami, a semi-double violet red, we hope to get 20 to 30%. I doubt that we or anyone else expect much more than 50% results. We naturally keep striving for better methods and a higher percentage of established plants.

CULTURE Culture of the tree peony, like the herbaceous type is completely simple Well drained soil, full sun or semi-shade and normal fertilization is all that is required, with one exception. Tree peonies are susceptible to Botrytis blight of the stems Cutting out of dead wood and general cleanliness will normally be sufficient. We have found, however, that spraying or dusting with Fermate or Bordeaux once before buds break and two times at two week intervals after leaves are formed will give good control. Tree ponies are completely hardy and when properly planted will remain in the garden practically forever.

I urge each one of you to obtain two or three varieties to plant in your own garden, only then can you appreciate them as the people of China and Japan did 1000 years ago.

* * * * *

Question: How long will the herbaceous root survive on a grafted plant?

MR. HICKS: Always, I think. There has been a lot of criticicm of the herbaceous roots — people say that the tree will not be as vigorous. As you know, as the herbaceous peony grows older, the roots get very large and will almost always have some rot in the center. We have always felt that there is nothing wrong with the way we graft and that the herbaceous root doesn't enlarge too much

MR. WILLIAM H. BURTON (Burton's Hill Top Nurseries, Casstown, Ohio): Have you ever tried grafting in the greenhouse in the winter time?

MR. HICKS: We never have tried it, so I can't give you an answer. However, I don't know any reason why you couldn't. We have more time in the summer and good scions are available then

MR. BURTON. Wouldn't you have to use harder wood in winter?

MR. HICKS: Yes, it would be harder. We have tried some other methods. We have taken regular herbaceous seedlings and grafted onto those because they have more roots. We have never gotten into any quantity of that because so many of the little seedlings have to be almost a full-grown plant (five years old) before they are big enough to graft.

MR. JACK SIEBENTHALER (The Siebenthaler Co., Dayton, Ohio): Did I understand you to say you have not tried root cuttings?

MR. HICKS: No, we have not tried root cuttings.

MR. SIEBENTHALER: On the stem cuttings which you said you have tried with moderate success. Could you explain when you took the cuttings?

MR. HICKS: We have tried several methods We have tried cuttings in winter. The results are very poor because the stem is too woody and hard. We tried cuttings in June just after we get enough growth, like a softwood cutting, in the greenhouse just in ordinary sand. The results have been practically nothing.

The last three years we have been using mist We have rooted as I said 10 to 20 per cent Some varieties have been better than that. Normally, the ones we really want to root are the hard ones. The European forms have been a little bit easier. I think there is a long way to go in experimentation. We haven't used any of the hormones nor the polyethylene case yet

MR. ROBERT A. NOETHEN (The Cottage Gardens, Lansing, Michigan): We are going to try air conditioned mist It is a bench covered with reinforcing material covered with polyethylene. At one end is the exhaust fan that pulls the mist through the covered bench and there is an electronic leaf to govern the amount of water.

MR. PETER G. ZORG (Cartwright Nurseries, Collierville, Tenn): Is there any difference between root stocks for tree peonies?

MR. HICKS: Is there any difference between using herbaceous roots or Officianalis, or Chinensis? When I say herbaceous, I do not mean *Officinalis* I just learned this morning then in Holland they use *Officinalis* for roots We haven't used it so, I really don't know. In all of my reading, I have not seen anything about *Officinalis* roots. I certainly want to try them next summer.

MR. ZORG: The roots of *Officinalis* are heavier than *Chinensis*.

MR. ROGER COGGESHALL (The Arnold Arboretum, Jamaica Plain, Mass.): When you graft and tie with the budding strip, do you do anything further, such as waxing the union, or just rely on the plunging alone to prevent drying out?

MR. HICKS: We do not wax them. I think some growers in the East did wax until they heard we were not waxing and they stopped it. We put them in the sand and peat mixture in a sweat box. The scion knits very easily. As far as we are concerned, there is no problem.

MR. COGGESHALL. When do you remove the rubber band?

MR. HICKS: We remove the rubber band when we repot from the three-inch to the five-inch pot. However, I think we could do it earlier.

MR. TED E. FOULKE (Peeper Hollow Farm, Cleveland, Ohio): The nursery where I work was originally a peony farm. After I took over and cultivated the ground, we dug out a lot of peonies. They looked very nice. The thing I am a little confused about is that for years afterward I had peonies coming up. Of course, in this operation they were just like weeds When one was dug out, two to five plants would come up. Did the plants come from the little roots which were left?

MR. HICKS: I am certain they didn't come from the roots. When the plants were dug, a root with an eye (bud) broke off. This year we dug about 40 acres of peonies. We use a digger to get all of the plant. We dont get all of the roots and I doubt if there will be five plants come up next summer. It is necessary to have eyes or buds on the roots in order to get plants.

MR. CASE HOOGENDOORN (Hoogendoorn Nursery, Newport, Rhode Island): When grafted plants have gone on their own roots, have you ever used these roots for grafting?

MR HICKS: No, we haven't because we have never had enough of these roots Roots from seedling tree peonies are compatible, however, it would be bad if suckering occurred. However, suckering probably would not be common.

MR. LESLIE HANCOCK (Woodland Nursery, Cooksville, Ontario): Have you been able to get any information at all on the Japannese method of propagation?

MR. HICKS: I haven't even tried to find out.

MR HANCOCK: I think it would be wise if we could get that information to check with our methods.

MR C. H. HENNING (Niagara Falls Park Commission, Niagara Falls, Ont.): Have you observed any influence of removing the herbaceous peony root stock and letting the tree peony go ahead on its own roots?

MR. HICKS: I expect that, if we would take the time, especially on a field plant, to remove the herbaceous root, it might give a little more area for the tree peony. Most of our tree peonies are sent out in five-inch pots.

MR. RICHARD VAN HEININGEN (Van Heiningen Nurseries, Deep River, Conn.): What is the range of the tree peony?

MR. HICKS. The herbaceous and tree peonies are very similar The tree peony came from the mountains in China They have been perfectly hardy with us in Michigan, and we have shipped to Canada, Massachusetts, and California. The herbaceous peony doesn't do well in the deep south.

MR. CONSTANT DE GROOT (The Sheridan Nurseries, Sheridan, Ontario): We have found some die-back in New England.

MR. HICKS. The terminal buds quite often will freeze back The plant is hardy but that doesn't mean that the terminal growth won't die-back in Michigan If you have a foot of new growth, three or four inches of new growth may die back.

MR. DE GROOT: There is killing of the flowers. If there are five or six buds in the summer, there might be only one left the next spring.

MR. CAMERON VERHALEN (Verhalen Nursery Co., Scottsville, Texas): What can be expected from tree peony seed?

MR. HICKS: Nothing but disappointment. Sevently to eighty percent will be poor color.

MR. JOHN B. ROLLER (Verhalen's Nursery Co, Scottsville, Texas): How long does it take to grow a good tree peony?

MR. HICKS: Five years.

MR. RALPH SYNNESTVEDT (Glenview, Illinois): What is the time and length of bloom for the tree peony?

MR. HICKS: If you had 25 to 30 varietes you could extend the period of bloom to about 10 weeks. Each plant will bloom for about two weeks. They last longer than the herbaceous peony. Rain doesn't hurt the tree peony flower. The lutea hybrids bloom two to three weeks after the herbaceous peony, but the European varieties bloom before the herbaceous forms.

MR. JACK SIEBENTHALER: What are the diseases and insects to look for?

MR. HICKS: There are no insect pests that amount to anything Botrytis is the major disease. If a plant gets Botrytis it will finally die. If you have tree peonies in the yard, it is desirable to cut away the wilted stems. Bordeaux is quite good We once thought that Botrytis could not be controlled, but since we have been using Fermate it has not been a problem.

The only other disease is leaf spot which appears quite late in the year. It doesn't amount to much if you clean up the old leaves.

MR. WINTHROP H. THURLOW (Cherry Hills Nurseries, West Newberry, Mass.): Have you ever tried using inverted root pieces as we have done so successfully with lilacs?

MR. HICKS: No, we haven't.

PRESIDENT SCANLON. As much as we would like to continue this discussion on peonies, time dictates that it must be concluded. Perhaps if there are further questions they can be included in the Question Box Session tomorrow night Our sincere thanks to you, Harold, for your excellent discussion and exhibit.

PRESIDENT SCANLON: We will now continue with the Speaker-Exhibitor portion of our program. Mr. Roger Coggeshall, Propagator at the Arnold Arboretum, Jamaica Plains, Massachusetts, is chairman of this portion of the program and will moderate the discussion.

MODERATOR COGGESHALL: This part of our program, as in previous years, will be devoted to short talks on plant propagation There will be a short question period following each talk.

The first speaker is Mr. F B. Gorton, Gorton's Nursery, Harbor Creek, Pa.

Mr. Gorton presented his talk, entitled "Own Root Versus Grafted Plants." (Applause).

## OWN ROOT VERSUS GRAFTED PLANTS

F. B. Gorton
*Gorton's Nursery*
*Harbor Creek, Pennsylvania*

Until several years ago, many ornamental plants, that would not come true from seed and could not be propagated successfully from hardwood cuttings, were grafted, budded or layered. A few of these were the Japanese red maple, certain forms of magnolia, pink flowering dogwood, selected forms of Blue Spruce, rhododendrons, lilacs, etc. Since that time, however, tremendous strides have been made in propagating plants from softwood cuttings. In many instances this has eliminated the need for grafting

The introduction of polyethylene plastic film, misting or fogging, and chemical rooting agents have created a mild revolution in the nursery industry. It has spurred the imagaination of many propagators to experiment for new and better ways of propagating certain plants. From these experimnts came a large number of new methods for inducing root growth on softwood cuttings A few of these were the intermittant or constant mist systems, the Burlap Cloud method, the plastic case method, and the Phytotektor System All of these systems, and several more not mentioned, are very successful in propagating large quantities of own-root plants at very low cost. The system you would use depends upon the climate in which you lived and the type of soil available In the Northern part of the country, most of the various systems in use require side and top protection of some type. Most of the own-root plants, propagated by any one of the above mentioned methods, have a very low mortality rate while being grown and will develop into beautiful true-to-name plants.

At Gorton's Nursery, which is located in Northern Pennsylvania, we do all of our propagating in shaded, glass-covered cold frames and in a greenhouse. The cold frames are watered by hand and the greenhouse has an automatic intermittent mist system Strange as it seems, the plants from the cold frames usually have a better root system than those from the greenhouse. As soon as the cuttings are well rooted, they are sprayed or dipped into a plastic wax and planted outside into well prepared and shaded beds.

As we are concerned only with own-root versus grafted plants at this time, we will not discuss the merit of the other methods of propagator at the Arnold Arboretum, Jamaica Plains, Massachusetts, is chairman of this portion of the program and will moderate the discussion.

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As we are concerned only with own-root versus grafted plants at this time, we will not discuss the merit of the other methods of propagation. For many years grafting was the main foundation for propagating the better than average ornamental plants. The usual procedure was to grow the understock for approximately two years, pot it up for one year, then do the grafting in late winter or in a few cases in late summer. In most instances the grafted stock would be plunged in damp peat moss, in a closed grafting case or so-called sweat box, for the union to callus. The propagator would then cross his fingers and hope for a good catch. For no apparent reason some years it was very good and some years very poor. This was especially true with the better varities of blue spruce, which many propagators have eliminated from their work schedule. However, in the last few years, many changes have taken place to help eliminate most of these hit and miss methods. Grafting cases, or sweat boxes, are gradually being eliminated. Most propagators now place their newly grafted stock on top of the open bench instead of in the case, thereby eliminating most of the disease problems. This has been made possible by maintaining higher humidity in the greenhouse, painting the union or dipping the complete scion into para-wax or some other similar material, and by using polyethylene strips or adhesive plastic material to wrap the graft union. In this case, no waxing is necessary but a fairly high humidity in the greenhouse is beneficial. Many recent articles have given this phase of the industry a shot in the arm. Today more propagators pay attention to quality than to quantity and the percentage of good grafts is very much higher.

A plant that has been grafted properly will develop much faster than a rooted cutting This is because the root system of the understock is two, and sometimes, three years old at the time the graft is made. This furnishes a tremendus push to the scion With an own-root plant, the roots and top grow simultaneously and thus is naturally slower developing. However, if you allowed the own-root plant the additional time it took to develop the understock for grafting, the own-root plant would be as large, if not larger.

We have just touched the high spots with regards to propagating own-root plants and grafted stock. We would like to draw your attention to some examples.

(*Editor's Notes* Mr. Gorton displayed plant materials propagated by grafting and own-root plants. The following account has been edited for presentation in these Proceedings.)

1. Japanese Red Maple:
   a) 6-month old, own-root plant. The plant is straight with active buds spaced equally around the main stem. Following transplanting there has been extensive root development.
   b) 2½-year old, own-root plant.The plant has grown considerably in size and is already developing into a good shape.
   c) 1-year old, grafted plant This plant is certainly larger than the 2½-year old, own-root plant. It will require a certain amount of pruning to shape it up. You must remember that this grafted plant had a three year start. Most grafted Japanese maples have a side shoot growing out

which make them rather crooked. It takes about a year after they have been planted out to get them to develop properly. In comparison, the own-rooted plant, after one year in the field, will be a much better shaped plant.

2. Magnolia Soulangeana:
   a) 6-month old own-root plant. The plant is in excellent condition. The very heavy root system is protruding through the bottom of the pot A plant of this size will grow approximately 12 to 18 inches in one year.
   b) 2½-year old, own-rooted plant. Although this plant is only slightly branched, it is well developed and has a very heavy root system. This plant was cut back a year ago to encourage branching.
   c) 1-year old, grafted plant. Suckers readily form with this graft if a large understock is used, or the grafting is poor

3. Blue Spruce:
   a) 6-month old, own-rooted plant The root system on this plant is not as heavy as most other plants of this age. Many will die if not watched very closely. They are extremely hard to root. We have had our best results with cuttings taken from young plants and placed in a cool shaded house. We have used Perlite for the rooting medium.
   b) 4-year old, own-rooted plant. This plant is taking a natural shape with branches evenly spaced around the main stem and rather close together A spruce on its own roots requires very little staking and pruning to develop into a nice tree.
   c) 2-year old grafted plants. These plants have grown more than the own-rooted plants and have very few branches on two sides. These grafted plants quite frequently develop their own roots after a year or two in the ground.

4. Red flowering dogwood:
   a) 6-month, own-rooted plant. It has a very heavy root system but it must not be allowed to freeze the first winter or it will be killed. Storage at 35°F is recommended until planting time.
   b) one-year old, grafted plant. The top, center bud did not develop very much, however, a side bud, adjacent to it, grew vigorously. This makes the plant rather crooked at the top. This is not serious, however, as it will disappear in another year

5. Lilac:
   a) 2½-year old, own-rooted plant This is an excellent example of a plant on its own roots. It is straight stemmed, very well branched, and of good size

To summarize, the advantages of own-rooted plants are:

Great quantities may be produced in a very short time and at very low costs.

They develop more naturally with very little staking or pruning.

They are propagated in the summer, which eliminates the expensive greenhouse heating required for grafted plants.

It eliminates the necessity of growing and potting up understock.

It eliminates the disagreeable suckers that develope on grafted stock.

The mortality rate is very low.

The advantages of grafted stock would be as follows:

Grafted stock develop much faster.

Grafting can be done in the winter when other nursery work is at a minimum.

Grafting is the best way of propagating many plants that cannot be rooted from cuttings

Grafted stock, in many cases, developes a heavy set of flower buds much quicker than own root plants.

MODERATOR COGGESHALL. Thank you, Mr Gorton, for a very interesting discussion. There is sufficient time for a few questions.

MR ALBERT LOWENFELS (White Plains, N.Y.): What success have you had over-wintering the dogwood cuttings?

MR. GORTON: Last year we had about 3000 in a cold frame. We lost all of them This winter we are trying the method suggested at our meeting last year by Mr. Charles E Hess. We have about 6000 in this trial.

MR. JAMES S. WELLS (James S. Wells Nursery, Red Bank, N.J.): Will you briefly outline your method with Blue Spruce cuttings?

MR GORTON: We are only experimenting in a small way and, as yet, have not developed a satisfactory method for commercial production This year we tried two different ways: in the greenhouse and in the cold frame. The cuttings in the greenhouse all rotted. Those in the outside frames developed a good callus and in some cases were starting to root. We lifted these cuttings, transferred them to the greenhouse, and lost everyone.

MR C H HENNING (Niagara Falls Parks, Niagara Falls, Ontario): Do you make any attempt to use juvenile wood, or terminal or lateral growth?

MR. GORTON: No we don't. We make sure we use good, new growth.

MODERATOR COGGESHALL: Thanks, again, Mr. Gorton, for this discussion.

The next speaker, this afternoon, is Mr. Thomas B. Kyle, Bohlender Nurseries, Tipp City, Ohio, who will discuss the propagation of miniature roses by softwood cuttings.

Mr. Kyle presented his talk, entitled, "The Propagation of Miniature Roses from Softwood Cuttings." (Applause).

# THE PROPAGATION OF MINIATURE ROSES FROM SOFTWOOD CUTTINGS

THOMAS B. KYLE
*Bohlender Nurseries*
*Tipp City, Ohio*

First, I would like to say that I have had only three years experience in growing miniature roses in quantity. I do not want to give the impression that our methods are the best. I can say, however, that we have been reasonably successful in the way that we grow them at Tipp City, Ohio.

Plant propagation is a fascinating profession. The urge to try new things and develop new methods is strong in good growers. We are fortunate that our industry has so many well-organized research programs in the hands of capable workers These men have brought about great improvements which have reduced production costs and added large sums to the value of inventories I would like at this time to express my appreciation for the privilege of hearing the experiences and significent findings of the research and commercial men at this meeting. It is a great opportunity for more economical operation and helps to keep us all abreast of what is new.

Miniature roses like hybrid tea, climbing, or any other class of roses, have certain varieties that are good growers and are easy to propagate, while other varieties are poor growers and more difficult to propagate. Springfield, Ohio, which is 20 miles east of Tipp City, was called the rose capitol of America from about 1900 to 1920 Millions of own root roses were produced each year. I know several men in Springfield who grew own-root roses during the early 1900 own-root-rose-era. When we decided to grow miniatures in quantity. I talked with these men to learn the way they grew roses. Their way of growing works the best for us today. They benched, or planted their stock plants on raised benches, in January They used good loam soil with about one-third cow manure. The roses were planted no later than early February. The cutting house was kept cold until late March. Two-eye cuttings were made and stuck outside in hot beds.

To make hot beds, they put 10 to 12 inches of wet straw-horse manure in the bottom of the bed, tamped it and covered the manure with five to seven inches of sharp sand The hot beds were covered with glass ash and shaded with a heavy muslin cloth during the day and the shade pulled back at night Cuttings normally rooted in ten days, were dug and potted Most of them were sold the following spring The varieties they rooted were mostly hybrid tea and climbing varieties. Limited quantities of species and miniature roses were also rooted in the same way

Our biggest problem with miniature roses is mildew We have tried all kinds of fungicides with only moderate success. We learned to regulate greenhouse temperatures, which helps as much as spraying to control mildew. In the Spring and Fall, we can grow and root the miniatures successfully During the late fall, winter and hottest part of the summer we are not able to get good cutting wood.

We now run our roses in a cold greenhouse during November, December, and January. We prefer 40 degrees or less temperature, not caring if the plants are frosted on cold mornings. With eight to twelve weeks of dormancy, the rose plants begin to grow vigorous with heat and the longer sunny days of early sprig. The plants are apparently less susceptible to mildew when they grow fast. By spraying them once a week with Captan we control it very well When we keep the roses in a heated house during the winter there is an abundance of mildew and very little growth

We have tried benching miniatures in late spring when our greenhouses are not so crowded. Experience has taught if you don't bench plants early and let them run cold for several weeks, most of them die and they do not make many cuttings. Benched plants are best on raised benches in a small, tight house which is shaded heavily during hot weather and the ventilators kept closed. We do not bench many plants because we are so crowded in our greenhouses during the winter months

Since we do not bench many plants, we have to rob cuttings from the pot plants we have for sale. Most of our miniatures are sold to mail order companies which want delivery March through May, and if we are not careful all of our plants are shipped before we have made sufficient cuttings for our next year's crop. Then it takes a year to build back stock. Miniatures are slow growing so do not make an abundance of propagating wood We have not been successful in keeping the plants healthy and vigorous during November, December and January and as I said before, most of our plants are shipped in early spring just at the time that we could get the best cuttings.

We do not use hot beds for rooting. In early spring and late fall we stick cuttings in open greenhouse benchs, using sand as a rooting media. It takes 3 to 4 weeks for most varieties to root, some longer.

Last summer we rooted our cuttings in an air-conditioned greenhouse under mist with excellent results. The cuttings rooted better and as fast as in hot beds. We used softwood cuttings from greenhouse grown pot plants. The ideal cutting is of vigorous new growth that has a flower bud Make the cutting just as the bud shows color.

First, we potted everything into two and a quarter inch pot. Now we are up to the two and one half inch size. The biggest trouble is that a plant like this will get crowded and get so much mildew on it that it will be killed I don't have a great amount of mildew, but if the houses were kept warmer, there would be lots of mildew.

I would like to learn how to make these plants grow during the winter so that cuttings could be made now.

MR. WELLS: Do you take the flower bud out when the cuttings are made?

MR. KYLE: Yes, we remove the flower bud. You can use hardwood, if you desire, but it will take longer to root

MR. WELLS: Do you use any hormone?

MR. KYLE: We can't see any advantage when hormones are used

MODERATOR COGGESHALL. Thanks, Tom, for your discussion of the propagation of miniature roses.

The next speaker is Mr. Ray E. Halward, Royal Botanical Gardens, Hamilton, Ontario. He will discuss the propagation of *Cercidiphyllum japonicum* from cuttings.

Mr. Halward presented his paper entitled 'The Propagation of *Cercidiphyllum japonicum* from cuttings in cold frames." (Applause).

## THE PROPAGATION OF *CERCIDIPHYLLUM JAPONICUM* FROM CUTTINGS IN COLD FRAMES

RAY E. HALWARD
*Royal Botanical Gardens*
*Hamilton, Ontario*

Having admired three beautiful upright specimens of *Cercidiphyllum Japonicum* for sometime and knowing that they were the only three trees of their kind on our property, I decided to try and propagate them from softwood cuttings.

My first attempt in 1954 encouraged me to try again in 1955. I took the first cuttings on July 12, 1954. The spring and early summer were extremely hot and dry in our section and the new growth was quite firm by this time, which probably accounted for the low percentage of rooting. Of 50 cuttings, only one rooted.

On June 23, 1955 I took 50 more cuttings. They were tip cuttings about 6 inches in length, and cut just below a node and were quite soft when taken, I removed the foliage from the lower half of the cuttings. Having used no treatment the previous year I decided to try them again with no treatment as I had noticed the other cuttings were quite heavily calloused by late summer.

The rooting medium used was one I have used for a number of years with good results: ⅓ sandy loam, ⅓ peatmoss and ⅓ sharp sand with 1½" of sharp sand on top of the mixture. About two days previous to sticking the cuttings, the medium was moistened and by the time I was ready to stick them the sand on top was quite dry. Thus, as the cuttings were stuck some of the sand dropped around them, giving them a clean, firm medium to begin the rooting process. When they were stuck and moistened, sash was put on and given a coat of white wash for shade.

The cuttings were syringed twice daily when the weather was hot, and sash kept closed for about three weeks. Following this, daily ventilation was given, that is to say the sash were opened a couple of inches to start with and gradually increased until they were entirely removed to give the cuttings a chance to harden before winter.

On September 1st, I checked the cuttings for rooting and found 38 out of 50 were well rooted and the remainder well calloused. The rooted cuttings were wintered in cold frames under glass and were set out in the lath-house in the spring of 1956.

In conculsion, knowing this tree to be dioecious, having male and female flowers on separate trees, I am not sure which sex I propagated as I have never seen the trees in flower. I have been lead to believe, The next speaker is Mr. Ray E. Halward, Royal Botanical Gardens, Hamilton, Ontario. He will discuss the propagation of *Cercidiphyllum japonicum* from cuttings.

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MODERATOR COGGESHALL: Thank you, Ray, for this discussion.

MR. LESLIE HANCOCK (Woodland Nurseries, Cooksville, Ontario): I think this work of Mr Halward is very significant, especially in view of the splendid growth obtained the second year with the cuttings It is difficult to get seed of a lot of foreign trees. Mr. Halward's results suggest that we should turn our attention to the production of shade trees by vegetative methods

MODERATOR COGGESHALL: At the Arnold Arboretum we have been propagating *Cercidiphyllum* by seeds These cuttings are much larger than our two-year seedlings.

Our next speaker is William Flemer, III, of the Princeton Nurseries, Princeton, N J. His subject concerns the budding of *Sophora japonica.*

Mr. Flemer presented his paper, entitled "The Propagation of *Sophora japonica* by Budding." (Applause).

## THE PROPAGATION OF *SOPHORA JAPONICA* BY BUDDING

WILLIAM FLEMER, III
*Princeton Nurseries*
*Princeton, New Jersey*

The propagation of *Sophora japonica* by budding is by no means new to the nursery world Back in the days of our Victorian ancestors when grotesque horticultural "novelties" were popular no matter how peculiar looking, it was common practice to bud *Sophora japonica pendula* on six or seven foot stems. This produced a tree similar to the weeping Ash (*Fraxinus excelsior pendula*) and certainly its equal in ugliness Two more useful forms, Sophora jap. columnaris which was narrow and pyramidal in form and *Sophora japonica violaces* with lavander colored flowers, were also budded, but these have long since disappeared from the trade and have apparently been lost.

For many years *Sophora* was just another rather rare leguminous tree only occasionally used as a lawn specimen, usually on some Landscape Architect's specification. With the arrival of various serious tree diseases on the national scene, most of these lesser known trees were subjected to more careful scrutiny in the search for better shade trees *Sophora* has received much favorable attention in recent years for this purpose, and we at Princeton have been enthusiastic in publicising its good qualities.

Eastern nurserymen who have had experience in growing the tree have noted how difficult it is to make it stretch out and grow during however, that the sex of the tree in this case can be determined by its growth characteristics. That is, that the male tree is quite upright and the female tree quite spreading

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Eastern nurserymen who have had experience in growing the tree have noted how difficult it is to make it stretch out and grow during the first years of its life. The tree starts out vigorously enough in the spring, but presently the shoot begins to branch excessively and become stunted almost with a "witches' broom" type of formation. Further investigation disclosed that this malformation is the result of toxins injected into soft growing tip in the course of the feeding activities of several minute leaf hoppers especially the genus Empoasca

This condition disappears later in the life of the tree for two apparent reasons. First, the leaf hoppers apparently have certain well defined limits as to how high above the ground they will feed and they no longer attack the branches as the tree exceeds this limit. Second, as the tree matures, in common with other trees generally, it makes but one flush of growth, and this takes place early in the season before the leaf hoppers build up. In pushing a young tree in the nursery to secure a straight trunk, intensive cultivation and heavy, fertilization are employed to force a long continuous thrust of growth which falls prey to the attentions of the leaf hoppers during the heat of summer. They have proved very difficult to control by spraying, as many broods occur in a given season and tolerance of insecticides develops.

In examining blocks of *Sophora* an occasional plant appears which is not attractive to leaf hoppers. Isolation and comparison of these rare individuals shows an occasional specimen which is of markedly better form than the regular run of the species and hence doubly worthy of vegetative propagation. The principle is well known in its application to selection of various Maple clones for resistance to *Empoasca fabae* and in *Ulmus americana* clones resistant to Elm Leaf Beetle.

This rather lengthy preamble establishes the reasons for budding sophoras. The actual process is simple enough. Vigorously grown one year seedlings as near pencil size as possible are lined out in the spring as early as the ground can be worked. These are cultivated and weeded carefully to insure rapid growth during the summer. Bud sticks of the current year's growth on older selections are cut in August, selecting the largest wood available because the size of the resultant whip is directly traceable to the size of the bud set the season before. The buds are peeled and inserted in August in exactly the same manner as apple or pear buds, and wrapped with rubber budding strips.

The following spring the understocks are cut bask to the bud and after growth starts, any suckers which appear are rubbed off. A light four foot bambo stake is inserted on the opposite side of the understock and the developing whip is secured to it by several ties during the course of the growth The plastic-coated wires sold as "quick ties" have proven quicker and cheaper to use than raffia. At the end of the growing season, stake and ties are removed and the subsequent culture of the tree follows established practices.

Specimens of ordinary Sophora seedlings, of a selected type, and of a budded understock are on display for those interested.

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MODERATOR COGGESHALL: Thanks, Bill, your discussion was very interesting.

MR. FRANK O ANDERSON (Belle Valley Nursery, Erie, Pa.): How old is this plant before it will bloom?

MR. FLEMER: It takes a long time, about 15 or 20 years.

MR. FILLMORE: Are the buds de-wooded?

MR. FLEMER: They are de-wooded. We use only the shell of the bark with the bud attached.

MR. JOSEPH C. MCDANIEL (University of Illinois, Urbana, Ill.): Have you tried budding *Sophora* on anything else?

MR. FLEMER: No, we haven't. I doubt if it would take on either *Gleditsia* or *Robinia*

MR. CARL E. KERN (Wyoming Nurseries, Cincinnati, Ohio): I understand that the roots of *Sophora* trees grow straight down, like the horse radish. If permitted to grow in the nursery, the main root will go three to four feet straight down. Therefore, root pruning is necessary.

MR. FLEMER: It is true that they have deep taproots. Our experience has been that we get better growth if we dig the *Sophora* as two-year-old trees and actually transplant them, than if we merely run a blade under them and leave them where they are. The same thing is true of honey locust trees. I think Jack Siebenthaler will agree. If you run the blade under them it glazes the ground or something underneath the tree and they stand still and refuse to grow, whereas, if you transplant them and prune them severely with the shears, they grow much more rapidly.

MODERATOR COGGESHALL: Our final talk this afternoon is also concerned with the propagation of roses. Mr. Harold A. Barnes, Barnes Roses, Inc., Huron, Ohio, will discuss the budding of roses.

Mr. Barnes presented his paper, entitled "The Propagation of Roses by Budding." (Applause)

## PROPAGATION OF ROSES BY BUDDING

H. A. Barnes
*Barnes Roses, Inc.*
*Huron, Ohio*

In the fifteen minutes which has been allotted for the "Propagation of Roses by Budding" I shall try to cover the most important details. I shall devote the first part of my talk to the actual technical details of the subject and the second part to some of the pitfalls and details which may not be fully understood at the moment.

Present day commercial propagation of roses is done by budding, not by grafting as in years gone by. In the beginning, as with any crop, we must start with the plot of land involved for the crop. Roses, of course, grow best in clay soils, but contrary to this, my first crop of roses was raised on pure sand, and for a beginner, I still consider that first crop a good one.

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Roses grow well in a pH of 5.5 to 7.5, which gives the grower a wide tolerance with which to work. As a starting point, wild rose (*Rosa amultiflora japonica*) is planted in the spring just as early as your soil will permit you to do so. Late March is excellent if it is possible to start that early. Two types of understocks are commonly available to the trade now, one is seedling, the other is rooted cuttings.

At our nursery we plant our rows 42 inches apart and the wild stock 10 inches apart in the row. We have recently started to block our fields so that we have a strip which will provide solid bearing for heavy machinery, in case of long sustained wet weather in July, August and September We are then able to use as a stopgap a high velocity duster to control Blackspot. This is a related subject which I will not discuss further as time does not permit

As each block is planted, usually 35 rows, we use 12 inch disc hillers to cover the understocks to the very top — when this is completed we move a line of irrigation in the middle and water for approximately one hour. As a result the soil is washed away from the top of the mound and all of the top lateral growth is then above ground. This whole process, as you know, tends to keep the plants from drying out until new roots are formed.

The next step is to cultivate for weeds — this time lapse can be from one to four weeks, depending on weather. The minute that weeds are one-half inch high, cultivate again with disc hillers only in reverse this time to take the soil away from the plants Usually our hillers are set at five inches. In other words, we have 2½ inches clearance on both sides of the plant. Never let any mechanical or hand tool touch the understock itself as this will wound the cambium tissue and at budding time the bark will not open properly. We do not make any attempt to etiolate the understock during the growing period. If, in the normal process of growing, we find it profitable to again use disc hillers to cover small weeds in the row, we do so.

In former years, some growers have felt that a good etiolated plant budded better, but we do not share this belief, principally because it is generally all hand work to remove this hill of soil which is around the plant at budding time and this constitutes another labor expenditure. From this point forward it is mostly a process of good growing practice until approximately July 1st in our area. At this time, we start to bud our plants. Usually we bud polyanthas first, on seedling understock, as they seem to come into shape some two weeks before the rooted cutting stock is ready.

Our budding procedure consists of three men per crew. One man to clean the soil away from the plants and wipe the working area of the understock with a clean rag The second man to follow is the budder. He slips the bud into the understock and the third man makes a tie with a rubber budding strip which seals the wound completely — leaving only the tiny eye exposed To go a little into detail concerning the budding eyes, they are cut from the present blooming field. The man who cuts the eyes from the field must have had considerable experience as this operation is very important and can "foul up," so to speak, a large part of your operation In general, we select rose canes that have had a bloom on them. At the proper time, this bloom has just started to dry up and is in a somewhat brittle condition. The thorns on this cane have brown color and will readily snap off with a little side presure, leaving a clean scar — not a torn one. Further — this cane will not squash when pressure is put upon it by first and second fingers. It is true that because of human error, we are not always able to cut our budding eyes in this condition, but head in the direction of these better requirements and your over-all bud stand percentage-wise will be better.

The next step in eye preparation is to make sure that these canes do not dry up in the process of collection. Usually we cut one variety at a time, place them in water at the time of cutting, bring them to the storage shed, de-thorn them, wrap them in wet newspaper and tag them twice as to variety and number of buds in the package, place them in refrigeration until the budder calls for this variety.

To recap this information and put it into workable form, here is an example. The bud cutter, or eye cutter, wants 500 buds of "Peace." He equips himself with a pail of water, pruning shears, and the location of the variety in the blooming field. When he locates the row, he inspects the plant for the cane he wants to cut, making sure that if he cuts this particular cane, he does not permanently cut this plant down in size from a No 1 to No. 1½ or No. 2 plant. This is accomplished by taking a lateral branch, or a main branch, only if there are 3 or more left on the plant, or if there are signs of a new shoot growing from the main graft, he may then cut a perpendicular cane from the plant.

In de-thorning, one small point to catch before we continue — the canes are all placed facing the same direction in the package so that the leaf scar is below the bud — this permits the budder to draw the cane from the case with less injury to the individual eyes and also the cane is in the right position for the budder to cut the eye out of the cane without turning the cane around.

The budder takes the 500 "Peace" buds that have been cut and conditioned for him, goes to the field with two men (the cleaner and the typer). The cleaner counts off 500 understock, labels the row "500 Peace" and the operation is underway The budder selects a cane from his case and cuts an eye from the cane, removes the small bit of wood from the back of the bud eye, takes his left foot and tips the top of the understock to the ground. This exposes the working area so that he can make a "T" cut in the understock and slip the eye into the cut. The top of the "T" cut is made first and the bottom of the cut is made last; as the budder is cutting the last tiny portion of this last cut the knife is twisted in position — ever so slightly, this allows the tabs (we use that word in want of a better one) at the finishing part of the cut to remain open and the bud is inserted with a deft push. Often in order to insert the bud tight enough the budder must place the back edge of the knife directly on top of the bud to gain a jutting surface on which to push. Too hard a push will break the tiny eye from the bark an then the bud will not grow and has to be removed. Sometimes if too many eyes are spoiled the budder will place his knife on the back just above the eye and push in that area. However, if the sap is flow-ing properly, within the plant, and other conditions are normal, this difficulty is not present. The budder then continues to the next plant and so on down the row.

The typer using rubber budding strips within 10 plants behind the budder. This is a "must" as the cut portion of the plant and eye will dry out very fast and die if not sealed up quickly. The rubber budding strips are 5 inches long and $\frac{1}{16}$ inches wide. The typer fastens the end and puts four complete winds underneath the bud and five complete of the strip on the understock by friction, crossing the strip on itself winds on top of the bud and ties the top by stretching the top of the band and pulling the end through the loop and again friction holds this from coming undone. The number of winds on top and bottom of the eye is conditioned by the length of the cut made by the budder. We always cover any and all of the wounded surface below and above the eye. A poor wind can cause the eye to push itself out from the union and result in a kill or at best a poor union.

At the end of 21 days, the budder with perhaps 50 more eyes of "Peace" will go over this variety (originally budded 500), cutting the band on the opposite side of the eye and the band will unwind itself and come off if it is cut in the proper place. If the eye is green and healthy-looking, we have a "take." If it is brown, or in any way looks poor, the budder will "re-bud" either below the first bud, or above, or on any other portion of the stock that is workable The bands on this re-budding operation are never cut and remain on the understock until the wild top is cut in February These bands ordinarily do not cut into the stock as the growth process increases because of the lateness of budding. However, this must be checked as it can girdle the stem if conditions are right for very rapid growth.

Nothing more is done in any way to the stock in the field until late February and early March when the wild tops are cut 1 to 1½ inches above the bud union, this is done with a short scissored topping shear. To avoid trouble such as the wind catching these tops and rolling them away and from freezing conditions anchoring them to the ground, we cut approximately 1,000 tops and gather them up at the end of the row and immediately burn them. A little kerosene is enough to start the fire rapidly, as the oil in the stems will make them burn with terrific heat. Other than cataloguing your field with a master chart, your work until the following spring is completed.

During spring cultivation extreme care must be taken so as not to break off the fast growing tender shoots. When the new rose canes have reached a length of 6 to 8 inches, cut them back half way. This will keep these shoots from breaking in the wind and will force the plant to throw new shoots from the basal portion of the graft. We go over our field as often as five times in the five or six weeks that the canes are in active growth during the months of April and May, making sure that each plant has had at least one pinch.

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MODERATOR COGGESHALL: Thank you, Harold, for this discussion of budding roses.

MR. FLEMER: For a given variety, do you prefer to use seedlings or hardwood cuttings for understock?

MR. BARNES: Production-wise, I prefer to bud on the cutting because it is faster. However, once you have a bud started on a seedling you can almost ring the cash register. Seedlings get very thorny late in the season and the budders dislike it.

MR. FLEMER: Do you cover the buds during the winter?

MR. BARNES: No, we do not

MR CHARLES A BURR ( C. R. Burr & Co. Inc., Manchester, Conn.): What is your average success with hybrid teas?

MR. BARNES: We have been averaging 85 to 90% on bud stand. We have had a lot of adverse weather these past three years, and gradings will not average 60%.

MR. PETER ZORG (Cartright Nurseries, Collierville, Tenn.): How can there be any question about compatibility on multiflora understock?

MR. BARNES. We have had experience of incompatibility with some understocks.

MR LOUIS VANDERBROOK (Vanderbrook Nurseries, Manchester, Conn.): Do you find incompatibility with the thorny or thornless multiflora?

MR. PAUL BOSLEY, (Bosley Nursery, Mentor, Ohio): There is a distinct difference, at least 10%, in your bud stands between thorny and thornless understock, in favor of the thorny understock We now specify nothing but thorny understock. There is a difference between cuttings and seedlings. Now a seedling is a normal, natural root system and the bud is put on the root tissue Above the crown on any multiflora, the top is constructed differently, made up differently, and a rooted cutting is simuly a piece of the top that has had to make an emergency root system in order to live, and there is a distinct difference. We get better stands on thorny stock than we do on thornless stock.

MR. McDANIEL: Is th thornless available in seedlings?

MR. BOSLEY: There have been certain strains of thornless developed. Seed picked from thornless understock will have a tendency to be somewhat thornless, and of course, with rooted cuttings you can select your wood and make them absolutely thornless.

While I am on my feet, I would like to make just one point about the winding with rubber bands. One year we had an experiment where we wound rubber bands solidly. Did you ever wear a pair of rubber boots in the summertime? That is exactly what is happening with your rose when you wind your band solidly. We took a block on every variety. Half were wound solidly and half were wound with spaces. small spaces to be sure We found as much as 10 per cent difference between the space band and the solidly wound rubber band. Now we try to have our winders give the rubber band some space.

MR. HENNING: Why is there a higher percentage of suckering from root stock propagated from hardwood cuttings as compared to seedling root stock material?

MR. BARNES: That is true and to the best of my knowledge that will always happen. In fact, there are some varieties of rooted understock that will sucker terrifically. There is a lot of difference in the material. There are a great many different types of multiflora rose, a great many more than a great many of us realize. Any grower who has kept this plant on his place for fifty years may have many different plants of his own. Many times we start propagation from a plant that is not the best we could have, had we selected better That is another factor in favor of seedling understock. I don't know as I have ever seen one sucker. There may be a possibility they could, but at least your troubles are far less.

MR. MERTON CONGDON (Congdon's Wholesale Nursery, North Collins, N.Y.): How many of the buds start growing the first year?

MR. BARNES: I find that it depends upon the time you start budding and also the weather, but on an average I would say perhaps 30 per cent will grow out. I am not in accord with all of the growers, but I like to see this condition. I wish I could make it happen more often On a seedling understock it won't make much difference.

MR. JOHN B. ROLLER (Verhalen Nursery, Scottsville, Texas): You can increase the percentage of the ones that break out this year in the selection of the buds that you use. It has been a long time since I have done very much budding, but if you take a good strong bud from the stick that is almost ready to break out, go ahead and bud it, because it has a tendency to break out early and give you a lot of these the same season if the bud is ready to break.

MR. BARNES: I will go along with that to this point; in a big production, time nor conditions permit you to select that kind of budwood. Other than that, I would go along.

MR. C. E. KERN: While I was out in California I visited one of the big rose nurseries. In their workships I noticed quite an elaborate system of refrigerators. I was very curious about that. What do we do with refrigerators in budding roses in a nursery? I found out in California they get the budwood after their normal budding period is over, I imagine sometime in September, because they haven't had any frost yet They will cu tbudwood, trim it properly, stick it in polyethylene plastic bags, put it in the refrigerator, carry it over at 35° or 40°F. until the first week in May when they are out in the fieild budding again on rooted cuttings which they had stuck in January. Of course, for us Eastern and Northern fellows that doesn't mean anything, but you can readily see where those boys can steal a ride on us as far as time is concerned.

MR JIM WELLS: I understand that a number of people refrigerate their buds for ten days or so before budding. Do you know anything about that in California?

MR. KERN: All I saw was the refrigerating outfit and, of course, due to the climatic conditions those fellows had tremendous advantage. Their greatest trouble is to stop their roses from growing in the Fall to get maturity. The only way they can do it is by cutting down their irrigation, no more water for maybe a month or two months, and gradually getting the maturity of the wood, and finally, they will get a ripening of the wood after which time they are able to dig. Now they tell me they have considerable trouble when the digging period comes, they are confronted with too much mud and they have to yank that stuff out of the mud.

As far as carrying over those buds, they are sure they can carry them over for three or four months until about the first week of May and the buds take it and they go right on The following year they cut that early May bud back and by Fall they can have another finished plant.

MODERATOR COGGESHALL: Thank you very much, Harold.

This concludes the afternoon series of speakers on the Speaker-Exhibitor symposium. I thank each of the speakers again for the interesting discussions.

The meeting recessed at 5:00 p.m.

# FRIDAY MORNING SESSION
## November 30, 1956

The third session of the Sixth Annual Meeting was convened at 9:45 a.m., President Scanlon presiding.

PRESIDENT SCANLON: The first paper on the program this morning is concerned with the cold frame method of propagation. It will be given by Kenneth B. Fisher of the Kingwood Nurseries, Mentor, Ohio

Mr. Fisher presented his paper entitled "Propagation by the Cold Frame Method" (Applause).

## PROPAGATION BY THE COLD FRAME METHOD

Kenneth B. Fisher
*Kingwood Nurseries*
*Mentor, Ohio*

Propagation by cold frame method is one of the oldest methods employed by nurserymen. As such it would seem that it is unnecessary to go into the matter to any great extent. Yet methods vary considerably from nursery to nursery and, therefore, it would seem wise to go into these variations as there seems to be no hard and fast rule to go by.

*CONSTRUCTION* Construction depends upon materials available and the use of the frame itself. Since most of the material we grow in the cold frame is of the more easily rooted items, such as various *Euonymus,* ours is very simple. We chose a spot at the base of a low bank By straightening up one side with a spade and leveling off, we obtained an area six feet wide and about fourteen inches deep at the back. We then laid out 1 x 8 inch planks, which had been treated with a wood preservative, the length of the frame and across the ends. On these we placed concrete blocks (8 x 8 x 16 in.) There are two tiers of blocks in the back and one across the front. The ends are built in stair step fashion and the sash are fitted inside the ends. The 1 x 8 inch boards prevent the tilting of the blocks as they are laid loosely with no mortar or cement. Here we have violated one of the rules of propagation as most references in textbooks will tell you to keep the frames air tight. The bank at the back, of course, prevents air flow there, but the other side and ends certainly allow some passage of air

For more permanent construction, frames are made of concrete. The walls should be from four to six inches thick and extend below frost level. Several years ago, cross bars were used on all frames at three foot intervals. One former nurseryman in our area had cross walls every three feet. Here again, the idea was to keep the frames air tight. Cross bars every three feet are also used in wood construction but it is not essential as I know of several propagators that do not use the cross bars. By using T-irons in the cement frame, more bracing is given. Certainly some bracing is required if the frames are of considerable length. Laurie & Chadwick in their book "Commercial Flower Forcing" recommend that if cement frames are more than 30 feet long, a cross wall should be inserted both to provide support and cut down on air circulation.

The type of soil or rather subsoil will have to be taken into consideration, particularly if you want to place your frames below ground level. You must have perfect drainage. One nursery in our area has reinforced concrete frames which are considerably below surface soil level but both the topsoil and subsoil are very sandy and drainage is no problem. Such a deep frame is usable not only for summer propagation but can be converted into a deep frame for winter storage of pot plants that might need the extra protection of the deep frame.

My good friend, Paul Otto of Perry, Ohio, on the other hand, even with a sandy soil, has his frames on top of the soil. They are of wood, using a 1 x 12 inch plus a 1 x 4 inch plank at the back, and a 1 x 12 inch plank in the front. His media is placed so that the surface inside the frame is about 3 inches above the outside. I think his frames are tighter than ours but there are a few cracks here and there, and a trip to his nursery will satisfy you that he can grow very good material in his frames.

The size of the frame is limited in one dimension by the sash used Since most standard sash are 3 x 6 feet, the cold frame is usually six feet wide by any multiple of three that you want to make it For ease of operation, some frames have hinged sash with sash cord and weights which take a lot of strain off the back, but I believe most commercial operations just lay the ash across the frames. Hinged ash would be disadvantageous if stock is to be uncovered and left in the frames all winter.

In laying out your frames, the accepted method is to run them east and west. We at Kingwood have again defied the textbooks by running our frames north and south. I don't recommend it but just bring it up to point out that you can get all the advice you need and read all the textbooks you want to, and still do as you please to a certain extent and make the frame work. Why north and south? Well we wanted the frame close to our greenhouse and water supply, and the area concerned was long and narrow. Running the frames east and west would make them too short or completely cut off a roadway to some beds behind our greenhouse. So the area concerned called for a north and south layout.

Generally speaking, however, the frames should run east and west. It all has to do with shading. If your frames run east and west, it is only necessary to shade the top and south sides. We, of course, have to shade the top, and the east and west sides as well I should mention also that some nurseries use a combination of the cold frame and the hot bed, although I think this is becoming obsolete in most areas. Certainly if summer warmth is a problem, it should be considered. In such an instance, the frame is made at least 18 inches below ground level and up to one foot of manure is placed in the bottom to keep the propagating medium at a higher temperature. With a hot summer, this, of course, could be quite a disadvantage. In our area, this past summer, it probably would have worked out well as it was so cold and wet nearly all summer. A friend of mine has a concrete frame with a concrete bottom in which he placed a network of pipe through which he can circulate hot water for bottom heat. This year he found it quite an advantage. He obtained quicker rooting than we did on the same items. If you are to pot off the cuttings or plant them out as soon as rooted, bottom heat could be quite an advantage.

In the matter of shading previously mentioned, you will find several types in use today. These will be discussed later. The mechanics is another thing that should be brought up at this time. Some propagators prefer fixed supports. This can be a wooden framework, whereas others use wires stretched about four feet above the ground, upon which the shading is fastened. Since our frames are not extensive, we built rectangular framework of 2 x 2"s which are ten feet long, supported at the four corners by 2 x 4 ft. legs. The back legs are about four feet long and the front legs are three feet long. They are wide enough to straddle the frame. By being movable, we do not have to dodge framework once the cuttings can take the sun.

Wind is not too much a problem for us since our frame is protected on the west by our greenhouse and a rise in the general terrain. Once in awhile we have to weight down the framework in high winds. One or two heavy planks laid across the top will do the trick.

*MEDIA.* The question of media goes right back to the propagator. Many in our area use bank sand. I believe that by and large, it is used more in our area than any other medium. We at Kingwood Nurseries use silica sand. Why, I don't know except that we started with it and were successful and, therefore, have stuck to it.

Now several textbooks decry the use of sand alone. They admit that it is generally used but tests have shown that for a great number of items, and that includes most of the shrubs grown in our area, a mixture of peat and sand is best. Kains & McQuesten in their book "Propagation of Plants" refers to a test by A. E. Hitchcock of the Boyce Thompson Institute. Out of 96 varieties tested (which were included in 46 genera) only six varieties rooted best in sand alone. The other 90 varieties rooted readily in a mixture of peat moss and sand, and the mixture proved far superior. Unfortunately, the text did not give the six concerned but refers you to the Botanical Gazette LXXXVI, 2, 1928. It would seem from this that those of us who are using sand alone should do a little experimenting along this line.

Some propagators, I find, use the same medium year after year and certainly those who can steam sterilize need have no fear of carrying any infection over from one year to the next.

We have gotten new sand each year as our operation is on a rather small scale and so far have found uses for the old sand. Semesan has been used and probably the more recent Captan can be used for sterilization. Naturally, if the operation is big enough sterilization of some sort would be cheaper than buying new sand and the time and effort involved in removing the old sand and replacing with new sand.

*CUTTINGS.* Briefly, I want to go into the cytology of plants As we all know, plants are made up of various cells. Seedlings develop from a single fertilized cell in the ovary of a flower The growth of that seedling by enlargement and differentiation of its cells, is limited only by conditions unfavorable to development

Therefore, with conditions favorable to growth, cell multiplication typical of that plant should continue without limit and supply parts suitable for vegetative reproduction. Theoretically, any one living cell is capable of producing a complete new plant. This obviously does not hold true in practice. Under well controlled conditions (and this is where an air tight frame wuold be employed). plants have been produced from a small number of living cells This, of course, varies with the plants propagated, methods used, and the propagator himself.

Cold frame propagation is not generally thought of on such a scientific basis for we usually think of a normal size cutting However, it must not be ruled out for with a proper frame and a good propagator many plants have been grown from very small cuttings.

Commerial growing by cuttage employs a larger cutting and therefore, a larger number of individual cells. Here again the size of the cutting can not be set down in black and white. It depends on the variety to be propagated and the propagator himself Generally speaking, the cuttings are from three to five inches in length I know of one nursery, however, that makes *Euonymus fortunei vegetus* cuttings eight to ten inches long, or even longer if they have enough wood

The cuttings used are referred to as summer greenwood or perhaps more properly, half-ripe cuttings. As with other methods of propagation, the condition of the cutting at the time of taking is very important Naturally, the cuttings should be taken from healthy, vigorous plants. Cuttings taken from plants with leaf diseases or in poor growth conditions usually prove disappointing. The wood used is of the current season's growth, but should be turgid rather than soft. This is one place where cold frame propagation and mist propagation differ in that cold frame propagation requires a more turgid cutting than is necessary by mist propagation Here again, the best stage of growth differs with various plants and some are more particular than others. Experience is the best teacher. Generally speaking, the cutting is taken just as the wood is beginning to harden. If it will bend or partially break, it is too old If it snaps off clean, it is just right.

We try to make our cuttings in the morning. If it is hot, they are immediately wrapped in moist burlap. Frequently, however, they are placed in baskets and when the basket is full, they are watered with a sprinkling can. When taken inside, they are spread upon the floor in a cool place and watered again. If we do not get around to them for some time, they are kept moist during that time.

The lower leaves are removed either by stripping or cutting off with a sharp knife. Our method is to strip unless there is a marked tearing of the outer layer of cells *Potentilla,* for instance, strips quite readily whereas we have trouble with *Weigela* and *Prunus* to name a few. With most cuttings, we pay little attention as to where the cut is made. Many propagators claim you should cut to a node or just below it — that a larger proportion of cuttings will strike Kains & McQuesten report that in most cases experimental evidence has not sustained this theory There are, of course, some items that have to be handled differently. For instance, we obtain best results with *Daphne cneorum* when we use heel cuttings Yet just a few days ago, a nurseryman friend was telling about an experience he had with this same item. He was going away for awhile and told his boy what cuttings to take while he was gone The boy misunderstood and made *Daphne* cuttings (this was in July) and, of course, there were no heels. Since the damage was done, the cuttings were made up in the hopes of salvaging some and that year, this nurseryman got his best strike ever. I think, however, that nurserymen will agree that *Daphne* cuttings should be made with a heel.

We do follow the practice of removing all the lower leaves, and if the plant produces large leaves such as *Forsythia, Weigela* and *Viburnum tomentosum* to name a few, those remaining leaves are cut back one half to one third Now this is another common practice that has been proven unnecessary insofar as rooting is concerned In fact, if the full leaves are left intact, the cuttings root faster, provided they are kept turgid, but it is more difficult to maintain a turgid condition in the cutting due to a more rapid transpiration.

Secondly, and certainly most important, is the saving of space in the frame. Naturally, cuttings with large, full leaves take up more space in the row and between the rows.

*GROWTH PROMOTING SUBSTANCES.* In the last few years, I think that most propagators have been using some growth promoting substance. This is particularly true if the rooted cuttings are to be removed for potting up or planting directly to the fields or beds. Since time is of the essence, growth promoting substances generally hurry up the rooting process so that a well rooted cutting is ready to go earlier than if no hormone is used. On the other hand, if as so often is the case, the cuttings are to be left in place over winter, growth promoting substances are not necessary, unless the subject is difficult to root. Certainly, they are not necessary or such readily rooted items as *Euonymus fortunei vegetus, Euonymus fortunei coloratus, Pachysandra* and the like. In fact before growth promoting substances were known, propagators of yesteryear did all their propagating without them and seemingly had no trouble even with many plants that some propagators of today consider difficult.

When we started five years ago, we used Rootone for everything and then changed to Hormodin No 1 for most items and Hormodin No. 2 for those more difficult subjects we encountered. Recently, instead of Hormodin No. 1, we have been using Rootone F, which has a fungicide included. Actually, we have not made tests on this but figured that the addition of a fungicide was not detrimental at least.

| | |
|---|---|
| 5/25 - 6/5 | Euonymus alatus compactus |
| 6/1 | Cydonias (Hybrids and Aurea) |
| 6/15 - 6/30 | Spiraea japonica coccinea<br>Deutzia gracilis<br>Viburnum opulus nanum<br>Viburnum burkwoodi<br>Potentilla, Gold Drop<br>Hydrangea, Domotoi |
| 6/10 - 6/15 | Philadelphus coronarius aureus<br>Caryopteris, Blue Mist<br>Forsythias { Lynwood Gold, Spring Glory |
| 6/20 - 6/30 | Viburnum tomentosum, plicatum and grandiflorum |
| 6/20 - 7/5 | Weigelas { Vaniceki, Fairy, Candida |
| 6/30 - 7/15 | Hydrangea acuminata<br>Hypericum, Hidcote Variety |
| 6/25 - 7/15 | Euonymus fortunei acutus<br>fortunie coloratus<br>fortunei radicans<br>fortunei vegetus<br>fortunei patens<br>Berberis mentorensis<br>Thunbergi, atropurpurea and Nana |
| 7/1 - 7/20 | Philadelphus virginialis |
| 7/15 - 7/25 | Azalea Kaempferi Hybrids<br>Gable Hybrids |

*PLACING IN FRAMES.* Placing the cuttings in the frame is no major operation. The medium has been leveled off and tamped. We tamp ours rather lightly. We cut the sand with an old butcher knife and insert the cuttings about an inch apart, or so that the leaves are just touching. A depth of 1½ to 2 inches is sufficient. Some might argue this depth and I suspect that in peat or a mixture of sand and peat, you could run into trouble. By placing them in the sand at that depth, there is less chance of them drying out. We make it a practice to get at least one node below the soil surface of the media. Some cuttings such as *Vibrunum opulus nanum* which root at all nodes be set rather shallow, particularly if they are to be potted. Otherwise you cuttings such as *Vibrunum opulus nanum* which root at all nodes below the surface and those which root all along the stem should be set rather shallow, particularly if they are to be potted. Otherwise you end up with roots above the top of the pots

We use a firming board of 1 x 2 inches. The cuttings are firmed in by striking the board sharply along its length and a new incision is made in the sand after the board has been removed. The next row is stuck in the sand and firmed as before. After the cuttings are stuck in the sand, the area is flooded with water to settle the sand around the cuttings and to make certain that the sand is wet. Immediately after an area the size of a sash is filled, that area is covered with a sash.

*CARE DURING ROOTING.* For the first week to ten days, it is desirable to keep the frames completely closed to provide the temperature and moisture wanted. On the other hand, some ventilation may be necessary on very hot days. Our practice is to ventilate some if the temperature within the frame gets past 90° F. After this first period, it may be desirable to ventilate a little each day as fresh air will reduce the danger of mold and fungi

In order to keep the air saturated and therefore have good turgid cuttings, it will be necessary to syringe the tops of the cuttings and the glass and sides of the frame. This should be done lightly two or three times daily, for the first few days or a week. Later the cuttings will begin to draw up moisture from the medium through their stems and less spraying is necessary. Watch them closely on very hot days, however, as they must not wilt. Remember that the syringing should be light and often. This prevents overwatering the propagating medium, as too much moisture there would cause rotting of the stems.

*SHADING.* As mentioned previously when discussing construction, shading is very important. As much light as possible should reach the cuttings as long as it does not overheat the frame. A moisture laden atmosphere inside the frame with a temperature between 70° and 90° F. is desirable. But direct sunlight must be avoided. Again, let us refer to direction of the frame itself. If set east and west, it is only necessary to shade the top and south side. Your shade, of course, should extend far enough beyond the ends that the first sash at each end are shaded.

In the past shade cloth meant muslin stretched on supports three or four feet above the frame and along the sides. It should be arranged so that it can be put in place readily in the morning as soon as the sun's rays begin to strike the glass. It should be removed in the late afternoon. This also holds true for dark cloudy days as during such times the shading should be completely removed Today many growers are turning to Saran cloth We use both muslin and Saran cloth. You will find the latter listed as to the various percentages of shade provided. We use 81% shade, and during very bright days and particularly in areas where the sun is normally quite bright, two layers of this may be necessary. Paul Otto uses two layers of varying percentages during the time the cuttings are rooting His first layer is 67% shade Saran cloth which he leaves on day and night, as well as cloudy days. Then he uses a layer of 90% shade for covering during the time the sun is up. Since Saran cloth does not rot, mildew or tear easily, it has advantages over muslin

*TREATMENT AFTER ROOTING.* As rooting takes place, the cuttings are gradually hardened off. We pass from the early days of a well saturated, closed frame with daily syringing to one where there is some ventilation and, therefore, a less saturated atmosphere. This, of course, tends to harden up the cuttings somewhat. If the cuttings are to be left in the media through the rest of the summer, fall and winter, the glass is removed entirely when they are well rooted and shaded with lath The cuttings are watered daily during hot weather and we believe it pays to do some foliar or liquid fertilizer (KAPCO 15-30-15 Liquid Fertilizer) feeding about once a week during the summer.

If the cuttings are to be potted up, it should be done as soon as properly rooted. This will be done while they are comparatively soft. Therefore, it is wise to place the potted cuttings where moisture and temperature can be kept similar to those in the frame. After a few days, they can be handled as any other potted plant.

Early rooted cuttings such as Forsythia can be planted directly to the field. It is advisable to have irrigation, however, for losses can be high if the weather should turn hot and dry for any length of time after planting. We have done it without irrigation by using our trans-plantor which has a water tank, and the cuttings are watered in as planted. This, however, is not entirely satisfactory during hot, dry summers. This past summer we lost hardly a plant in planting out directly such items as *Forsythia, Euonymus alatus compactus,* and *Caryopteris.* I suspect what loss we did have were from a super abundance of rain.

Those cuttings which remain in the frame over winter get no further protection other than lath shade, which prevents alternate freezing and thawing, and thus heaving.

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PRESIDENT SCANLON: Thank you, Ken, for the interesting and informative discussion on cold frame propagation. There is now time for questions

MR. WILLIAM BURTON (Burton's Hill Top Nurseries, Castown, Ohio): Have you used cable or manure for bottom heat for early or late materials?

MR. FISHER. We have not used any bottom heat.

MR. BURTON: I know it has been used quite extensively in the past and I wondered if you found that it was necessary to go to the extra cost of cable or manure?

MR. FISHER: As I stated before, I think it depends upon your operation. It might be advantageous if the plants are to be potted or set out in the field. If they are to be left over-winter in the frame, I see no necessity for it.

MR. PAUL F. OTTO (Perry, Ohio). I used bottom heat quite extensively for one year, then discarded it because I found too much condensation at night due to the differences in temperature.

MR BURTON: We have had the same experience. Have you used Wiltpruf or related materials on cuttings before transplanting?

MR. FISHER: We have not, but perhaps someone here has had experience with such materials.

MR. PETER ZORG (Cartwright Nurseries, Collierville, Tenn.): We used Wiltpruf on most of our cuttings when planting them outside We found it was really an asset because there was less loss

MR FISHER: I might add one thing along this line, but it has nothing to do with cuttings One landscape man, who uses large *Berberis mentorensis,* sprays them in the field before digging them for transplanting. This past August he transplanted them without any difficulty. I can understand that, particularly in a hot, dry area, treating the cuttings certainly would be advantageous before putting them in the frame or planting them out in the field from the frame.

MR. CASE HOOGENDOORN (Hoogendoorn Nursery, Newport, R.I.): Did you ever try summer evergreen cuttings?

MR. FISHER: No, but I will ask Mr. Otto to tell about his experience.

MR. OTTO: We take cuttings of golden pyramid and dark green arbor vitae the latter part of June or early July. Usually, they root within three or four weeks I use Hormodin No. 1 on these cuttings.

MR HOOGENDOORN: Do you stick the cuttings in sand in these frames?

MR. OTTO: Sand is used and we water the cuttings once in three weeks The frames are aerated every night. If you don't aerate, you get a lot of moisture condensing and that is what causes the damage. If the dampness is there at night and you aerate, it doesn't hurt, but if the frames are kept closed, it causes rotting.

MR HOOGENDOORN: Do you also propagate *Taxus* and junipers in frames during the summer?

MR OTTO: I propagate Andor juniper in the summer. *Taxus* are made in September.

PRESIDENT SCANLON: I think we should proceed to the next paper. Thanks again, Ken, for your information.

The next speaker is well known to most of you He is Case Hoogendoorn from Newport, Rhode Island, and his subject is concerned with the successful establishment of cuttings and seedlings in the field

Mr. Hoogendoorn presented his talk, entitled "Sucessful Establishment of Rooted Cuttings and Seedlings in the Field." (Applause).

# SUCCESSFUL ESTABLISHMENT OF ROOTED CUTTINGS AND SEEDLINGS IN THE FIELD

CASE HOOGENDOORN
*Hoogendoorn Nurseries*
*Newport, Rhode Island*

This subject takes in a large territory as there are so many different varieties and types of cuttings and seedlings. There are also different ways of accomplishing this and I am going to tell you only about the groups I am acquainted with and the way I try to handle them in my own nursery

When I first saw this heading, I had a very easy answer In order to get the best results in planting and transplanting you just plant everything early and on time. It is as simple as that.

But I don't think you people are satisfied with such a simple answer as that. No doubt you have the same problems as I have, that is, you simply can't plant everything early and on time. Now we try to do the next best thing and that is to see how to get around this in order to get a satisfactory stand when we are planting later than we should.

To start with, we have one very good method and that is potting up all your cuttings and seedlings or putting them in bands To my mind that is an excellent method to insure good stands, especially where a good many people take this small stock and line it out in field rows over the field. But all nurserymen do not operate their nurseries in the way.

We are all nurserymen and most all of us have nurseries, or responsibilities to operate a nursery. We use almost as many methods as there are nurseries Yet we are all after the same results, which is to get good stands and try to make a profit on our operations.

Now to come back to potted and banded stock. As I said before this is an excellent way to insure good stands and would recommend this for retailers who do a small amount of propagating.

However, for wholesale growers who often propagate in large quantities, it seems to me it is quite expensive to pot up or band cuttings and seedlings.

Personally I prefer to bed out all my cuttings and seedlings for one or two years to build them up before lining-out, especially where we have irrigation and shade over the beds, which gives very good control over the rooted cuttings and seedlings and gets them established very successfully.

Speaking of irrigation I would like to say a few words about it. Some years ago when we were forced to use irrigation, which was new to us at that time, we learned that there was more to it than just throwing water on the beds The summer we started it was hot and dry and we laid out a small irrigation system. A number of cuttings and seedlings were dying in the beds even under shades. After we laid out the system, we turned on the water and let it run for 8 hours and then moved the sprinklers. While moving the sprinklers we would sink ankle deep or more in mud and thought we were all set.

But what a disappointment! Three or four days later you came back to these places and found the ground was hard and dry again, as if it had never been irrigated.

As far as I was concerned, it did not do much good and we had to find a better way of irrigating. The following spring every time we planted six or seven beds we would irrigate them. I decided that if we irrigated while the soil was still loose and open, the water would go down much deeper and last much longer. That is just how it worked out.

After these rooted cuttings and seedlings have been bedded for one or two years, they have a strong root system of fibrous roots, which will help to eliminate losses after lining them out over the field.

We also take hardwood shrub cuttings and root grafts and plant them very close together in narrow rows for one year so that when we line them out the following year, we will also have heavier stock by the time they are dug.

As you have noticed up to now, I have been talking about the preparation of the liners, which I think is very important. To me a good liner with a good root system is more than half the battle in order to get a good stand after planting. A strong liner will also produce a stronger and better plant.

To me it is always very poor economy to try to save a few pennies on a liner. A poor liner or a light liner will give poorer results in stands and a poorer block of stock. You are not only apt to have more losses after planting but will also end up with every so many more culls. Personally I always try to buy the best liners or seedlings as they are the cheapest in the end and will give you best results after planting.

Now we come to lining out these transplants over the field and I'd like to say just a few words about the land these liners are to be planted on

I think it is very important to have as much humus as possible in your soil either by using manure or cover crops, or better yet by using both, and have the ground well worked over and plowed quite deep.

I like to plow 12 inches or more When you plow deep, you will find that your soil will retain more moisture when you run into dry weather as deep, loose soil will sweat better. Humus will also help to retain moisture. A deep plowed soil and humus makes a happy combination and will help to insure better stands and better growth

Now if you are so fortunate that you can start lining out as soon as the weather opens up in the spring, you don't have much to worry about your stands as that is the proper time to start planting. We are not so fortunate as we have to get our orders out first and then start planting. Naturally, we try to get some items planted early between digging orders but the amount of that depends a good deal on the weather. If the spring breaks late, we are out of luck. If it breaks early and we get 2 or 3 rainy days a week so we cannot make any headway with our orders, we are out of luck. You see we are always battling with the weather.

I mentioned before, so long as we can't plant early we try to do the next best thing and see how we can get around this.

What we try to do is to dig and heel in as many liners as we can.

Take for instance shrubs from hardwood cuttings or root grafts. We dig them and trim the roots but not the tops By trimming the roots when you heel them in, you will not have to cut them back again when you come to plant them. By the time you come to plant them, they will have made a lot of new roots and all of new roots are saved when planting.

Now the reason we don't cut the tops back at the time we heel in these liners is that when these shrubs start to grow, the branches will start to leaf out all over, but the eyes at the base will remain dormant longer. When we plant these shrubs, we cut back the branches and do not have to contend with all the soft growth, which wilt badly and make the plant suffer considerably In this way you have a plant that does not suffer much when it is lined out and by leaving all the young roots intact they reestablish themselves within a few days. We apply the same method to shrub seedlings.

On the other hand if you have rooted softwood cuttings, which were rooted the previous summer in frames, you can line them out very successfully even if they are leaved out, due to the fact that they have much softer and finer roots and do not get such a shock when you dig them. They reestablish themselves very quickly

Of course there are a great many different varieties of shrubs and woody plants and they do not all respond to the same treatment therefore there will always be exceptions.

For instance, I would like to mention just one item, *Vibrunum* from softwood cuttings I prefer to line these out after they are leaved out as they seem to pick up quicker and grow better. I have seen *Vibrunum* softwood cuttings planted dormant, which gave a poor stand.

I would also like to mention *Cotoneaster*. Some varieties are rather troublesome to transplant. This can be easily overcome by transplanting them every year or root pruning them every year. They should be handled in the late fall or early spring as they make new rootts in cold weather. I also prefer a seedling to rooted cuttings as they have a better root system

*EVERGREENS* With the evergreens, when we heel them in, we cut the roots and the top back as they don't break out as lush as shrubs do and will hold back for quite a while but they will be making new roots while they are waiting to be planted. Here again the new roots will help to insure a good stand.

*BROADLEAFS* We do not worry too much about the transplanted broadleafs, such as azaleas, rhododendrons, andromedas, etc. as they have a very fine root system and respond very easily If they get too far ahead of us before we can get to planting them, we shear off all the young growth before digging them.

Of course there are also rather troublesome broadleaves, such as large leaf holly, for instance, *Ilex opaca,* when it comes to transplanting. They seem to dry up easily. In order to overcome that, we have gone through the trouble sometimes to cut off all the leaves. We would wait until the eyes in the axil of the leaf would swell and turn red, which signifies that the sap is running. By doing it that way we have transplanted holly very successfully.

You may wonder why I have not stressed irrigation more than I did. The reason for that is that very few of us have irrigation all over the nursery as it takes a tremendous amount of water which most of us are lacking. For those that are fortunate enough to have irrigation all over the nursery, it means added insurance to obtain good planting stands.

Today we also have temperature controlled storage cellars or sheds, which are very valuable to the nursery business. This is an ideal place to keep your liners perfectly dormant until you get around to planting them. This way the plant does not spend any of its energy before planting and is a great help to late planting. There is only one drawback to this and that is it is so expensive to build that most of us do not have them.

I have omitted fruit stock and shade trees as I have not had any experience with them as I only grow ornamental stock.

What I have tried to bring out is that your soil structure, irrigation and the preparation of your liners all play a vital part in the successful establishment of your planting.

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PRESIDENT SCANLON: Thank you, Case, I am sure that there will be a number of questions or comments on this subject.

MR. HICKS (The Cottage Gardens, Lansing, Michigan): Do you think it is better to trim the roots of junipers and try to get new growth in the spring or would you plant them earlier in the spring if you could or would you prefer to have new roots?

MR HOOGENDOORN: Sure, you can trim them and plant them.

MR. HICKS: You prefer to trim the tops of the evergreens first before you plant?

MR. HOOGENDOORN: That is right.

MR. HICKS: I had heard some preferred to plant the junipers and then trim the tops after a couple of months, getting better growth that way

MR. HOOGENDOORN: That is just it; everybody has his own opinion.

MR. C. S. INGELS (The Home Nursery, Lafayette, Ind.): I did not hear you say you used any Wiltpruf in transplanting your evergreens.

MR. HOOGENDOORN: No, we have never used it.

MR. INGELS: I would like to ask if anyone has used it on cuttings and do they find it shocks them just a little? Does it take the cutting a few days longer to take off after you use Wiltpruf than if you didn't use it?

MR. HUGH STEAVENSON (Forest Keeling Nursery, Elsberry, Mo): I have had very little experience with Wiltpruf, but I sort of proceeded with the idea Wiltpruf and other anti-desiccants were a lot of hog wash There are reports of a group of experiments in this country, Canada, and Australia where an attempt was made to extend the planting season of conifer field planting stock, by using antidesiccants such as Wiltpruf. In no case in those three countries was there any benefit from the use of antidesiccants in late planting.

I wonder if there is anybody here who has good control tests using Wiltpruf or not using it, or any other antidesiccants where the control was such that they knew really whether they were getting any results

MR. ZORG. As I told the previous speaker, we use Wiltpruf on our cuttings before we put them out in the field. In our nursery we have 100,000 cuttings, handled in the shade house for a whole year. Before we take them out we Wiltpruf them. We spray it on with a hand pump, with a little hand sprayer, and the recommendation is that you use one gallon of that substance in eight gallons of water. We use it just double, so we use one gallon for four gallons of water, and we found that it really helps the cuttings to establish themselves quicker, because it gives a thin film on top of the leaves. We use this on evergreens and it keeps them for a while until the cutting really makes a few new roots. We really found it was an asset. We have planted plenty of cuttings without Wiltpruf.

MR. STEAVENSON: Do you also use it on your fall planting lining out?

MR. ZORG: With the fall planting, you wouldn't have much difference, because with the fall planting you wouldn't lose much because you don't get the hot weather, but with the spring planting and, especially when you plant in June, in Tennessee, when it is really hot weather, you lose plants where you don't use it.

MR. FISHER· When they go out in the field after they have been treated with Wiltpruf, are they planted with a transplanter and watered in or do you have irrigation that you use afterward?

MR. ZORG: We plant them out with a planter, the mechanical planter, and after they are planted we do not irrigate them at all We just leave them in the fieldd Of course, when we get rain, so much the better. When we don't get rain we just don't bother reaching that special field with an irrigation system. Our nursery is quite extensive and you can't always reach everything with water. Of course, we have a lot of irrigation system, which we use for transplanting, when it is necessary, but we have parts we can't reach

MR. JOHN B. HILL (Hill Nursery, Dundee, Illinois): I think I can give a small report on the use of Wiltpruf. In the summer of 1955, owing to a delay in getting going in the spring, we found it necessary to plant established cuttings out of the plant beds in the field. We took the time and trouble there to set up a control experiment whereby we applied Wiltpruf at the recommended 1 to 4 rate If we waited 48 hours after applying Wiltpruf before we lifted the plant, without disturbing it, and planted it out, there was an appreciably better stand on the plants that had been treated against those that hadn't been.

What experience have you had going directly from the rooting bench to field rows?

MR. HOOGENDOORN: We don't do that at all.

MR. LEROY HETZ (Fairview Exergreen Nurseries, Fairview, Pa.): We line out about 800,000 cuttings out of the greenhouse right out in the sun with the mechanical planter. It is Hawlins cylinder planter. We don't shade them but we cultivate them immediately and if the weather becomes too dry, we use portable irrigation. The cuttings are lined out in rows which we cultivate with an Allis Chalmers G tractor, three rows at a time Then we leave them either two or three years and they become quite large in three years and we have a U digger on this Allis-Chalmers. There are three of the U-diggers really, and we dig three rows at a time.

I would like also to state we planted about 40,000 upright *Taxus* this fall and we used Wiltpruf on them. We had a very dry fall and they didn't die. They are good. They didn't grow any tops but they did grow good root systems.

MR HOOGENDOORN: In other words you take your cuttings from the greenhouse bench and line out into field rows. Ours would all die.

MR. HETZ. Not with Wiltpruf.

MR. THOMAS S. PINNEY (Evergreen Nursery Co., Sturgeon Bay, Wisconsin): We do the same thing as the former speaker mentioned. We will plant directly from the greenhouse bench. We can't even get out until the first of July to do the transplanting. We shade them and irrigate them heavily. We have very small losses and we figure the actual cost of banding is not worth it in our operation. We do prune them at the time we plant them out On succulent things we will use Wiltpruf. This is hand planting. We will plant directly out with a machine, *Euonymus*, Alpine currant, and other things of that nature and we will use Wiltpruf on them.

MR. HOOGENDOORN: Can you plant *Taxus* cuttings from the sand bed right out to the field without any shading?

MR. PINNEY: No, we haven't tried them as yet. They are shaded. Most of the evergreens go out in beds planted by hand and shaded or planted by machine and shaded at least for two weeks afterward.

MR. J. S. WELLS (James S. Wells Nursery, Inc, Red Bank, N.J.): Soon after I came to this country I happened to take my father to Mr. Hetzs' nursery and was amazed at what he was doing. I can vouch for his system. It works with him, and it works for a number of other people Vincent Bailey up in Minnesota does it, but he happens to be living a few miles from a large stockyard and can get unlimited supplies of manure and treats his land in an astonishing manner He ends up with a soil condition which is just perfect. With that soil condition I think you can go direct from the bench We tried it at Koster's Nursery and it worked fairly well for a few years, I thought, until we began to keep accurate records and, consequently, found out how many of the plants were not growing. I am convinced that if an accurate tally is maintained of the number of plants planted, and of those that finally get through, you will find that the extra work is not necessarily a liability.

MR. WILLIAM FLEMER, III (Princeton Nurseries, Princeton, N.J.: Do you think there is any value in puddling — that is dipping the roots in a mud solution as they used to do in the old-time nursery, or do you think it mats the roots together and doesn't improve the stand?

MR. HOOGENDOORN: Years ago we used to dip in thin mud, but then we found when you get dry weather and the soil is dry, you pull the plant up, the mud will cake to the roots, and naturally, it is going to be that much harder for the young roots to break through. We have eliminated puddling and we just dip in clear water and plant.

MR. LESLIE HANCOCK (Woodland Nursery, Cooksville, Ontario): Will you give us your opinion about hilling up immediately after planting in the fall?

MR. HOOGENDOORN. You can do that very well with young shrubs. You can hill them and take the hill away again in the spring. But when planting evergreens, you would be spoiling all the bases of the evergreens. I don't think it would work out well. Furthermore, if you have real wet land, I don't think you should hill.

MR. ZOPHAR P WARNER (Warner Nursery, Willoughby, O.): To get back to this Wiltpruf problem, I would like to suggest that maybe we are trying to put all the plants into one category, and I don't think we can. On the things like *Taxus* or spruce or those things that do not make any top growth after they go out, then it might be very beneficial. With some of the broad leaf evergreens, such as *Pieris, Rhododendron*, and magnolias, where the top growth precedes the root growth, it is absolutely detrimental. You sometimes will get defoliation of the older leaves that you badly need to support the new root growth.

The question I would like to ask is: What has anyone done with starter solutions, like liquid fertilizers or whatever you want to call them, to cut down this lapse until the new roots start?

MR. LOUIS VANDERBROOK (Vanderbrook Nurseries, Manchester, Conn): I might pass out the thing we have done in the past few years. For everything that we plant out, we take out a 55-gallon barrel of water to the field, and we take a pailful of soil and throw it into that 55 gallon of water and we add seven pounds of Ra-Pid-Gro to it, stir thoroughly and dip every plant we plant in there as it goes out to the planting crew. We find that there is a lot quicker starting and a lot better results.

To get back to the Wiltpruf problem, we have conducted what these fellows call control tests with the originator of Wiltpruf, Dr. Baumgardner. We definitely had detrimental effects and complete scorching of leaves on *Magnolia soulangeana, M stellata,* and *M. stellata rosea*. I had put on the Wiltpruf and potted the magnolias in the greenhouse before we planted them out in the field. They would be planted out anywhere from 12 to 48 hours. Those Magnolia leaves had considerable scorch on them and they dropped. I did have Dr. Baumgardner come out and he said, "We will have to change our formula." We were using a dosage of one to ten and not one to four, and we got scorch. We have come to the conclusion, that on tender succulent growth, Wiltpruf can be detriemntal on our hardwood cuttings in the greenhouse. On our propagation, before they went out in the field we sprayed those right on the bench with Wiltpruf, perhaps 36 to 48 hours before they were planted out Plants like *Philadelphus virginalis* and *Hydrangea* suffered terrific scorch. I did the same things on pyramid arborvitae and Pfitzer's juniper and those evergreens were planted out in the field. This was a control test They were scorched terrifically with Wiltpruf and they have been there two years and still show the effects of the Wiltpruf.

What I am trying to convey is that Wiltpruf has its proper use under proper conditions. It is a good thing to use in transplanting retail material, to prevent desiccation, but on the tender stock right from the bench to the field, we cannot make it work

MR. HOOGENDOORN: You meant to bring out, Louis, you scorched all these by using it 1 to 10?

MR. VANDERBROOK: That is right. My conclusion is if the foliage is too tender and Wiltpruf is put on, it has the effect of almost a burning. It scorches right through the leaf sometimes. Some fellows may bring up the point if you use it as a misted spray and break up the spray into very fine molecules you might not get the scorch. We have used different types of nozzles. We have put it on as a coarse spray and we have put it on as a fog Some minutes particles, almost pinpoints, maybe an eigth to quarter inch fall, and we get the same results, whether pinpoint or coarser, of scorching throughout the tender foliage. It might work in other localities but not where we are in New England. I might make one other comment. Before we used Wiltpruf we were using Dow Wax. When we were using Dow Wax we never get any scorch.

MR. HOOGENDOORN: You would think the wax would scorch more because it draws more heat

MR. A M. SHAMMARELLO (A. M Shammarello & Son Nursery, Cleveland, Ohio): I have had a very unpleasant experience with Wiltpruf. It may bring out a lot of arguments. I can only tell you what happened to me. In any case, we plant in July We can't get to our planting until then. We transplanted several thousand rhododendron and azaleas, mountain laurels, spiraeas and *Ilex opaca*. When I read about Wiltpruf I thought that was the answer to all my problems. So we went ahead and sprayed perhaps a couple of days ahead of time we were to move our plants. Now the plant material we were to move was two or three years old. It was not soft as Mr. Vanderbrook's plant material. We had over a 50% stand. So we don't Wiltpruf anything any more.

MR TADPOLE (Beaver Hall Farm): My experience is just a little bit different In our greenhouse operation we don't sell any rooted cuttings. They are all transplanted into a prepared soil flat and we deliver none of these transplants until the latter part of July.

In other words, they have all had new growth but it is hardened off. The flats are under the trees outside for about a month or six weeks. This includes *Taxus,* arbor vitae, juniper, rhododendron, azaleas, American holly, English holly, and a few other things. They are all treated with Wiltpruf before they are taken out of the flats and shipped in packages. I have yet to find a customer who kicked, so it must be all right.

MR. SHAMMARELLO. It seems to me that when we had a shower or even a dew in the morning, that dew would just roll of the foliage of the treated rhododendron and azaleas. I believe, that caused those plants to dry.

MR. WARNER· I would like to hear one of the professors here carry this thing a little further in regard to what physically happens to the plant when you put Wiltpruf on it. Doesn't that slow down the transpiration? If you put it out in the sun under a forced draft and slow it down, would you have a little different effect than if you used it in the shade?

MR. AART VUYK (Musser Forest, Inc., Indiana, Pa.): We used the material for spring planting only once, and I think it definitely set the plants back. It burned about 75 percent of the leaves.

MR HOOGENDOORN: It would seem that it doesn't work very well on soft foliage.

PRESIDENT SCANLON. Perhaps it would be wise to discontinue this discussion at this point. If there are further questions, they can be included in the Question Box Session tonight Thanks again, Case for the discussion.

MR. WELLS· We have a guest here whom I think can describe a type of propagation frame, the Nearing Frame, better than anyone else. I ask permission for David Leach, of Brookville, Penna. to describe the Nearing Frame.

PRESIDENT SCANLON: I am sure we will want to hear from Mr. Leach.

MR. DAVID LEACH: My experience with the Nearing Propagation Frame began about eight years ago when a nurseryman from New Jersey told me of the inconsistant results he was having with it. He asked me if I would undertake a series of experiments with hormones to try to find some method which would be effective for this particular type of propagation and I did. More chance than anything, I got started on an 18-hour soak in aqueous solutions. It finally developed that 75 parts per million of indolebutyric acid aqueous soak for 18 hours gave results at least as good and probably a little better than any I had heard about in any other method.

Over a period of about eight years the poorest results we ever had were 92 per cent on about 800 cuttings, anywhere from 50 to 70 varieties, a large part of which were the hard-to-propagate red sorts.

Now the Nearing propagating frame is essentially a cold frame, which sets on top of ground. It has a bottom in it and has a sloping back The length of the back is calculated according to the angle of the declination of the sun, so that when the sun is in the northern limits of its travel, on June 21, it doesn't enter the frame. It must be oriented due north.

Now, after experimenting with this device for about eight years, there are aspects of it I don't understand and I think there is a little bit of witchcraft going along with it, but it has worked out very successfully.

I have found you have to have a minimum of 350 foot candles of light for the frame to operate successfully.

Another thing about the propagation which come from it, there is a very low post-rooting mortality, anywhere from six-tenths of one per cent to one per cent, whereas rhododendron propagated in a greenhouse with heat, at the end of one year the average mortality is about 15 per cent.

The method is slow but it is cheap. The cuttings are stuck in the middle of September and taken out the following August. However, they usually put out one growth in the frame. There is no expense of greenhouse space involved. The cuttings are watered once a week until they freeze in the fall, and there is no attention of any sort required until the following spring when they are watered once again.

These cuttings aren't ventilated, which is contrary to one of the speakers we heard this morning, who said he found the condensation overnight in a cold frame to be injurious. That is not the case at all with rhododendrons. There is no ventilation until the cuttings are taken out of the frame in August At that time they have such root masses that you can't get them into four-inch pots.

With such hard-to-root varieties as Dresselhaus, Charles Dickens and Mrs. C. S. Sargent, I find the Nearing Propagation Frame is a successful device. It is a successful device in a commercial sense. I only have one of them and it has a capacity of 600 cuttings but I feel it is a representative pilot system that can be expanded indefintely. Warren Balwick in New Jersey propagates many, many thousands of rhododendron each year with this method.

That is a brief description of the frame and how it works. If there are any questions you would like to ask me about it, I will try to answer them.

MR. RALPH M. FISHER (D. Hill Nursery Co, Dundee, Ill.): What is the foot candle reading when they are taken out? Do you shade them or what is the light intensity after the shift?

MR. LEACH: They are taken out in August and put in ground beds in a pine woodland.

MR. FISHER: In deep shade?

MR. LEACH: I wouldn't say so. The slats are spaced one and a half times their width. I suppose the total shade would be 50 per cent.

MR. FISHER: It would be close to the foot candles in the frame?

MR. LEACH: I couldn't say, because I have never measured the foot candles in the outside beds. I had no further interest in it.

MR. FISHER: That is a point I would like to know. You hear everybody get up here and tell about "we shade" and "we don't shade."

How much do we shade, and why? Is there any experimental evidence of stress put to a plant in rapidly changing lighting intensities? For instance, say in the greenhouse bench when you denuded the cutting, when you move them from 350 foot candles maybe to 1,000 to 2,000 or a bright sunshine, is there any experimental evidence or references someone can refer me to, to get some basic thinking on this thing? I have some, but I can't substantiate it. I would like to find some references.

MR LEACH: As far as the propagation in the frame is concerned it is 350 foot candles. As far as I would be concerned from the standpoint of propagation, I wouldn't be concerned with the foot candles afterward as long as the cuttings were shaded and didn't burn. I don't think I understand the point of the foot candles after they are transplanted out of the frames.

MR. FISHER: The point I would like to know is how much stress in the change of light intensity can a young plant stand?

MR. LEACH: The limit of tolerance — I don't know.

MR. HOOGENDOORN. Does the frame come as a unit or is it something you can build yourself?

MR. LEACH: I am not here to sell anything. I wrote a book on rhododendrons I have blueprints for the frame in the book If anyone wants to build these frames I have extra copies of the blueprints.

PRESIDENT SCANLON: Thank you, Mr Leach, for your description of the Nearing propagation frame and of your results with rhododendron propagation.

The meeting is adjourned until the afternoon sessions.

# FRIDAY AFTERNOON SESSION

## November 30, 1956

The fourth session of the Sixth Annual Meeting convened at 1:50 p.m. President Scanlon presiding.

PRESIDENT SCANLON: The program this afternoon is a panel discussion on the "Propagation of Hybrid Lilacs by Cuttings and Other Methods." There are five speakers on the panel. Questions will be deferred until all of the speakers have finished, then your questions can be directed to any of the panel members.

Th first speaker is John Sjulin, of the Inter-State Nurseries, Hamburg, Iowa.

Mr. Sjulin presented his talk entitled "Propagation of Hybrid Lilacs by Cuttings." (Applause).

## PROPAGATION OF HYBRID LILACS FROM CUTTINGS

JOHN J. SJULIN
*Inter-State Nurseries*
*Hamburg, Iowa*

It is our opinion that Lilacs grown on their own roots are superior to lilacs which are budded or grafted on some other rootstock. We believe they grow into better plants and also the troubles which are experienced from incompatability and hardiness of rootstocks are eliminated.

However, our early attempts to root lilacs from cuttings were unsuccessful, then about ten years ago we learned from Mr Albert Swanson, now deceased, but at that time head propagator for the Mount Arbor Nurseries, that the time of taking lilac cuttings was the main reason for his success in rooting. This suggestion from Mr. Swanson, plus much work and observation by our propagator, Mr. Charles Woodworth, has brought us more success in rooting lilacs I would like to say at this point, that we are not always entirely successful in rooting lilac cuttings. Some varieties, such as Firmament and Pres. Falliers, absolutely refuse to root for us.

Our procedure for rooting lilacs is this: we construct cold frames in the usual manner, except they are twelve inches deeper in the ground than our ordinary frames. The frames run in an East-West direction and they are built of wood. We consider it very important that the frames be constructed of wood because it allows the sash to fit tighter on the frame. Mr. Woodworth considers this seal betwen sash and frame to be fully as important as proper timing in taking the cuttings. In fact, we put several layers of creped saturated kraft paper over the top edge of the frame for the sash to set down on in order to make even a better seal. The total depth of our frames on the inside is seventeen inches on the South edge with the frames being two inches higher on the North edge. The frames are above the level of the ground only five inches on the South and seven inches on the North. Therefore, even with five inches of sand in the frame, our five to six inch cuttings are below the level of the ground. We believe this results in an air condition which is necessary for rooting lilacs.

Our rooting medium is three parts sand and two parts vermiculite We use a total of five inches of rooting medium We do not tamp the medium.

Following the advice of Mr. Swanson, we take our cuttings just as soon as the terminal buds are formed. In our case, this is usually from the middle to end of May. We have tried taking cuttings earlier and they always failed. We have taken cuttings two or three weeks after the terminal buds were formed and the stand was reduced.

We make cuttings only from the terminal growth. The cuttings are five to six inches long and are cut to a node. The bottom leaves are removed and the remaining leaves are folded in half and trimmed to a point, leaving about half of the original surface.

The cuttings are dipped in Hormodin Powder No. 3 and are stuck two inches deep in the medium. The cuttings are thoroughly watered in and the sash is put on making sure the seal between frame and sash is tight Lath shades are put on with a brick placed between shade and sash. Burlap is rolled on the frames from eight to five o'clock. We water the cuttings every morning

The sash is kept tight until the cuttings are rooted, this time will depend on varieties and ranges from one to two and a half months. As soon as the cuttings are rooted, the sash is raised one half inch for four days, then it is raised two inches for two days and then the sash is removed. The lath shades are left on and the burlap is rolled on for another five days.

We carry the rooted lilac cuttings in the cold frames until the following Spring. The cuttings are fed once during August and once during September with a soluble fertilizer. During the winter the frames are covered with straw. Paper is rolled out on top of the shades and the straw is put on the paper about 8 inches deep. We do not want straw to fall down among the cuttings. As early as possible in the spring the rooted cuttings are potted and after four weeks in the pot they are ready to be lined out in the field We have tried planting them bare-rooted early in the Spring but we have found that late Spring freezes will kill many of the cuttings.

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PRESIDENT SCANLON: Thank you, John, for this interesting discussion of rooting lilacs. The second speaker, this afternoon, is Donald Wedge, Wedge Nurseries, Albert Lea, Minnesota.

Mr. Wedge presented his paper entitled "How We Propagate French Lilacs at the Wedge Nursery." (Applause).

# HOW WE PROPAGATE FRENCH LILACS AT THE WEDGE NURSERY

DONALD WEDGE
*Wedge Nurseries*
*Albert Lea, Minnesota*

I have read many interesting articles on propagation which were written by many of you present today and published in the *American Nurserymen.* They have stimulated our thinking — many of the ideas presented we have experimented with and some we have put into regular practice. One such fine article on lilac propagation by Mr Wells, spoke of 98 percent stands, which has certainly set a high goal to shoot at and has caused us to do some serious thinking and to run some additional tests. Stands of 91 percent have been the best we have been able to do in the past ten years and that only in two varieties in two different years. Our average of all varieties for a given year, including some rather poor propagating varieties, is considerably below that.

We, at the Wedge Nursery, located at Albert Lea, Minnesota which is 15 miles north of the Iowa border, have grown "own root" French lilac since 1902 In 1935 we jumped up our propagation, growing mainly for other nurseries under contract. My father, Robert C. Wedge, is mainly responsible for what success we have in propagating and assisting him is my sister and partner, Dorothy Wedge; our Nursery Superintendent Ervin Young, and myself

We are now growing about 32 varieties of lilac, all but a few are listed in the 1953 list of "The 100 Best Lilacs for America." Many other varieties we have discontinued because of inferior quality or because it was a poor propagator.

During the past ten years and especially the last few we have made numerous tests using 500 to 1000 grafts under each test and comparing these stands with the stands under our usual procedure. The results have given very definite indications on some and have been confusing on others because they differ from year to year We also have to remember that the varieties differ. That which is good for one variety may not be good for another. The white lilac varieties usually tend to start sooner than the dark varieties Also they tend to continue growth in the field later in the summer. Some make a wonderful root system and have short canes, while other varieties have beautiful tops and poor root systems.

In brief our method is to bench graft the lilac scion on green ash piece roots We use a whip graft and secure the graft with grafting thread. Grafts are packed in pine shavings in wooden apple boxes, stored in our regular nursery storage until Spring, and planted directly to rows in the field.

We have two sources for scion wood — a scion block where we cut back to short stubs every year and one year old plants in the field which we cut back anyway to eliminate single caned plants. The scion wood is cut after we finish putting stock in storage, usually after November 10. Quite often the ground is frozen and snow is on the ground. Our tests have shown that with later cutting, even in March, the results have

have been good and that scions cut in the field are almost as good as those from the scion block. Whips taken from the scion block are cut to make 2 to 4 scions per whip, while those taken from the one year block seldom make more than one scion The buds on these scions are quite close and are harder to whittle with the knife.

The root stocks we use are green ash. We prefer one year old seedlings 1/4 to 3/8 inch caliper. They are usually straight, clean and without small fibrous roots Our tests have shown two and three year old ash, both seedlings and transplants, work practically as well, but they do slow down our grafting time considerably, with more frequent knife sharpening required. The fibrous roots are especially in the way when winding the graft. The ash serves to feed the scion until it is able through it's own roots to take care of itself The root stock usually sloughs off With only one variety, Mont. Blanc, does the ash root seem to persist to some extent Both the ash root and ash suckers are easily detected from the lilac and can be removed. In our experimental tests we have grafted to both Villosa lilac roots and European Privet (Liqustrum vulgare), but the percentage of stands were well below those with ash One important point in favor of green ash is that is cheaper to produce than either privet or Villosa lilac roots. Those of you living in other parts of the country where white ash is commonly grown may wonder whether they would make suitable root stocks. Personally, I do not know. My father is under the impression, from some experience he had before my time, that white ash is not as compatible as green ash.

The scion wood is cut to 6 inch lengths into a holder making sure there is a set of buds within 1/2 inch of the top. Terminal buds are cut off to eliminate flower buds. Wood which is 1/2 inch or over, as well as light immature wood, are discarded One hundred scions are wrapped in a damp cloth until the men who do the actual grafting are ready for them later in the day.

The garfter slices the buttends of the scion and makes the back cut on 1/2 or all the scions in the package He takes a hand full of roots and lays them on his lap and proceeds to slice the root stock at the crown end, make the back cut, fit in a scion of approximate same caliper and making sure one side matches perfectly. One test made showed 20 percent better stand where both sides matched over only one side. The root is then cut off with a knife at a length of 3 1/2 inches or graft placed in a tray. We make as many cuts as we can, with sufficient caliper, out of each root. Our tests have shown the crown graft results in only a slightly better stand than the piece root and it is more apt to send up a sucker. The placing of the buds in respect to the cut seems to favor the lower bud opposite the splice which usually means slicing through one bud We tried inverting the ash root, but the stand was only 13 percent.

The wrapper sets the tray before him and holding the scion in his hand with the union of the scion and root held firmly between his finger and thumb, makes two tight winds with the grafting thread at one end and two tight winds at the other end. We formerly prepared the grafting thread ourselves but now buy it from Chase Nursery, Chase, Alabama Our tests have shown three winds — another wind in the middle — have made for better percentage in stands, which proves the importance of the graft being firmly bound We have used grafting tape but felt you could not bind the graft tight enough. We also believe it prohibited roots from forming right where they are most apt to form first, thus prolonging the length of time before they do go on their own root. Our experiments has proven grafting thread percentage better than tape.

The grafts are then dipped tops down in a shallow pan of shellac to seal the pores of the fresh cut. Our test last summer of leaving 500 to two different varieties without shellac was not conclusive. One showed a decided advantage for shellacking while the other did not come up to regular check percentage.

We made another test on two varieties by dipping the whole scion, including the graft, in Wiltpruf. This proved almost a flop. Another experiment was to cover the splice with grafting wax. Three tests were made on this. One showed definite advantage, the other two no advantage and the labor required is considerable.

We place the grafts in wooden apple boxes in layers using moist pine shavings for packing material. Each box has a printed label, indicating the variety, tacked on each end We like the apple boxes as a uniform and easy method of handling, especially in the field for planting. A few of the larger grocery stores save them for us. We have used shingle tow, moss and a mixture of the two. We have found all satisfactory but we prefer clean pine shavings. These shavings should be wet down and mixed at least 24 hours ahead of use in order that the moisture evens up Excessive moisture will cause buds to start. Peat we consider questionable from tests made last summer but we should make a retest as the peat used may have held too much moisture. We have also tied the grafts in bundles, put in polyethylene sacks without packing material and kept in storage with very excellent results. But those in polyethylene sacks left in a warm room to callous spoiled by mildew.

Our usual procedure is to place the boxes of grafts in storage which we try to keep near freezing. The alternative is to leave the box in our grafting room or some other warm room for about 12 days to callous the splice, then move into storage. Three out of four tests showed definite increase in the percentage of stand. After another years test on best temperature and correct length of the period, this probably will be standard procedure with us.

Next we plant by hand behind a two row trencher on loam to sandy loam soil. One field in our rotation has a streak of heavier soil running through the middle. The lilac growing in this area has a much poorer root cystem and more ash root can be seen at digging time. The more sandy the soil the better the style of root system we seem to get. The field has been in a two-year program of soil building by sod cropping. The sod is plowed under in the fall and gone over with a Howard Rotovator just previous to planting. The rows are then packed with a heavy packer and if there is not sufficient moisture in the soil they are given a stream of water with a larger trailor tank, pulled by tractor, watering two rows at a time. The rows are then cultivated. Then we sit back and pray for warm moist weather. We are not fortunate as yet to have an irrigation system for our big fields.

We plant our grafts so that only an inch of the top of the scion appears above ground. Our tests have shown this depth much better than buds just at the surface or buds two inches above surface

It has been our policy to start planting lilac grafts as early in the spring as the ground would allow soil preparation and to plant the white varieties first as they are the first to start bud growth. Many times we find this early planting has been halted by a spell of cold, wet and even snowy, freezing weather. The results would be poorer on this early planting and much better on the later plantings. If we wait until later there would be too much bud growth before planting which would result in a poor stand. This is where controlled cold storage may be a big benefit in holding back the buds until soil temperatures are warmer. In the three experiments we made last year two out of three varieties made better stands when held in cold storage than those handled in our regular way This will be standard procedure with us this year.

To sum it up, judging from our experience and experiments, the important things are.

1. Keep the scion wood and root stocks neither too wet nor too dry, but absolutely dormant.
2. Make a nice clean graft with scion and root matched as nearly as possible and firmly wrapped.
3. Callous in a warm room for about 12 days at 70 to 80 degrees fahrenheit.
4. Keep in a controlled cold storage 32 to 35 degrees F. to keep grafts dormant until planting time.
5. Do not plant until the ground is warm and in good condition and plant with top graft one inch above ground.

I have one bone of contention — which I would like to voice at this time It has nothing to do with propagating methods though. I do not think the retail catalogues should list lilac varieties as double and single, maybe that goes for wholesale lists too. The average person will invariably pick a double if given a choice yet he would not be able to detect the difference unless he was within three feet of the bloom. If he could actually choose between two lilacs in bloom, being double or single would have very little bearing on his decision. The terms double and single should only be used as means of identification.

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PRESIDENT SCANLON: Thank you, Don Wedge. I am certain there will be questions for you to answer when we reach the discussion portion of this panel.

The next speaker is well known to our membership. Jack Siebenthaler, The Siebenthaler Co., Dayton, Ohio will discuss the rooting of cuttings of hybrid lilacs

Mr. Jack Siebenthaler read his paper, entitled 'Propagation of Hybrid Lilacs from Cuttings." (Applause).

# PROPAGATION OF HYBRID LILACS FROM CUTTINGS

JACK SIEBENTHALER
*The Siebenthaler Company*
*Dayton, Ohio*

While many forms of plant propagation, other than Hybrid Lilacs, produce more satisfaction in terms of financial renumeration or quantity production, I believe there are few which contribute any more toward satisfying the inherent love of growing plants, which we all must share.

The taking of cutting wood from a fine specimen plant of hybrid lilac, which is in full bloom and covered with morning dew, leaves little to be desired in this great feeling of being an integral part in the creation of beauty and form. So much for the aesthetics of lilacs.

Perhaps the one thing to stress more than any other is the inconsistency of results in producing hybrid lilacs from softwood cuttings. It is neither my purpose, nor intent to pretend, that we get anyhing other than mediocre results in our attempts.

Generally, our percentage of survival from propagation frames to the field is from 20% to 50%. Seldom do we experience a greater success than indicated above While it is true that with an adequate supply of stock wood, 50% would be very nice, if not the best, the fact remains that in most varieties we are quite limited in our supply.

An explanation of our propagation must begin with a brief accounting of our physical set-up. We propagate in concrete slab frames which are sunk in the ground and protected by glass sash and canvas duck curtains We have also had two-years experience with a mist bed and I am happy to say that most of the experience has been quite encouraging. Up to the present time, however, we have attempted no hybrid lilacs in the mist frame.

The cutting medium is a sand and Michigan peat mixture of 3 parts sand and one part peat which is approximately 4″ deep after dry compaction before sticking.

The long frames run East and West and the top of the medium is approximately 12″ below the sash level.

The cutting wood is taken when the blooms first begin to open and this is usually about May 5th to 10th in our area. Several cuttings can be obtained from each terminal branch and our practice has been to bring the entire branch end into the cutting room before removing the individual cuttings.

The cuttings is removed with a sharp knife through the basal ring and a portion of the large soft leaves is removed (about ½ of the individual leaf). In addition, the very tender tip end of the cutting is removed to prevent excessive wilting.

The cuttings are treated with Hormodin Powder No. 2 and stuck in the sand and peat medium.

After a thorough watering, the sash is laid over the frame and made as nearly air-tight as possible to prevent moisture loss. Our method of producing this semi-airtight condition is to use folded newspapers. We don't use anything fancy for sure, but we do fold the newspapers long ways, getting about eight thicknesses and we lay these between the frame side itself and the sash and also between the sash, across the frame so we do get a reasonable moisture proof barrier there and fairly airtight situation.

The lilac cuttings are then left until the rooting action has begun Periodic checks, in which random cuttings are examined, indicate the time when the sash should be lifted up slightly in order to begin aeration of the beds. This should occur when the roots are approximately ½" long.

When the roots begin to attain a brown color and toughen up, the sash are removed and replaced with lath shades. Periodic hand watering is essential at this time.

The rooted cuttings are banded in 3" x 3" vita-bands in early September if everything has gone well Sometimes it has been found desirable to leave them in the propagating frame over winter for early spring banding.

The lilacs which are banded in late summer are plunged in a deep pit (36") and covered over with sash during cold weather. This usually readies them for regular lining out the following spring.

I would like to emphasize the fact that percentages can be weighted or affected by many factors. We attain a survival percentage of 20-50% as I have said. This would, no doubt, be higher if we were to leave many of the heavily-calloused cuttings longer in the frame.

Another factor is the scarcity of stock wood. I feel definitely that in varieties where there is an abundance of wood, the resulting higher percentage of success is in part due to the ability of the propagator to be more choosey in his material

There is no doubt that a better rooting percentage can and will be attained through more careful attention to detail, better sources of wood and better hygenic practices.

The prime motivation for our method of hybrid lilac propagation is the desire to produce a better plant for the consumer which will be as trouble-free as possible. This we are doing with soft wood cutting propagation

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PRESIDENT SCANLON· Thanks very much, Jack. Our next speaker is Dr. Henry Kirkpatrick of the Boyce Thompson Institute for Plant Research, Yonkers, N.Y. Dr. Kirkpatrick will also discuss the propagation of lilacs from cuttings.

Dr. Kirkpatrick presented his paper, entitled "Propagation of Hybrid Lilac from Cuttings." (Applause).

# PROPAGATION OF HYBRID LILACS FROM CUTTINGS

HENRY KIRKPATRICK
*Boyce Thompson Institute for Plant Research, Inc.*
*Yonkers 3, N.Y.*

French hybrid lilacs, *Syringa vulgaris* vars., can be successfully propagated by cuttings. Considerable work was done at the Boyce Thompson Institute for Plant Research, Inc., from 1937 through 1942 on the propagation of hybrid lilacs, and preliminary results of this work were published in April, 1939 (1). Later work substantiated these results and indicated that from 75 to 100 per cent rooting could be obtained. Twenty-four varieties of the hybrid lilacs were successfully propagated from cuttings (Table I), and no significant differences were noted in the rooting responses of the different varieties. Rooting occurred in from four to five weeks, and the cuttings were ready for potting in approximately two months Rooted cuttings grew and developed normally.

Propagating methods involved the use of open benches in paint-shaded greenhouses where a minimum temperature of 68° F. was maintained. Temperatures lower than 68° F inactivated or noticeably reduced the effectiveness of the root-inducing substances A rooting medium consisting of a mixture of sand and peat moss was found to be satisfactory. The medium was placed in the benches without tamping or packing. After treatment the cuttings were planted on a 30-to 40-degree slant so that the leaves lay flat on or close to the surface of the rooting medium.

Immediately after planting the cuttings were heavily watered to firm them in, then shaded with a single layer of cheesecloth placed directly on the cuttings. The cheesecloth was removed for watering, then permanently removed after the cuttings had been in the bench for three weeks. Cuttings were taken periodically throughout the year

**TABLE I—Rooting Response of Cuttings of SYRINGA VULGARIS Varieties One Month after Treatment with 8 to 12 Mg. of Indolebutyric Acid in Talc**

| Variety | Date cuttings | Per cent rooting | Variety | Date cuttings | Per cent rooting |
|---|---|---|---|---|---|
| Adelaide Dunbar | 5/11 | 75 | Elihu Root | 5/21 | 75 |
| Amethyst | 5/27 | 75 | Mme Florent Stepman | 5/3 | 100 |
| Antoine Buchner | 5/11 | 75 | Oliver de Serres | 5/18 | 75 |
| Arthur Wm Paul | 5/19 | 100 | Paul Thirion | 5/21 | 100 |
| Capt Baltet | 5/20 | 100 | Perle von Teltow | 5/16 | 100 |
| Charles Joly | 5/20 | 100 | Pres Lincoln | 5/14 | 75 |
| Christophe Colombe | 5/27 | 100 | Pres Poincaire | 5/3 | 75 |
| Clara Cochet | 5/19 | 75 | Prof Sargent | 4/27 | 100 |
| Comte Adrian de Montebello | 5/14 | 75 | Reine Elizabeth | 5/19 | 100 |
| Dame Blanche | 5/15 | 100 | rubella plena | 5/20 | 75 |
| Decaisne | 5/9 | 100 | Siebold | 5/18 | 100 |
| Duc de Massa | 4/29 | 75 | Toussaint Louverture | 5/18 | 100 |

and various types of cuttings, including complete shoots cut through the annual rig, tip portions of long shoots, and basal portions of long shoots, were used in the tests. Indolebutyric acid (IBA) and a-naphthaleneacetic acid (NAA), alone and in 50-50 mixtures, were used in a range of concentrations, and the chemicals were applied to the cuttings by the 24-hour solution soaking method, by the talc powder method, and by the concentrated dip method. Treatments found to be effective were repeated for at least three years to substantiate results.

Three types of peat moss, including German, Canadian, and Michigan, were tested to determine the best type to use in the rooting medium. Little or no differences were noted in the induced rooting responses in the different media, but root growth and development appeared better in the mixture containing the German peat moss. A mixture containing ¼ to ⅓ peat moss and ¾ to ⅔ sand by volume was found to be satisfactory. Larger amounts of peat moss increased the possibility of overwatering and resulted in more basal rot on the young succulent cutting material A sharp sand provided better drainage and aeration than a fine silty type of sand. The peat moss should be finely broken and well moistened before mixing with the sand

The three more important factors influencing the rooting response of the hybrid lilacs were found to be the stage of growth or time at which the cuttings were taken, the type of cutting used, and the chemical treatment. The critical time period for taking the cuttings was found to be early in the spring when the new growth had reached a length of four to six inches but before the stem had become hard and woody. This time period cannot be dated and varies with local environmental conditions affecting growth In the Yonkers, New York, area this time period is usually the month of May. Cuttings taken after the end of May periodically throughout the summer and fall showed progressively poorer rooting as the growth matured Dormant cuttings callused but failed to produce roots.

The best type of cutting material was found to be complete shoots, four to six inches in length, cut through the annual ring. Shoots destined to grow 12 inches or more did not provide good cutting material, and tip portions or basal portions of such shoots failed to root. Cuttings with an actively growing terminal continued to grow after rooting, whereas those with a dormant terminal bud did not grow until dormancy was broken by a cold treatment Shoots with an actively growing terminal were found to be difficult to maintain in a good turgid condition in the rooting medium. In some instances, if the terminal appeared to be too soft, it was removed when preparing the cuttings. The selection of the cutting material is most important because if shoots with dormant terminal buds are used, one year's growth will be lost.

A relatively high concentration of either IBA or NAA was found necessary to induce a good rooting response on hybrid lilac cuttings. The solution soaking method required a 24-hour treatment in solutions containing from 40 to 80 mg. of active chemical in one liter of water. The solution soaking method has been largely replaced by the talc powder method because of the work and time involved in preparing solutions and the problems involved in preventing the cuttings from wilting during the 24-hour soaking period. The concentrated dip method required concentrations of from 10 to 20 mg. of active chemical per ml. of solution (20 to 30 times stronger than used for solution soaking). In preparing concentrations of IBA or NAA in this range, 95 per cent ethyl alcohol must be used to dissolve the chemicals since they are not water soluble to any extent. The problem of evaporation is always present when using alcohol, and care must be taken to prevent this evaporation, particularly in holding or storing the concentrates. For the talc treatments a concentration of from 8 to 12 mg. of active chemical per gram of talc gave optimum results Commercial preparations of IBA in talc are available, and one that is of particular value and which we have used to a large extent is Hormodin Powder No. 3. These talc preparations will lose strength over a period of years and should be bought in limited quantities so that preferably, they are not held for more than two years IBA and NAA were found to be of equal activity for inducing roots on the lilac cuttings and induced a 75 to 100 per cent rooting response in one month. Treated cuttings averaged 10 roots per cutting in contrast to one or two roots found on untreated cuttings. Less than 25 per cent of the untreated cuttings rooted.

A limited amount of work has been carried out at the Boyce Thompson Institute on the use of the misting systems for propagation. They certainly should be of considerable value in the propagation of hybrid lilacs since one of the difficulties encountered has been preventing wilting of the young cutting material while in the propagating bench. The use of the misting systems, however, does not preclude the use of the correct type of cutting taken at the correct stage of growth and treated with the correct root-inducing substance.

Any propagation methods now in use should certainly be adaptable for propagating cuttings of the hybrid lilacs. If the critical requirements discused in this report are met, a propagator should have no difficulty in obtaining a 75 to a 100 per cent rooting response of the French hybrid lilacs within four or five weeks after the treatment

## Literature Cited

1 Kirkpatrick, H., Jr Propagation of lilacs on their own roots Amer Nurseryman 69(6) 3-4 April 1, 1939.

PRESIDENT SCANLON: We are all indebted to you, Dr. Kirkpatrick, for meeting with us today and discussing your work with lilac cuttings.

The next speaker on our lilac panel, Roy M. Nordine of the Morton Arboretum, Lisle, Illinois, needs no introduction to the members of the Plant Propagators Society. He is one of our original members and a constant and loyal supporter of the Society.

Mr. Nordine presented his paper, entitled "Production of Lilac Plants from Cuttings." (Applause).

# PRODUCTION OF LILAC PLANTS FROM CUTTINGS

ROY M. NORDINE
*The Morton Arboretum*
*Lisle, Illinois*

This paper will describe our experience over the past three years in rooting and growing lilacs from cuttings. An examination of the literature on this subject revealed a surprising lack of information. Only four references were found, one by a professional, one by an amateur and a mention in two books. In "Plant Propagation Practices" by J. S Wells, a chapter is devoted to Lilacs, one page describes Lilacs from cuttings, while three pages are used to describe his method by grafting. The page that describes Lilacs by cuttings quotes the professional previously mentioned Wells ends the chapter with a paragraph on the controversal aspect "Cuttings versus Grafts" McKelveys book, "The Lilac" devotes many pages to the propagation of Lilacs, a host of growers prefer grafting, only two favor growing by cuttings but no directions are given for this method

The professional mentioned above is H Kirkpatrick, Jr. of The Boyce Thompson Institute who writes in the American Nurseryman, April 1, 1939 on results of rooting Lilacs with the aid of the root inducing agent indolebutyric acid The results ranged from failure on most of the untreated check lots to results of 50-75-100% on lots of treated cuttings. He used varieties of *Syringa vulgaris.* This work was done before the advent of any form of mist propagation.

The report by the amateur is interesting for it follows the frequent and peculiar methods employed by these people. This is a report by Francis C. Wilson in the "Gardeners Chronicle of America," April 1947, page 101. The varieties used were not named but all were forms of the common lilac Eight inch cuttings from vigorous shoots were taken on June 3 and treated with a hormodin powder. Cuttings were stuck in sand to their full depth, leaving only the terminal bud and the two top leaves above the sand In a shallow frame, results of 75% were obtained, but when she moved to a deep frame, results moved up to 98%. He attributed the better results to a more humid condition found in the deep frame. An additional irony is that in the experience of Kirkpatrick and myself, these long cuttings from vigorous growing shoots have given us the poorest results.

When the results of todays discussions are published, the void in the literature on the propagation of lilacs by cuttings will be filled, and we will leave unsettled the controversal question of cuttings versus grafts.

Our cuttings have been taken from plants of all ages and sizes, but all of blooming age. The cutting material was selected from the upper half of the plant and all were the stronger growing side laterals, 3 to 6 inches long. The very long and vigorous shoots common on younger plants and made into long tip cuttings or second cuts have produced very poor results. The time for taking the cuttings ranged from June 12 to July 11 Results were equally as good from those taken on the later date as any taken earlier On July 11 this year 14 lots were taken, 10 of which were *Syringa vulgaris* varieties and of these 14 lots, 10 lots rooted nearly 100% without any treatment — of these 10 lots well rooted — 7 lots were *Syringa vulgaris* varieties. Cuttings were made 3 to 6 inches long and the two top groups of leaves were left after trimming them back about one half their surface. The basal cut was made just below a node, when made above a node very poor results were obtained. All lots were small, from 2 to 15 cuttings per lot and were divided into check lots and those treated with Hormodin No. 3 and this year a 1% mixture was also used.

Cuttings were inserted in flats that are 4 inches deep and filled with a local torpedo sand, cuttings were pounded in and watered down. A small greenhouse was used that was provided with a fogging machine set to create 90% humidity. The first two years slated lath shades were used on the roof This past year the house was provided with intermittent mist and no shade was used on the house.

We have found lilacs in the cutting bench to be sensitive to an excessive amount of water, due to extra watering that can occur or to any form of drip. The cuttings respond by a water logged appearance of the leaves and defoliation, followed by rotting of the cutting.

Cuttings were allowed to go dormant in the greenhouse and lifted in early December and packed rather tightly in polyethelene bags long enough to take their entire length. A small amount of damp sphagnum moss was placed in the bottom of the bag, the top of which was left open. The bags were packed into apple boxes and wintered in cold storage.

In the spring the cuttings have either been planted directly to nursery beds or potted and placed in a warm greenhouse and transferred to beds in the late spring. The cuttings will quickly make a length of growth, depending on the growth characteristics of the particular variety, and then go dormant. Attempts have been made to force additional growth after mid-summer by foliar feeding but the results are not satisfactory. This early dormancy condition we believe, arises from the type of cutting used, and is carried over from the plant furnishing the cutting. With some varieties, especially the *vulgaris* types, this one flush of spring growth and then going dormant persists through the second year. In the third year this growth habit breaks down and plants continue growth through the growing season.

In 1954, 8 lots were taken and all lots rooted from 50-100% with almost the same rate of survival. In 1955, 128 lots were taken and 104 lots rooted from a low percent to a high percent Of these 104 lots 10 lots failed after being planted in pots and into beds later on. Most of the lots that failed in 1955 were retaken in 1956. In 1956, 51 lots were taken and 38 lots rooted with all degrees of success, while 13 lots failed. A number of these failures have been tried twice

A list of the results for these species and varieties is included at the end of this paper. Results, except for this year are based on survival after rooting, storage and subsequent planting.

Results in the cutting bench vary according to variety. Most Varieties of *Syringa oblata dilatata* and *S. oblata giraldi* and *S. Prestonia* root quickly with excellent results and equally high survival. Results with *S. vulgaris* varieties vary from those that will not root through all the possible results to those that root with a high percent and provide the same rate of survival. In most instances when rooting was above 50%, both check and treated cuttings were rooted but treatment provided more and stronger roots and a better survival. When rooting was below 50% the treated cuttings proved to be the better ones, in a few cases the check or untreated lots were the only ones rooted, treated material would form little or no roots.

## ROOTING CLASSIFICATION OF LILACS

The number preceeding the variety name indicates the final percentage of rooting:

1—75 to 100% 2—40 to 75% 3—blow 40% 4—Failure to root.

4 - "Carlton" RS
2 - chinensis "le Troyers"
3 - "Germinal" HT
2 - "Grace Mackenzie" CD
1 - "Hedin" VS
1 - "Hunting Tower" VS
2 - EH-D "Assessippi"
2 - EH-D "Evangeline"
1 - EH-D "Excel"
3 - EH-D "Fraser"
1 - EH-D "Laurentian"
2 - EH-D "Minnehaha"
1 - EH-D "Nokomis"
2 - EH-D "Pocahontas"
1 - EH-D "Swarthmore"
2 - oblata Giraldii nana
4 - EH-G "Kate Sessions"
2-EH-G "Montesquieu"
4 - EH-G "White Hyacinth"
1 - persica laciniata
4 - Potanini
1 - Prestone "Dawn"
2 - Prestone "Ethel M. Webster"
1 - Prestonae "Handel"
1 - Prestonae "Hecla"
2 - Prestonae "Hiawatha"
2 - Prestonae "Kim"
2 - Prestonae "Regan"
4 - pubescens
2 - villosa aurea
3 - vulgaris "Admiral Farragut"
4 - vulgaris alba grandiflora
2 - vulgaris "Alice Harding"
4 - vulgaris "Allison Gray"
4 - vulgaris "Alma"
3 - vulgaris "A. M. Brand"
3 - vulgaris "Amethyst"
3 - vulgaris "Anne Schiach"
3 - vulgaris "Arthus William Paul"
3 - vulgaris aurea
2 - vulgaris "Candeur"
4 - vulgaris "Capitaine Perrault"
3 - vulgaris "Carolyne Mae"
1 - vulgaris "Christophe Colomb"
3 - vulgaris "City of Kalama"
3 - vulgaris "City of Longview"
1 - vulgaris "Claude de Lorrain"
2 - vulgaris colmariensis
2 - vulgaris "Comte de Kerchove"
2 - vulgaris "Crampel"
3 - vulgaris "Crepuscule"
1 - vulgaris "Dame Blanche"
3 - vulgaris "Danton"
3 - vulgaris " De Jussieu"
2 - vulgaris "De Saussure"
2 - vulgaris "Desfontaines"
2 - vulgaris "Deuil d'Emile Galle"
3 - vulgaris "Diderot"
2 - vulgaris "Doyen Keteleer"
2 - vulgaris "Dr. Charles Jacobs"
2 - vulgaris "Dr. Maillot"
3 - vulgaris "Dr. Noble"
2 - vulgaris "Duc de Massa"
2 - vulgaris "Edmond Boissier"
3 - vulgaris "Elizabeth Mills"
3 - vulgaris "Emile Gentil"
3 - vulgaris "Emile Lemoine"
2 - vulgaris "Emil Liebig"
2 - vulgaris "Etoile de Mai"
3 - vulgaris "Fraicheur"
3 - vulgaris "Frank Klager"
2 - vulgaris "Fred Payne"

1 - vulgaris "Geant des Bataille"
3 - vulgaris "General Sherman"
2 - vulgaris "George W. Aldridge"
1 - vulgaris "Glory of Aalsmeer"
3 - vulgaris "Henri Robert"
3 - vulgaris "Henry W. Long-
fellow"

3 - vulgaris "Herman Eilers"
3 - vulgaris "Hiram H. Edgerton"
4 - vulgaris "Hyazinthenflieder"
3 - vulgaris "Jan Van Tol"
2 - vulgaris "Jeanne d'Arc"
2 - vulgaris "Joan Dunbar"
1 - vulgaris "Jules Ferry"
4 - vulgaris "Julien Gerardin"
3 - vulgaris "Justi"
3 - vulgaris "Katherine Haver-
meyer"

1 - vulgaris "Lady Lindsay"
1 - vulgaris "Languis"
3 - vulgaris "La Tour d'-
Auvergne"

3 - vulgaris "Leopold II"
1 - vulgaris "Louise Henry"
4 - vulgaris "Marceau"
3 - vulgaris "Marechal Foch"
3 - vulgaris "Marengo"
4 - vulgaris "Marie Finon"
1 - vulgaris "Martha"
3 - vulgaris "Massena"
3 - vulgaris "Maurice Barres"
3 - vulgaris "Maurice de
Vilmorin"

3 - vulgaris "Maxime Cornu"
2 - vulgaris "Midwest Gem",
2 - vulgaris "Mme Abel Chatenay"
3 - vulgaris "Mme. Kreuter"
2 - vulgaris "Mont Blanc"
3 - vulgaris "Monument Carnot"
3 - vulgaris "Mrs. Flanders"
1 - vulgaris "Mrs. W. E Marshall"
3 - vulgaris nana
3 - vulgaris "negro"
3 - vulgaris "Paradise"
4 - vulgaris "Pasteur"
2 - vulgaris "Paul Hariot"
3 - vulgaris "Paul Thirion"
4 - vulgaris "Planchon"
4 - vulgaris "President Fallieres"
2 - vulgaris "President Loubet"
3 - vulgaris "President Massert"
3 - vulgaris "President Monroe"
1 - vulgaris "Prince de Beauvau"
2 - vulgaris "Princess Camille
de Rohan"

2 - vulgaris "Princesse Clementine"
3 - vulgaris "Professor Sargent"
4 - vulgaris "Professor E. Stoek-
hardt"

3 - vulgaris "Rabelais"
2 - vulgaris "Reine Marguerite"
3 - vulgaris "Renoncule"
3 - vulgaris "Roi Albert"
2 - vulgaris "Ronsard"
1 - vulgaris "Rosace"
3 - vulgaris "Saturnale"
3 - vulgaris "Siebold"
2 - vulgaris "Sonia Colfax"
3 - vulgaris "Souv. de Claudius
Graindorge"

2 - vulgaris "Souv de Henri
Simon"

3 - vulgaris "Splendor"
3 - vulgaris "Todmorden"
3 - vulgaris "Tombouction"
1 - vulgaris "Toussaint l'Ouver-
ture"

3 - vulgaris "Triomphe de
Orleans"

3 - vulgaris "Triste Barbaro"
3 - vulgaris "Turenne"
1 - vulgaris "Versaliensis"
3 - vulgaris "Verschaffelt"
3 - vulgaris "Vesuve"
2 - vulgaris "Virginia Becker"
3 - vulgaris "Virginite"
4 - vulgaris "Volcan"
3 - vulgaris "William C. Barry"
2 - vulgaris "William Robinson"
4 - vulgaris "W. K. Mills"

PRESIDENT SCANLON: Thank you, Roy. Our last speaker this afternoon will be our good friend, Carl Kern, Wyoming Nurseries, Cincinnati, Ohio

## THE USE OF GRAFTS TO OBTAIN OWN-ROOTED LILACS

CARL KERN
*Wyoming Nurseries*
*Cincinnati, Ohio*

Recently I became the well-pleased owner of a copy of *The Lilac,* a monograph by Susan Delano McKelvey My interest was aroused concerning the most satisfactory method of propagation of the hybrids of *Syringa vulgaris,* better known to the trade under the term of 'French Lilacs.' The work of this author is an outstanding achievement in the annals of writings in horticulture, especially of a genus possessing such complex aspects as the lilac with its many garden forms and varieties.

I have studied the able comments made by many authorities, such as the late E. H. Wilson, E. O. Orpet of California, the late John Dunbar of Highland Park at Rochester, N.Y., the eminent hybridizer of lilacs, Mr. Emile Lemoine, Nancy, France, and many other European and American experts. I am impressed by the many theories as to methods of propagation and as to desirability of suitable understocks. A summary of opinions, however, clearly shows that hybrid lilacs on their own root are the most desirable.

There are only three possible ways for the increase of lilacs on their own roots by the usual vegetative methods of propagation: Cuttings, layers, and suckers

*Cuttings*: Cuttings may be made from partly-rippened green-wood during April and May depending upon the locality. They are treated in the usual manner as soft-wood cuttings of woody plants. The production of saleable plants from such cuttings is often a long and tedious process and entirely too costly from the viewpoint of the producing nurseryman, as he must meet the competition of budded or grafted lilac plants in the open market.

*Layering*: This is a good method which perhaps has been most practiced in Europe and especially in England. Here again we are confronted with the important factor of the time involved.

*Suckers*: The practice of taking suckers or runners from own-root plants is feasible They are often produced freely with some varieties but others will sucker very sparingly or not at all. This erratic behavior of many of our hybrid lilacs is proof enough that we could not depend entirely upon this way of propagation for general satisfactory results

In the conclusion of an article written by the late John Dunbar of Highland Park on lilac propagation (Florists Exchange, Sept. 1923) he stated: "There is an urgent demand for lilacs on their own roots for permanent plantings, and, whatever methods nurserymen adopt, the aim should be ultimately to establish them on their own roots."

PRESIDENT SCANLON: Thank you, Roy. Our last speaker this afternoon will be our good friend, Carl Kern, Wyoming Nurseries, Cincinnati, Ohio

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It should be realized, with the present methods of propagation, that one can not promise that all budded or grafted pants will eventually grow on their own roots even if deep planting is recommended and practiced. Satisfactory results are too uncertain and the purchaser is the loser in the end. The question of price is not always important, when quality is the deciding factor.

It is conceded by many authorities that, in order to produce lilacs in commercial quantities, some type of a graft holds out more promise for success than any of the mentioned methods. With this idea in mind, I have perfected a simple method of grafting the lilac which I would name the 'inverted wedge graft.' In this form of grafting, my plan is to obtain as many callusing or contact surfaces as possible I place most reliance upon the blunt and exposed ends of the split scion for the maximum amount of callus and of subsequent root formation.

For understocks, I prefer California privet (*Ligustrum ovalifolium*) cuttings. For the more northern states where the California privet is not sufficiently hardy, I presume that the English privet (*L. vulgare*) would furnish a suitable substitute This may be debatable from what I heard in the talks today In preparing for winter grafting, I use hardwood cuttings each 8 to 10 inches long and containing 4 or more nodes. These are made a year in advance of grafting and are planted outdoor, for rooting as soon as the ground thaws in the spring.

These cuttings must be planted deeply so that the cuttings will root at several nodes In the fall of the year, these rooted cuttings are dug and stored until the time of grafting in January and February. At that time, the rooted cuttings are cut into 2½ to 3 inch pieces with a rooted node on each section. For summer grafts, I use ripened wood of the current year's growth

In selecting scion material, I use the current season's growth of choice lilacs. If possible, I divide these scions so that the terminal one will have three pairs of buds and the lower ones only two pairs. The base of each scion is nearly one inch below the lowest bud.

In some recent experimental work with cuttings in the Department of Floriculture and Ornamental Horticulture at Cornell University by Dr. L. C. Chadwick, it was found that *Syringa* belongs to the group of plants which root best when the basal cut is one-half inch below the bud. It is believed that in this particular area, there are the greatest number of dormant root initials. These must be present and stimulated into action to obtain the prompt own-rooting of the lilac scion.

The grafting operation is reduced to as few motions as possible. The understock is prepared by two cuts, one on each side of the top of a rooted section of the hardwod cutting, forming an inverted "V"-shaped wedge. Then a lilac scion of approximately the same diameter is split upward through the middle of the stem, carrying the cut through the area of dormant root initials. The scion is then laid over the stock and tied in place.

The usual storing of completed grafts in a cool cellar or storage house is recommended with an occassional examination during the latter part of February and early March as to their state of advancement of growth. Too high a temperature will excite the buds. If too far advanced at planting time this premature activity will reflect itself in unnecessary losses.

The callused grafts are planted in light sandy soil under irrigation and are given the same treatment as root-whip grafts. The grafts should be placed with the union completely covered by the soil As soon as root action sets in, the function of the short understock of California privet as the main supporting unit diminishes as the vigor and root formation of the scion advances in like proportion.

For summer grafts, I use ripened wood of the current year's growth of the California privet for understock purposes. The grafts are made on unrooted cuttings about three inches long. The method is exactly the same as with the winter grafting. The completed grafts are handled under glass in frames in a manner similar to that used for soft-wood cuttings. The union is placed below the level of the bed and callusing takes place as the base of the privet begins to root. These callused and partly rooted grafts may be wintered by mulching the frame or by any other treatment given to slow rooting summer propagated plants. The rooted grafts are planted out the following spring for growth into size.

In offering this suggestion for the grafting of lilacs to the nursery industry at large, I do not claim that this method could not be improved. It has given me satisfactory results which have pointed the way to the production of own-root thrifty plants on an economical basis in the shortest possible span of time.

Now, in concluding my talk here, I will say, however, I have found there are certain of the lilac hybrids which go on their own roots using this method of grafting very rapidly, some types that will not go on their own roots until the second year, and that some will never do it. They just refuse to do that sort of thing, and if you realize that we are dealing with over 800 main varieties of *Syringa vulgaris,* let's pick out at least 10 or 20 of the best top variety flowers and forget about the others.

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PRESIDENT SCANLON: Carl, we thank you very much for these tips on the propagation of lilac.

The time has now arrived for the many questions and comments which I know these talks will raise.

MR. RICHARD VAN HEININGEN (Van Heiningen Nurseries, Deep River, Conn.): Mr. Nordine, how do you feel about grafting hybrid lilacs on *Syringa vulgaris?*

MR ROY NORDINE: I believe this to be an unethical and unfair practice because of the suckering habit of common lilac that presists during the entire life of the plant. I don't know when it begins on lilac seedlings but I presume sometime after the second year and would increase with age. It might be possible for a few vigorous varieties to outgrow the lilac root by their own roots, but surely on most varieties, the root piece used will continue to grow and serve as the root supporting the top. Lilac roots are vigorous and most certainly would also retain their natural habit of producing suckers from the root stock. This may not appear during the three or four years the plants are in the nursery I believe the owner of a lilac plant is entitled to the variety they purchased and not one that produces suckers of an inferior variety.

MR. VAN HEININGEN: In Holland, they used to graft white varieties on a dark type of lilac. When suckers came up you could tell by the buds they were suckers The dark varieties were also grafted on the white type. We imported lilacs from Holland in 1948 in order to get stocks. They were grafted very high. The distance between the crown of the plant and where the roots started was probably a foot or more on one-year old plants — a terrifically long stem. We planted those along with our own grafted material which was then grafted on privet There was never any comparison between the growth of the ones grafted on *S vulgaris* and the ones grafted on privet. The privet definitely stayed behind all the while and, sometimes, they just didn't grow beyond one or two years' growth.

Some varieties, such as Alphonse Lavallee and Michel Buchner, went on their own roots.

MR PETER ZORG (Cartwright Nurseries, Collierville, Tenn.): May I comment on grafting *Syringa vulgaris*? In Holland, they start right away by de-eying the one-year seedling to be used as understock. In the second year when the seedling is growing to grafting size they continue to de-eye the seedling.

When these understocks are properly de-eyed, the lilacs are grafted on the *Syringa vulgaris*. As soon as any suckers are found they go through the row and take the suckers off, and after a certain number of years there are no more suckers. I don't see why we can't graft lilacs on *Syringa vulgaris*. There is no doubt that is the best understock. It is much better than privet, but the privet suckers are easy to distinguish.

MR. CASE HOOGENDOORN: (Hoogendoorn's Nursery, Newport, R.I.): I was surprised to learn this afternoon that they use green ash as an understock. You say that is compatible for lilacs?

MR. WEDGE: It is enough to use.

MR. HOOGENDOORN: Is it more valuable than privet?

MR. WEDGE: We get a better stand with green ash than privet. According to our tests the green ash always came out ahead of the privet in percentage of stands. It is also much cheaper to produce than the privet

MR. HOOGENDOORN: A lot of our lilacs don't go on their own root even if you graft them. Now, personally, I don't think privet is the cause. If the scion doesn't go on its own root you never get a good lilac. What happens to the ash? Does it produce a better plant if the scion doesn't go on its own root?

MR. WEDGE: When we dig our lilacs in two years you find very little sign of the ash root It is either ready to come off or almost off. I would say you wouldn't find more than one or two per cent that shows any sign of the ash root growing. Maybe with a few varieties there may be as much as 10 percent.

MR. HOOGENDOORN: What happens to the other varieties which refuse to go on their own root after that?

MR NORDINE: In northern regions where winter temperatures are reached 15° below zero, and the frost line is six feet, and where winter winds are bitter cold, privet, even Amur River North is not hardy. It cannot be depended on as an understock for lilacs. Nurserymen in these area have been using Ash as an understock all the years that lilacs have been grown.

PRESIDENT SCANLON: Another question from the floor?

MR. KENNETH REISCH (Ohio State University, Columbus, O.): In those tests that you ran, Dr. Kirkpatrick, how many cuttings did you use in your treatment?

DR. KIRKPATRICK: In most of those tests, particularly those I showed photographs of, a maximum of perhaps ten to a treatment, that is in one test, but the tests were always replicated The percentage figures were based on more than one test.

MR. REISCH: Did you state that root-inducing substances were detrimental at low temperatures?

MR KIRKPATRICK· Yes, to the extent that we know these root-inducing substances, show less activity at low temperature than at a high temperature That applies to the whole field of plant hormones and many times when you treat cuttings with a root-inducing material and hold at low temperature, particularly between 45 and 55, you get a little proliferation at the base of the cuttings and it will rot. Many times you will get much more basal rot on your material with treatment at low temperature than if you didn't use the treatment at all. In other words, our recommendations have always been to use root-inducing substances at the higher temperatures.

DR. STUART H. NELSON (Central Experimental Farm, Ottawa, Ontario): We have heard a lot of different dates mentioned for making lilac cuttings The panel comes from various parts of the United States. Could we correlate the best time for taking lilac cuttings with, let's say, the floral development?

MR KIRKPATRICK. I don't think so, although I am not sure. I doubt very much if the exact stage of growth could be correlated with the stage of flowering, if that is what you mean. I think that many times the weather would affect the flowering more than it would the development in growth after the buds break. Perhaps someone else here will have a different idea.

DR. L C. CHADWICK (Ohio State Unversity, Columbus, O.): One comment relative to Nelson's question, I believe your question applies to a correlation of the rooting with the development of flower buds for the following year and not with the blooming period of the current season.

DR. NELSON: No, I was thinking particularly of flowering of the current season.

DR. CHADWICK We are running some experiments right now at Ohio State where we think there may be some direct correlation with rooting and the formation of the flower buds for the following year You will start with a high percentage, as has been indicated here, and just gradually drop on most varieties until the flower bud is formed for the following year, which on a few varieties we have examined is about the 20th of June, in Columbus, Ohio. Also, there is a little indication that once that flower bud is formed, then the rooting percentage will start going up again.

MR ROGER COGGESHALL (The Arnold Arboretum, Jamaica Plain, Mass.): I will add a little more confusing information to this topic As far as lilac cuttings, we make the cuttings when the annual growth is long enough to make a cutting. Now that is way before the lilac is even thinking of blooming. Not only that, but we run it roughly, depending on the season, of course, from the first week until the fourth week. In that range, if we take the first flush of growth that is four inches long, that will root just as well as cuttings from the same plant taken a month later, providing we take the terminal portion of the growth. It is very soft, immature growth The cuttings are stuck directly into the ground under polyethylene plastic.

The advantage of taking them at this time of the year, and I concur with Mr Kern, is that we can root them in relatively short time, one to six weeks. The plastic is gradually removed and you have most of the growing season ahead of you. Depending upon the variety, the cutting grown in the ground will grow two to eight inches in the first growing season.

MR. HANS HESS (Hess Nursery, Mt. View, N.J): I wonder if any of the gentlemen on the panel have had any experience regarding the difference between the cutting and the graft as to the length of time required from the time the plant is propagated until it develops flowers? There are a number of people that say a graft will flower sooner than a cutting.

MR. SIEBENTHALER: I will say this much about it, some of them will set flower buds in the bands in the lath house or the deep pit. On the other hand, some of them won't. Being primarily interested in the retail value of these plants from a commercial standpoint, we don't feel we can very well sell them until they have a good flower bud formation in the spring, which is primary when we do sell them. From that standpoint, we feel we get very good flowering from the cuttings. If we didn't we wouldn't grow them that way.

MR. VAN HEININGEN. How long does it take?

MR. SIEBENTHALER. Four year plants. As I said, some of them were bands in the lath house.

MR HANS HESS: Would you say that is faster than grafting?

MR. SIEBENTHALER: I made a statement before, that we quit grafting before I was born.

MR. WEDGE: You are asking about length of time the grafted plant takes to flower I think that practically all of the grafted plants will be in good shape in three years, some in two years' time.

MR. PAUL BOSLEY (Bosley Nursery, Mentor, Ohio): We used to grow lilacs by a method that still today seems very obvious. We bud on California privet The second year you have a plant that is 18 to 24 inches high. At the end of that year we lift those plants and here is the gimmick: we take an ordinary wire label and twist it on the lilac itself, just above where the bud comes out. We than replant the lilac about four to five inches deep in the ground. Then as the lilac continues to grow, that label wire starts to choke off the nurse stock, like weaning a baby. That lilac, in order to live and survive, has to make its own roots. It continues to grow, and we have had excellent results. The privet is buried, choked and dies. If you have a variety that is difficult to get on its own roots, you can make a cut in he lilac stock insert a tooth-pick at the time you bury it and you have an easy practical way of getting lilacs on their own roots. They are always saleable and you can beat the time by grafts or any other method I know of by years.

MR. RICHARD FILLMORE (Duke University, Durham, N.C.): *I would like to ask Mr. Sjulin if he has had any experience with mist propagation?*

MR. SJULIN: We had had some experience but we had the trouble that was mentioned previously of the leaves falling off after they rooted. I would like to pass that on to Mr. Templeton..

MR. HARVEY M. TEMPLETON (Phytotektor, Winchester, Tenn.): We have had fairly good success rooting the easier varieties, but the difficult ones are still difficult, commercially impractical I would say. Mist doesn't help any.

PRESIDENT SCANLON: Ladies and Gentlemen, our closing hour has arrived. Save additional questions for tonight's session.

I want to express our sincere appreciation to each and every member of this panel on lilac propagation for a very interesting and informative afternoon.

The session recessed at 4:20 p.m.

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# PLANT PROPAGATION QUESTION BOX

## FRIDAY EVENING SESSION

### November 30, 1956

The Plant Propagation Question Box Session of the Sixth Annual Meeting convened at 8 p.m Mr. Jack Siebenthaler, The Siebenthaler Company, Dayton, Ohio, was the moderator for the evening.

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

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# SATURDAY MORNING SESSION
## December 1, 1956

The Sixth session convened at 9:30 a.m., President Scanlon presiding.

PRESIDENT SCANLON: This morning we are extremely fortunate to have Dr. Lela V. Barton, of the Boyce Thompson Institute for Plant Research, Yonkers, New York, as a guest speaker. Dr. Barton has been investigating seeds for a number of years, and I am certain that many of us here this morning are familiar with many aspects of her work.

Dr. Barton presented her paper entitled, "Gathering, Stratification, and Sowing of Seeds." (Applause).

## GATHERING STRATIFICATION, AND SOWING SEEDS

LELA V. BARTON
*Boyce Thompson Institute for Plant Research, Inc.*
*Yonkers, New York*

A supply of good seeds is the first requirement of the plant propagator Since it is seldom possible for him to grow his own seeds, it becomes necessary for him to understand the best techniques for collecting and cleaning seeds, and some of the factors which influence their viability.

Let us consider the collection of seeds of woody plants. This subject is covered very well in the Woody-Plant Seed Manual prepared by the Forest Service of the United States Department of Agricuture, Miscellaneous Publication No 654, June 1948. Collection is usually handled by a seed collecter who must know where sufficient seed can be found of plants having desirable characteristics. He must know when the seeds are ripe enough to gather and the time period over which it is safe to harvest. He must also know whether the seeds can be collected most easily from the plants, from the ground, or from animal hoards.

The source of the seed has come to be recognized as of prime importance — next to the selection of the species itself. Earlier it was thought that any viable seed lot of a given species would serve the purpose but as large plantings developed in Europe, it was noted that trees from seeds of foreign origin were inferior in many ways to those grown from local seeds. Europeans have been aware of this situation for a long time, but it has been ignored by the United States until rather recently, partly due to the fact that unsatisfactory results from using seeds of improper origin have not been so prevalent in the United States. However, the safest procedure is to use seeds of local origin wherever possible and to restrict the use of other seeds to those which come from regions with similar climate and soils which prevail at the planting site.

Fully mature (ripe) seeds are usually considered superior to immature ones in viability and vigor as well as in keeping quality. It is usually easy to distinguish fully ripe seeds, but because of the possibility of their falling from the plant or being eaten by animals after they are fully mature, it becomes necessary to know the earliest stage of ripening consistent with good, viable seeds This makes it very difficult for inexperienced collectors, especially since the exact time for gathering seeds must be determined for each species in each locality each year. Guides to cone ripeness based on their specific gravity measured by their flotation in a test liquid are available for a few pines. To complicate matters, ripening of seeds is apt to be uneven, especially in some of the fruits such as cherry and plum. This necessitates going over the plants more than once to finish the seed collection. Although it is usually assumed that the best quality seeds are obtained from well-ripened fruit, some exceptions to this are claimed. It has been reported, for example, that the normally dormant seeds such as cotoneaster, eastern redbud, and arrowwood viburnum show good germination the first spring if the fruits are collected in late summer while still slightly green and the seed sown immediately This may be related to a hard coat effect, as we shall see in the discussion on stratification to be presented below.

Extraction and cleaning of the seeds, especially those enclosed in cones or fleshy fruits, is very important to subsequent germination. Inadequate cleaning can reduce germination by mechanical restriction or by increased rooting, the latter especially in seeds improperly cleaned of fleshy fruits.

## STRATIFICATION

"Stratification" is a term which applied originally to the practice of placing alternate layers of seeds and soil or some other medium for exposure to low temperature for the purpose of breaking dormancy. The term has been carried over to apply to any low-temperature pretreatment method for breaking dormancy. For example the seeds may be mixed with the medium, such as granulated peat moss, and placed at controlled temperature instead of out-of-doors for definite periods of time preceding sowing, or the exposure to low temperature may follow regular soil plantings.

"Dormancy' is a term which has not been clearly defined in the literature. Primary dormancy present in the seed at maturity presumably has its origin during the development of the embryo and its surrounding structures while in contact with the mother plant In certain instances, conditions which are usually favorable for germination and growth, i.e, a moist medium and a warm temperature, are the conditions which prevent germination and actually may induce a type of dormancy known as secondary dormancy. Secondary dormancy has also been known to be imposed by unfavorable germination temperatures or the presence of an excess of carbon dioxide. Since our main consideration in this paper will be primary dormancy, we may use the term as signifying the failure of viable seeds to germinate when they are placed under conditions of moisture and temperature which would ordinarily bring about sprouting. This is in contrast to the so-called dormancy of the dry, resting seed. The term, "after-ripening" will be used in its broadest sense, that of preparation of the seed for the resumption of growth.

It should be kept in mind that not all germination failures are due to seed dormancy. There may be loss of viability due to age or improper storage conditions or the seeds may be devoid of embryos. This latter condition is especially characteristic of some of the coniferous forms and of such seeds as *Liriodendron tulipifera.* It would be helpful to know the source and history of the seed lot to be tested and to cut a few of the seeds to be sure they are not empty.

Dormancy, characteristic of many types of seeds, has both good and bad features It is of definite advantage to the continuance of the species in that germination under conditions unfavorable for seedling survival is prevented. This is true for many temperature-zone forms whose seeds mature in the autumn. If germination took place immediately, the young seedlings would not be able to withstand the vigorous winter weather and would all be killed. This disadvantages of dormancy are chiefly from the point of view of the gardener and nurseryman. Dormant seeds require special, and generally time-consuming, treatment if a good stand of seedlings is to be secured.

*Impermeable Coats*: It has long been known that certain seeds, especially of the family Leguminosae, possess coats which prevent the absorption of the water necessary for germination. Among the known methods for making the coats permeable are shaking or mechanical scarification, soaking in concentrated sulphuric acid or alcohol, and hot water of special temperature treatments. The honey locust, *Gleditsia triacanthos,* may serve as an example of seeds with impermeable coats. The effectiveness of mechanical filing of the coats of these seeds is well known. Usually, in such instances no other type of dormancy is involved so that once the coat is made permeable, germination proceeds without further difficulty. There are, however, certain forms which combine an impermeable or hard seed coat with a dormant embryo. These will be discussed later.

*Seeds Favorably Affected by Low Temperature Pretreatment (Stratification)*: The changes which take place during after-ripening of the seed at low temperature may involve actual growth and development of the embryo itself, as in the case of the American holly, *Ilex opaca.* Changes also may, and usually do, include an increasing acidity and altered enzyme activity within the tissues of the embryo. Also there may be chemical changes within the endosperm or stored food of the seed, as well as chemical or physical changes within the seed coats during this after-ripening period. Endosperm in an insoluble form, such as hemi-cellulose, within the seed may become chemically changed in the presence of moisture at low temperature so that it is available for use by the embryo.

Even if the embryo seems fully developed and has attained considerable size while the seed is still attached to the parent plant, it may still grow in size before germination will proceed. This is true of at least one of the species of ash, *Fraxinus excelsior* Seeds were examined on March 19th after having been planted in soil the preceding September and kept over winter in a board-covered cold frame, a mulched and board-covered frame and a 70° F. greenhouse. In all three of the soil conditions the embryos grew to the full length of the seed. From the appearance of these embryos one would expect that seedlings would be produced under the three conditions. However, this is not the case. By June 10th, those seeds which had been subjected to the low temperatures of winter at Yonkers, N.Y. produced good seedling stands while no seedlings appeared in the greenhouse flat. Obviously, growth of the embryo alone does not always bring about the changes necessary for germination. Additional changes in the endosperm or seed coats or both occurring at low temperatures, but not at 70° F., must have enabled the embryo to overcome the mechanical resistance of the coats and thus germinate.

In many instances there are no observable differences in appearance between an after-ripened and a dormant embryo. Upon transfer to a higher temperature, however, after-ripened embryos begin growth immediately while the control untreated embryos do not change in size. The external appearance of the intact seed which has been after-ripened certainly gives no clue to its germination capacity and yet a planting of these seeds in the greenhouse reveals the after-ripend lot without question. This is shown for one of the roses (*Rosa rubiginosa*) in Fig. 1. These seeds are more specific in their temperature requirement for after-ripening than most others, since 41°F. was the only effective temperature used. Also, these seeds have a deeper dormancy than those of some other rose species; *Rosa multiflora*, for example, which requires only 6 weeks instead of 6 months for after-ripening. Rosaceous forms,


Fig. 1.—Germination of seeds of *Rosa rubiginosa* in soil in the greenhouse after six months in moist sand at the designated temperatures. A control lot of seeds was held dry before planting.

including fruits such as apple, pear, cherry and peach, are well known for their production of dormant embryos

The conifers vary greatly in their need for after-ripening. In the genus *Pinus* are to be found examples of different degrees of dormancy, ranging from the very dormant *Pinus koraiensis* which fails to germinate seventy days after planting in the greenhous to the less dormant *Pinus resinosa* which gives 67 per cent germination in twenty-four days. Low-temperature pretreatment is essential in the first instance, but can be beneficial in the second instance also in the hastening of germination so that a prompt, complete stand of seedlings is obtained. A uniform seedling stand is very desirable from the point of view of cultivation, disease resistance, and response to ecological factors, both favorable and unfavorable. *Pinus rigida* occupies an intermediate position as far as intensity of seed dormancy is concerned, as is shown in Fig. 2. Here it is seen that one month at 41° F gave as good results as two or three months. Seeds planted in the soil in the greenhouse after one month at 41° F. gave 87 per cent germination after twelve days and 95 per cent after eighteen days, and when the experiment was extended to forty davs the percentage germination rached 99 This is in sharp contrast to the untreated seeds, of which only 3 per cent had germinated after twelve days and which reached only 33 per cent after thirty days. Very good germination of this species can also be obtained after one, two, or three months at 34° or 50° F.

Germination of seeds of the spice bush, *Benzoin aestivale,* is increased by stratification. The same advantage of low-temperature pretreatment of seeds is obtained with the barberry, *Berberis vulgaris.*

These examples will probably suffice to demonstrate the general effectiveness of low-temperature pretreatment We shall now consider some seeds which possess both an impermeable coat and a dormant embryo.

*Germination of Seeds Possessing Both Hard Coats and Dormant Embryos*: A background of the knowledge that some seeds fail to germinate because of an impermeable seed coat and that others fail because their embryos are dormant made possible the assumption that there must be seeds possessing both of these hindrances to germination. Consequently some of the especially difficult forms were tested with this in mind Several of them, including some of those which had been listed as requiring two years for germination were found to fall in this class. These species have offered great difficulties to practical growers and to scientists. Since after-ripening proceeds at low temperature only if the seed has been able to absorb water, it follows that a coat treatment must be given before low temperature stratification. This may be done by soaking in concentrated sulphuric acid. Sulphuric acid must be handled with extreme care to prevent injury to body or clothing Furthermore, the exact time of treatment must be known for each kind of seed. Too long a period of soaking eats through the coats and kills the embryo. Too short a period is of no value since the coats remain impermeable These facts make the application of the method difficult for the ordinary gardener or nurseryman Is there a simpler and safe procedure?

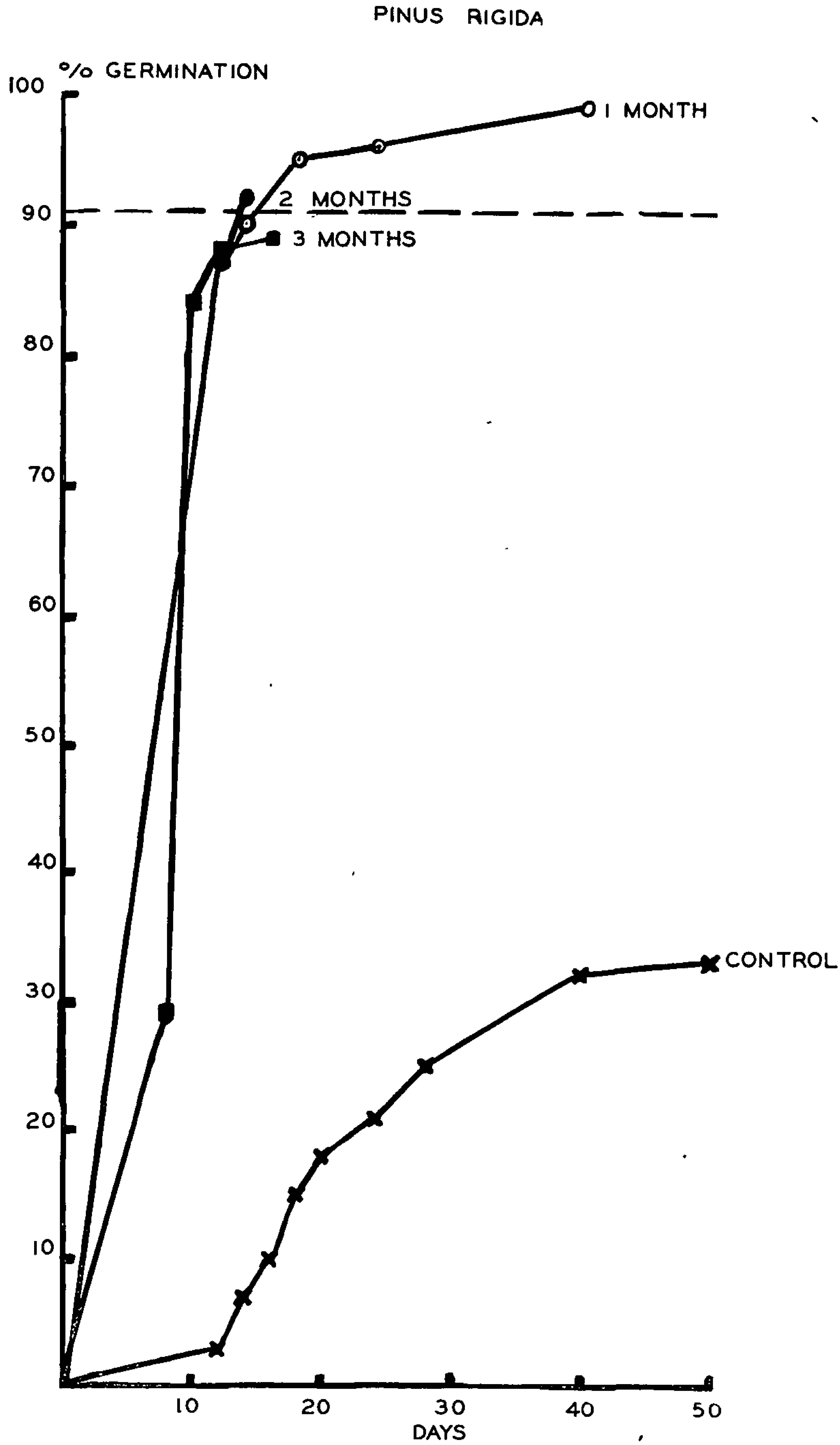


Fig 2—The effect of moist pretreatment of seeds of *Pinus rigida* for 1, 2, or 3 months at 5°C on germination in soil in the greenhouse

It has been shown now, in several cases, that a period at high temperatures (68° to 77° F.) in a moist medium causes the disintegration of the seed coats making them permeable. No germination was obtained with Crataegus after 9 months pretreatment at 41° F., but a combination of 4 months at 80° F. and 5 months at 41° F. brought about excellent seedling production in the soil. It should be noted, however, that not all hawthorn species have impermeable coats. Both high and low temperature treatments may be given at controlled temperatures, but this is not at all necessary. Practically, late spring or summer planting out-of-doors is the solution. This is shown in the Fig. 3 for seeds of *Tilia americana* where the effect of planting time is noted. Seedling production in the spring from seeds planted in June, July, and September and wintered in open, mulched, and board-covered frames is pictured. The best seedlings were produced from the June planting, and very few from the September planting.

Other species, whose seeds are known to respond in a similar fashion are *Arctostaphylos Uva-ursi, Cotoneaster sp., Halesia carolina, Symphoricarpos sp.,* and *Taxus cuspidata.*

*Epicotyl Dormancy*: Certain seeds produce roots readily when exposed to ordinary germination temperatures. The root systems develop until the stored food supply in the seed is exhausted, but no shoots are produced if the seedlings are kept continuously at these temperatures. The main problem in the growing of plants from these seeds has proved to be the forcing of the dormant shoot bud after the root has already started to grow. This type of dormancy has been

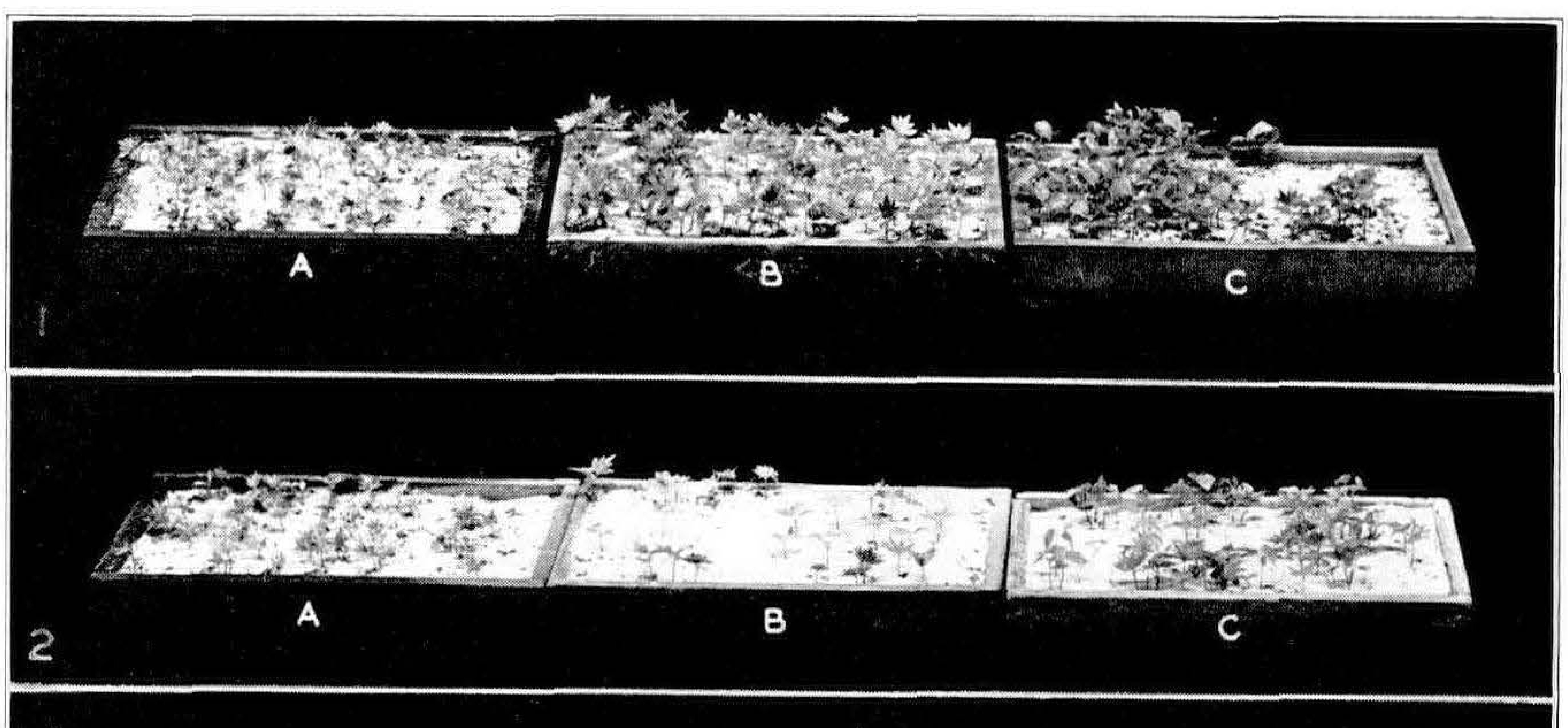


Fig. 3.—Seedling production in the spring from seeds of *Tilia americana* seeds planted in June, July and September (1, 2, and 3) and wintered in open, mulched, and board-covered cold frames (A, B, and C).

called "epicotyl dormancy" and was first reported in 1933 for seeds of the tree peony, *Paeonia suffruiticosa*. The increasing popularity of this flower coupled with the difficulties in rooting cuttings have augmented the need for adequate germination methods.

Since the roots exhibit no dormancy they may be produced in any moist medium at ordinary temperatures. After the roots have started to grow seedlings must be given a period at low temperature to after-ripen the shoot. This is accomplished by planting the germinated seeds in soil in pots and placing the pots in a cold room for two to three month. The soil must, of course, be kept moist throughout the treatment. At the end of the period, the pots should be transferred to a greenhouse or other warm place where the green shoots appear within a few days. If treatment at low temperature is prolonged the shoots start to grow and are injured unless the light requirement is provided in the cold room.

Figure 4 illustrates these effects, showing the growth of green shoots in the greenhouse after low-temperature pretreatment of the germinated seeds. No green shoots were produced in the greenhouse without low-temperature pretreatment.

Since these seeds require a high temperature for root production followed by a low temperature to after-ripen the bud which forms the shoot, the practical way of obtaining seedlings is spring or early summer planting. It will be recalled that this method may be used for seeds in the preceding category also, i.e. seeds with a combination of a hard coat and a dormant embryo. The effect of the initial period at high temperature is different, however, for the two classes. In one instance it favors the growth of the root system necessary before the epicotyl will after-ripen at low temperature and in the other it permits the microorganisms of the soil to make the seed coats permeable.

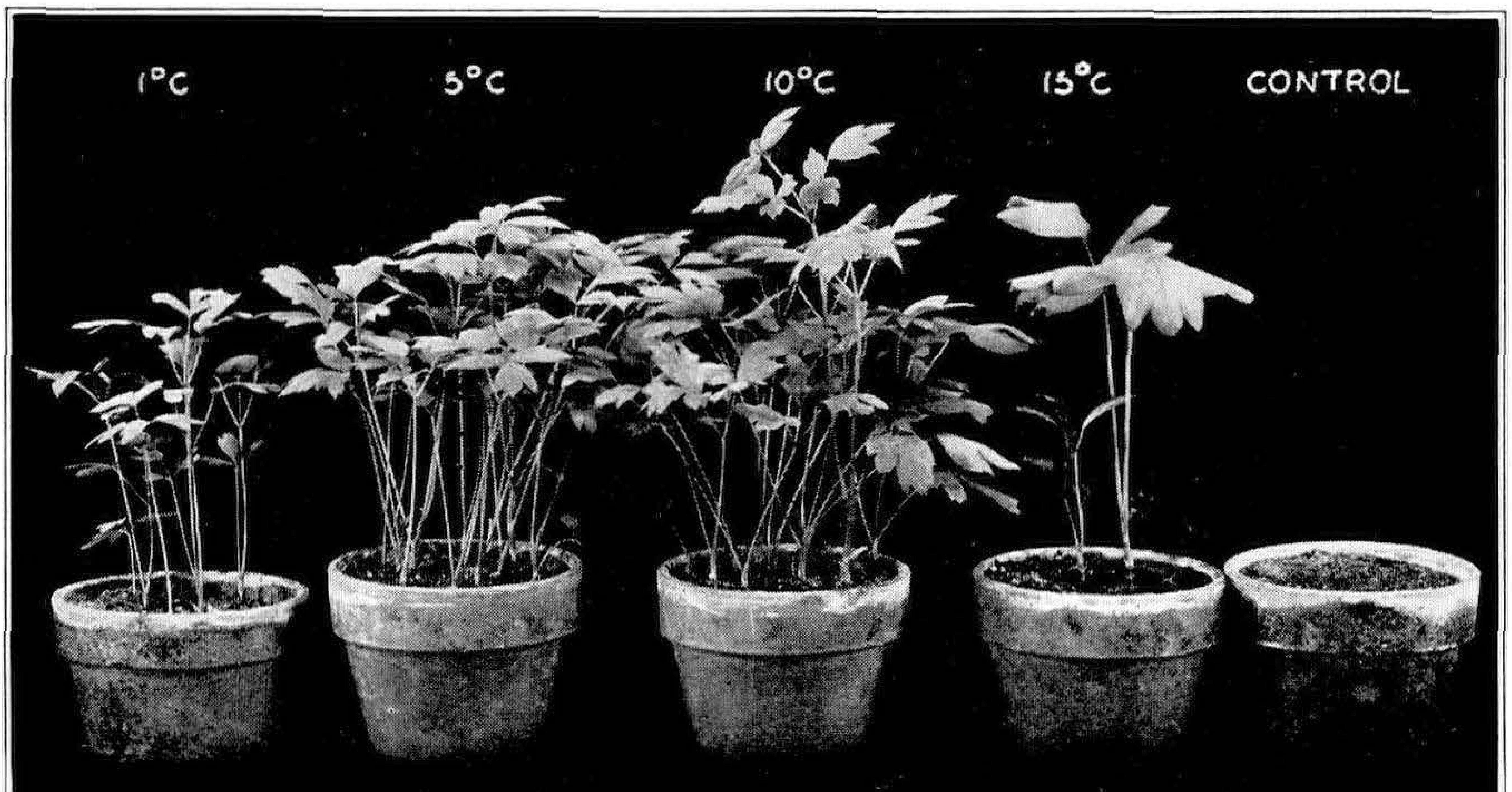


Fig. 4.—Greenhouse production of green shoots of the tree peony, *Paeonia suffruticosa*, from germinated seeds kept for two and one-half months at 1°, 5°, 10° or 15° C. The control pot was kept in the greenhouse for the entire period.

It should be noted that this same type of dormancy is exhibited by seeds of the herbaceous peony the so-called two-year lilies (such as *Lilium auratum, L. canadense, L. japonicum, L. rubellum, L. superbum,* and *L szovitsianum*) and several species of *Vibrunum.*

*A Combination of Root and Epicotyl Dormancy*: From the foregoing description of the types of dormancy, one might expect to find seeds with a combination of root and epicotyl dormancy. This would be distinct from the ordinary type of dormancy where, once the growth of the radicle is initiated, the whole green plant follows quickly. It would also be different from the epicotyl dormancy type where the production of the root at high temperatures is a prerequisite for low-temperature treatment to form the shoot. Seeds of several forms have been shown to have this "double dormancy" To bring about seedling production, it would appear that these seeds would need a period at low temperature to after-ripen the root, followed by a period at high temperature to bring about actual sprouting and growth of the root, a second period at low temperature to after-ripen the epicotyl, and a second period at high temperature to grow the green shoot. This is exactly what is required

The results of experiments with seeds of *Trillium grandiflorum* have demonstrated complete double dormancy. Only an occasional root is produced without low-temperature pretreatment and a separate period at low temperature is necessary to after-ripen the shoot. Lily-of-the-Valley, *Convallaria majalis,* seeds respond to the same sort of treatment but differ from *Trillium* in that the roots are only partially dormant. This is to say, some root production takes place at ordinary temperatures without previous low-temperature treatment, but the percentage is increased by such treatment. For example root production from seeds of lily-of-the-valley can be increased by low-temperature pretreatment from 16 to 82 per cent. A further complication in the germination behavior of these seeds is found in a special type of epicotyl dormancy. In the ordinary type as exhibited by the tree peony, the dormancy of the epicotyl or the bud which forms it may be broken at any time between the first appearance of the radicle and the time of the maximum development of the root system from the food stored in the seed. To break epicotyl dormancy in lily-of-the-valley, however, the low temperature must be given, not merely after root production, but after the shoot has developed to a certain stage. Low temperature is ineffective if applied before this certain stage of development is reached.

*Dwarfs from Nonafter-ripened Embryos.* At the beginnig of our discussion of dormancy, we dealt with the after-ripening of seeds with dormant embryos. After a period in a moist medium at temperatures of 41° to 50° F. usually, such seeds germinate to form normal plants. Studies of the physiological behavior of embryos, which have been freed of the seed coats and all enveloping structures, have shown that it is possible to obtain some growth without low-temperature pretreatment. The resultant plants, however, do not grow in a normal manner but develop a characteristic dwarfed appearance The stems fail to elongate and to produce internodes of normal length. The nodes appear to be superimposed one upon the other. Seedlings produced from non-after-ripened embryos may remain dwarfed indefinitely, or may start to grow normally after a certain time has elapsed. The growth can be made normal upon exposure to low temperatures at any time in the seedling stage. Also it is known that better growth of such seedlings takes place in the long days of summer than in the short days of winter. Grafting experiments have failed to reveal the mechanism of dwarfing.

More reecntly, it has been demonstrated that lanolin preparations or aqueous solutions of gibberellic acid promote the growth of physiologic dwarfs produced from nonafter-ripened embryos of the crab apple, *Malus Arnoldiana* (Fig. 5). Such growth is characterized by the extension of internodes, resulting in the elimination of the dwarfed condition. The number of leaves and nodes were not affected by the chemical under the conditions of the present tests. This is the first chemical shown to induce extended growth of physiologic dwarfs, and may represent a forward stride in the elucidation of the dormancy mechanism, a problem which has challenged many workers for many years.

We have not spoken of the sowing of seeds, except indirectly. Since all of our work has been done on an experimental basis, we have had no experience in the handling of large lots of seeds.

Fig. 5—Use of gibberellic acid to promote the growth of physiologic dwarfs produced from non-after-ripened embryos of the crab apple, *Malus arnoldiana*.

It has been a pleasure for me to present this outline of the different types of dormancy, and I hope it will be of some help to you.

*   *   *   *   *

PRESIDENT SCANLON. Thank you, Dr. Barton. The discussion was excellent. I am certain there will be many questions.

DR. SNYDER (Rutgers University, New Brunswick, N.J): *What* was the concentration of gibberellic acid used on crab apple dwarf seedlings?

DR. BARTON: In solution we put one micogram on each seedling, but in the lanolin mixture we put a small drop of lanolin which was made by mixing five milligrams of lanolin in five grams of lanolin.

MR. JACK SIEBENTHALER (The Sienbenthaler Co., Dayton, Ohio): How permanent is the effect of gibberellic aid on elongation?

DR. BARTON: A lot of us want to know the answer to that one. With the dwarf embryos, the gibberellic acid is finally just used up and the plant will form another little dwarf at the top. These dwarf seedlings I am speaking of are not permanent dwarfs, they are only physiological dwarfs. If they are given a low temperature, they will grow out An amazing thing is that sometimes they grow out without any apparent reason.

MR. CARL KERN (Wyoming Nurseries, Cincinnati, Ohio): Have you done any work with maleic hydrazide to effect dwarfing?

DR. BARTON: Some work with maleic hydrazide has been done at the Boyce Thompson Institute, however, it was not with the view of dwarfing plants.

MR. CONSTANT DE GROOT (The Sheridan Nursery, Toronto, Ontario): We have had germination of seed of *Cotoneaster Wardii* in one year. Is this an exception?

DR. BARTON: We have not tried all of the cotoneasters but I think it is likely an exception. The three species of hawthorne I mentioned earlier require a high temperature prior to germination, but not all species of hawthorne require this.

MR. CASE HOOGENDOORN (Hoogendoorn Nurseries, Newport, R.I.): Have you found any chemicals which will hasten the germination of umbrella pine seed?

DR. BARTON: No, we haven't tried chemicals on it. About 50% germination is our average on it.

MR. A. M. SHAMMARELLO (A. M. Sharmmello & Son Nursery, Cleveland, Ohio): Will you discuss the germination of American Holly (*Ilex opaca*) seed?

DR BARTON: I wish you would ask me something about seeds we have had good luck with. We have tried chemicals, cold and warm temperatures, etc. So far the best treatment is to plant outside in the fall. A few seeds germinate the first year, more the second, and still more the third. Dr Nelson at the Brooklyn Botanic Garden has been studying the dormancy of holly seed by excising the embryos, that is removal of the embryo from the seel

MR. JAMES S WELLS (James S. Wells Nursery, Red Bank, N.J.): I understand that isolated trees often do not produce viable seed. Do you have any information showing a difference in viability of *Cornus florida* seed depending upon where it is gathered?

DR. BARTON: I have no information on that point.

MR. LESLIE HANCOCK (Woodland Nurseries, Cooksville, Ontario): Have you been able to correlate your scientific findings with the natural climatic conditions under which the plant grows in nature?

DR. BARTON: Well, I think for the low temperature pretreatment. the seeds that you most often think of as responding to that treatment are temperate zone plans. They are the plants that would normally have a cold period in the winter. However, there is more variation in the requirement for germination with different localities than you would expect. I will illustrate with southern pines. You wouldn't expect the Lombardy and the commercial southern pines to respond to treatment with low temperature, but they do respond much the same way as the *Pinus rigidida*. They will germinnate but they will germinate a lot better after low temperature treatment

In general, with the tropical seeds you are more apt to find seeds that will not tolerate drying out. They lose their viability in drying out. That is not so characteristic of temperate zone.

MR. WILLIAM FLEMER, III (Princeton Nurseries, Princeton, N.J.): I believe I have read somewhere that trees which have a wide, natural distribution such as, red maple which grows in Alabama and as far as north as Nova Scotia, exhibit no embryo dormancy in the southern part but partial embryo dormancy in the northern part. Have you any findings on the geographic origin of the seeds as related to dormancy?

DR. BARTON: I mentioned in the first part of the talk the effect of obtaining seeds of local origin I think it has been definitely established that the same species which has acclimated itself to a new region also changes its characteristics

DR STUART NELSON (Central Experimental Farms, Ottawa, Ontario): Recently, the Forestry Branch has recommended a 24-hour soak in water or sulfuric acid treatment for Colorado blue spruce seeds. The cold treatment has been eliminated from the recommendations. Will you comment on this recommendation?

DR BARTON: Since this has been reported in the literature, we have tried soaking seeds at a range of temperatures and for various periods of time. We have not been successful with such treatments.

MR. THOMAS S PINNEY (Evergreen Nursery Co., Sturegon Bay, Wisconsin). It has been reported that cold treatment without stratification will suffice for many pines and some spruce. Do you agree with this statement?

DR. BARTON: No. As far as dry storage is concerned, the viability of the seed will be maintained but dormancy will not be overcome.

MR PINNEY: What is your opinion of indoor versus natural stratification out-of-doors?

DR. BARTON: If you have sufficient cold weather out doors, stratification is just as good as indoors. The only exception to that would be if seed require only one month of low temperature, germination may occur and the seedlings killed by cold weather.

MR. C. H. HENNING (Niagara Falls Park Commission, Niagara Falls, Ontario): With alpines and conifers, does a snow cover have any influence on germination?

DR. BARTON: Snow cover is very good because it keeps the ground from freezing and thawing, thereby giving the seeds the low temperature needed to insure germination.

PRESIDENT SCANLON: Thank you, Doctor Barton, for coming to Cleveland to tell our members of your interesting and useful work on the problems of dormancy in seeds We hope that the meeting has been of interest to you

I am sorry to announce that our next speaker, Dr. Wendall Camp of the University of Connecticut, has been unable to come to our meeting today. Dr. Camp is now Head of the Department of Botany at Connecticut. He has had an illustrious career in botany and horticulture and is eminently qualified on the subject of Soil Mirco-Organisms. Louis Vanderbrook, our Vice-President and Program Chairman, is well acquainted with Dr. Camp and has gratiously consented to read his paper.

Mr Louis Vanderbrook read Dr. Camp's paper, entitled "Mirco-organisms in Soils and Their Action on Plants." (Applause).

## MICRO-ORGANISMS IN SOILS AND THEIR ACTION ON PLANTS

DR. WENDELL H CAMP
*Head, Department of Botany*
*University of Connecticut, Storrs, Connecticut*

When your amiable Vice-President some time ago asked me to talk to you about certain items which he had heard me discuss previously I agreed to do so with the understanding that I would not be restricted by the title, but would be permitted to explore certain other things pertaining to the general field of plant propagation and nursery production which would lead into my general topic.

In certain circles there is a growing feeling that the responsibility of the plant propagator ends when he has produced roots on the base of a cutting, gotten the seedling out of its seeds coats, or achieved some sort of union between stock and scion. It is encouraging to note from the program before me that this group still feels it important to get the material established in the field for, when one considers the whole problem, a plant cannot be said to have been successfully propagated until

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*Soil organisms.* A single ounce of good garden soil usually contains about 10 billion living organisms. Of these about 6 billion will be bacteria, with the remaining 4 billion scattered among the protoza (one celled animals), the algae (one celled plants), the fungi, and a wide variety of small multicellular forms in the animal and vegetable kingdoms which, to be here named, would add little but length to this general list. Fortunately for those of us who grow plants, relatively few of those 10 billion living organisms in every ounce of good garden soil can be classed as pathologically dangerous. The bulk are friends Were it not so, life as we understand it, would long ago have ceased to exist in our world.

It is only within comparatively recent years that man has become aware of the teeming life in good soils, yet since Adam gardeners unknowingly have evolved practices which favored a healthy and abundant soil flora and fauna, for only by so doing can the gardener achieve the success he deires with the plants he really is interested in cultivating

About twenty-five years ago many of our experimental scientists were so chemically minded that fertilizers consisted only of inorganic materials However, the good gardener, seemingly stubborn and set in his ways, wasn't easily stampeded and so still believed in old fashioned manures. Then there was a period when a group, mainly amateurs, swung their fertilizer pendulum over to what has been called the "organic phase" — and soon discovered that, under intensive cultivation, organic fertilizers some how were not enough. And now we are again back at the place where good gardeners long have been — to an ample supply of some sort of organic material, plus the requisite amount and balance of inorganic substances. And by so doing we have again established proper conditions for the healthy growth of soil micro-organisms, requisite to the good growth of our garden plants. As will be noted later there are evidences from the plant-fossil record, which goes back well over 500 million years, that this system has been in the natural scheme of things for a very long time; and it is not likely soon to change scheme of things for a very long time, and it is not likely soon to change, no matter how much more soil and plant chemistry we come to know.

*Conditions for propagation:* It would be a waste of time to discuss before this group the basic factors in propagation, for they are too well known to all of you. However, I should like to review a few to see if we can shed any light on certain practices. We all are now fully familiar with the fact that roots don't "just grow" on the bottom of a cutting, for there are root-inducing auxins or hormones responsible for this specialized plant reaction. The fact that these now can artificially be supplied has made the work of the propagator much easier. However, we still have problems where cuttings are concerned.

One of the problems always has been that of keeping the cutting from wilting until it has formed its own absorbing roots. We have sometimes tried sweat-boxes, but here conditions were such that certain pathogenic fungi sometimes got the upper hand. The surface appearance or feel of the rooting medium in a propagating bed often is misleading so that the right amount of water is not always available in the lower layers. To correct this situation tight benches with constant water levels have been tried, but this has not been much of a success under most conditions I have analyzed some of these set-ups and discovered several items, either of which dooms them to ultimate failure for all but a few types of material. In the first place the water level was usually maintained by an automatic device which added additional water as it was evaported from the bed itself and from the plants This water of evaporation was pure water, while that constantly being added contained the usual salts of our water supplies. The result was an increasing salt content of the water at the base of the plant so that is osmoic value was such that no self-respecting root primordium would develop, save under continual physiological protest and then only with difficulty. But, worse yet, the oxygen content of the static water in these beds fell far below the point where the basic physiological process of respiration was sufficient for what it should be for good growth, for respiration requires abundant oxygen The result generally was tardy and usually very poor root development.

I have tried a modification of this with considerable success in several of my pilot experiments This is to have a constant water level, controlled by a simple over-flow mechanism, but with the water always moving through the bottom of the bed, being injected at one end from a cock with needle-valve control In one such bed there was an especially fine root development of a variety of materials In analyzing the situation the most obvious thing was that the cock had been placed too high and its valve-seat not ground perfectly, so that instead of delivering a thin stream of water directly into the bed it was more like a fine spray falling about 18 inches into the collecting receptacle at the end of the bench, from there to trickle under the cuttings. The only difference betwen this set-up and the others was that the water, being in a fine mist and also falling through the air before entering the bench, was fully aerated In brief, while at a constant level, the water in this bench never suffered salt accumulation and always was full of oxygen. To reduce water loss from the cuttings, all series were covered with sheets of plastic on frames. But to me the really important factor leading to success in this particular bench was that the bases of the cuttings were supplied at all times with ample amounts of both water and oxygen

This basic principle was later applied to a much larger propagating unit with the same sort of success and with a much wider variety of cuttings. It does not require a large amount of water, but it must be fully aerated and anybody with the spirit of experimentation can devise some simple appartus for mixing the oxygen of air with the water used in such a propagating bed by agitation, bubbling, or some other means. I have long felt that the success some have had with propagation under mist lay not only in the high humidity of the air about the exposed tops of the cuttings but in the fact that the water trickling through such beds first had fallen as a fine mist and so was fully oxygenated. The relation of oxygen content of soils to root growth in crops plants has long been known Why it has not been more widely studied in relation to the formation and growth of roots on cuttings in propagating beds is something of a mystery. I do not here imply that oxygen can take the place of root-inducing hormones, but once their primordia are initiated the success of root growth depends largely on the speed of respiration, and this process is governed by the oxygen supply and is further regulated by temperature (bottom heat), so long as the cutting has ample available food.

Although we often proceed by rule-of-thumb in many of our cutting practices the food reserves in the cutting, or its ability to synthesize further amounts, often spells the difference between success or failure. To reduce water loss we often have resorted to dense shade over the cuttings. By so doing we did reduce water loss, but we often were starving the cuttings by reducing the light beyond the point where they could manufacture sufficient food to keep themselves going. Another factor pointing to the success of propagation under mist is that the house need not be shaded to the extent we usually thought necessary, thereby speeding up the synthesis of food in the cutting itself.

*Plastic-covered propagating units*: The basic food manufacturing process in plants — photosynthesis — does not occur in just any sort of light and sunlight is a mixture of various wave lengths of energy. Experimental evidence indicates that photosynthesis is most rapid in the blue-violet and red ends of the spectrum, and that it proceeds at a low rate or not at all in other wave lengths. And, as we all know, ordinary greenhouse glass is notable in excluding large percentages of the short rays at the violet end of the spectrum, and almost entirely cuts off the ultra-violet end of sunlight. Thus, on the basis of straight photosynthesis, ordinary glass is not the theoretically ideal covering for a greenhouse. Furthermore, there now are indications that there is an increased synthesis of natural plant hormones under the stimulation of ultra-violet light and, as noted, this our greenhouse glass almost entirely excludes. Therefore, no matter how one looks at it, our propagating processes always are somewhat behind the proverbial 8-ball when done under glass. This as much as anything has stimulated the search for glass substitutes for our greenhouses and propagating structures, that is, for substances which would have the insulating quality of glass but have a better light transmission factor, especially in the blue end of the spectrum. And I think, at long last, we are on the right track.

Much has recently been written and discussed regarding plastic-covered greenhouses. And, as always with a new topic, extravagant claims have been made for something new — perhaps only because it is new. Now there are plastics, and there are plastics. But so far in our tests only one type begins to meet the requirements which we would wish for both light transmission and durability, and this is Polyflex 230, supplied by the Plax Coropation, Box 1019, Hartford, Connecticut. Others of a similar formulation doubtless soon will be available from other firms At present it is furnished in rolls 42 in. wide and of different weights, from 5 thousandths to 20 thousandths inch thick. The thinnest seems to be too thin for general use, and I would recommend either the 10 or 15 thousandth inch thickness. One important thing, however, must be remembered. So far, in the first year of its use, it has been applied to structures of almost standard greenhouse design which, basically, have been designed for glass. The ultimate success of this plastic will depending on evolving a new type of greenhouse fitted not only for good growing conditions but also to the material. The application and fastening of the material has presented problems, but these will not be solved by trying to fit it into our concepts of traditional greenhouse construction. Here is where our imaginations will have to come into play.

For a propagating unit there is no point in constructing special chambers using this plastic inside a regular glass-enclosed unit, for by so doing we have defeated the basic function of this material — its special light-energy transmission qualities. We will have to start with a specially designed propagating unit, if we are using it for propagating, and in northern climates probably use two thicknesses with an air space between, for the heat loss appears to be somewhat greater than with ordinary glass when used only one layer thick. Plants grown under this particular plastic have a deep rich green color and a firm texture which one does not find in those grown under glass. But, I repeat, success with this type of plastic will come only when we have done a rather thorough job of redesigning our greenhouses and propagating units We can't put a 200 horsepower engine into an old surrey with fringe on top and think that we have achieved the ideal in automotive design.

As this is being written I am in the process of building (by commercial standards) a very small experimental propagating unit, old-style, with glass enclosure. But on my drawing board are the beginnings of a completely unorthedox design for a small, experimental propagating house, started from the beginning with the idea of using plastic. And, except for the slanting roof, it doesn't look very much like anything that any of us have ever seen in a propagating unit. But the point is, in the house using plastic I will be getting the short-ray end of the spectrum which I can't get under glass. The plants grown under this plastic are not leggy. They are compact and, having already been exposed to ultra-violet light, can be set directly into outdoor beds without "shock" once the weather is warm enough, thus eliminating an extra move which, under commercial conditions, can be a costly one. I predict that within a few years most of us will be using some form of plastic-covered propagating unit

*Seed beds for trees with heavy tap roots*: All of us who have propagated trees from seed have experienced the problem of transplanting, especially when they are sorts prone to the production of heavy tap roots with almost no laterals the first several years. Your Vice-President especially requested that I pass a special method of handling such materials on to you for, although I picked it up years ago from a forester, it seems not to have been widely circulated in the nursery trade.

There is nothing complicated about it for the whole set-up looks very much like an ordinary cold frame. There are, however, a few important modifications The pit or trench is dug to the necessary depth with the sides of the frame placed as usual. The necessary bottom drainage is supplied as always. Then ordinary copper window screen is unrolled and tacked along the bottom of the frame inside, forming a floor for the whole unit. Obviously, in constructing the frame it is best to adjust its width to the width of the copper screen available so that piecing is not necessary. A frame 3 inches narrower than the screen is ample, giving an inch and a half margin for turning up and tacking. To finish it off so as to be sure it is tight and rodent proof at the bottom, narrow battens can be nailed over the edges of the screen. The copper screen is then covered with your favorite seed-propagating mixture to the depth desired, usually about 8 to 10 inches, and the seeding done in the usual manner. Then the propagating frame is covered with quarter-inch or half-inch mesh galvanized screening. This can be tacked directly to the upperedges of the frame, but for ease in adding or removing mulch, or for weeding or spraying as needed, it is better to have this covering screen fastened to removable frames, under any situation making certain that the edges are tight. Thus, both at top and bottom one has a completely rodent-proof seed propagating bed.

However, the set-up as here described does not function merely as one which excludes rodents. The copper window screen at the bottom is the secret of its real success. When the seed germinates and drives its tap root deep into the soil the top of the root ultimately comes into contact with the copper screen, and the copper is just sufficiently toxic to kill the tip of the root but not the upper part Then from the upper part branch roots soon develop. Those then penetrate to the copper screen where, in turn, their tips are killed, forcing out additional lateral roots, and so on until the seedling has produced a bushy root system no longer than the depth of the soil above the copper screen. And if there is one thing the tree propagator wishes for a tree seedling it is a compact bushy root system.

Furthermore, if not overly crowded (and one easily can thin such a bed) the seedlings can be left alone for longer than in the usual bed since they never develop the overly long tap roots characteristic of so many of our horticulturally important trees. Also, in such a set-up one does not dig the seedlings for transplanting directly into the field. All one has to do is to flood the bed until the soil is thoroughly saturated and completely soft, so much so that the seedlings can easily be pulled up by hand with no damage to their root systems and far more complete than when spaded out.

It is obvious that this procedure would not be necessary with ordinarily shallow rooted types, but where one is dealing with those prone to the production of particularly heavy tap roots and few laterals during the first years of growth, the method has real advantages. The initial extra outlay is liquidated by eliminating the cost of at least one transplanting, and if the wood of the frame is treated wih a good preservative it should last long enough to become a real asset, the only care needed over a period of years being the necessary renewal or reconditioning of the soil before each planting cycle.

*Propagating mediums*: Fortunately there is one topic unnecessary to discuss with this group and that is the troubles one has with damping-off of seedlings and losses from rots and other diseases afflicting the bases of cuttings. Nor is it necessary to note that the ideal propagating medium has yet to be found. Regardless of our individual preferences for one or another type for special purposes, we still have to strike some sort of compromise each time we prepare anything from a single flat to a house full of benches.

When we stop to think about it there is something approaching the ludicrous about the conflicting demands we place on our propagating mediums. They must retain water, yet they must drain thoroughly and quickly, and they must "firm" properly when the cuttings are placed, yet they dare not pack tightly under continued watering. Here is our first great set of compromises for in both the tacit understanding that the medium must be aerated to the bottom is clearly enunciated. Lastly, and rightly, dreading the inroads of pathogenic organisms at the cut end, we have demanded that the propagating medium be sterile. Clean sharp sand, vermiculite, pearlite, shredded sphagnum, and our own pet combinations of these are the stand-bys. The sand, vermiculite and pearlite can be obtained in reasonably sterile condition But the oft-repeated statement that shredded sphagnum is sterile is strictly for laughs Bottom peat, while not sterile, is relatively free of living organisms, whereas the type of fairly fresh, top sphagnum, best liked by most of us, actually is teeming with organisms. What we should say is that such sphagnum, being highly acid, inhibits the growth of the bulk of pathogenic organisms, and so is reasonably safe to use, save in a few exceptional cases

The current trend toward propagating in sphagnum, often sufficiently fresh to continue its growth, or in a mixture of this sphagnum and sand, has some interesting backgrounds. Completely inert materials such as sand and pearlite often have rather wide and sudden fluctuations in pH, unknown to most of us, particularly if the water we use is at all alkaline. And such fluctuations are not good. The addition of an oragnic component such as sphagnum buffers the medium and holds these fluctiations in check Here in its buffering action is one of the reasons for our gradual shift to propagating mediums containing sphagnum. The fact that some of the sphagnum cells are so constructed as to retain water, while at the same time its coarse structure resists packing and so permits easy access of oxygen also are points in its favor. But the more I delve into the situation the more I am convinced that another reason for the trend toward use of raw sphagnum over other media for the propagation of certain things lies in the fact that the raw sphagnum is not sterile, but contains a rather wide variety of micro-organisms. And this is where I get right into the middle of the topic of my title.

*The friendly fungi:* Our battle with the organisms of disease is so constant that we have rather lost sight of the fact that there is a host of micro-organisms always willing to extend a helping hand to the propagator or gardener if he would but give them half a chance Here I will quickly pass by those organisms which constantly convert raw organic materials into substances which the plant is capable of assimilating, those which transform the nitrogen of the air into nitrites as well as those which convert nitrites, and the host of others with which the good earth teems. Passing by all these, for they are part of the common lore of soil science, I wish to go to a group of which so little is known that our ignorance of them is almost appalling. I refer to those fungi regularly and helpfully associated with the roots of the great bulk of our forest, field, and garden plants.

Pick up any standard text of horticulture or botany and look in the index for the word "mycorrhiza." And don't be amazed if you can't find it. If you do find it, don't be at all surprised if not more than a short paragraph on the subject appears on the page cited. Although European workers long have been concerned with these matters, it was not until recently that an American worker got sufficiently interested in the problem to summarize in book form in 1950, the world's scientific knowledge on the subject. This was done by A. P. Kelley in his volume entitled "Mycotrophy in Plants," published by the Chronica Botanica Company

*What are mycorrhizae?* Still entirely in the realm of technical language, this word "mycorrhiza" (or "mycorrhizae" in the plural) needs to be translated. Literally, it means "fungusroot" and connotes an association between the root or other underground structure of one of the higher plants with the strands of a fungus. It further connotes a mutually beneficial association, one which technically is known as symbiotic. So deeply are we ingrained with the idea that any fungus which penetrates the tissues of another plant must, by this act, be a dangerous enemy, that we have overlooked the great host of fungi regularly associated with the plants all about us, which do penetrate the underground parts of the plants, but which cause absolutely no damage. In fact in a number of proved cases, some of these plants could not exist without the aid of the fungus any more than the fungus could exist without aid from the higher plant. Here is where the symbiosis — the living together — principle comes in.

Although it is easy to understand that the non-green fungus plant derives at least some nourishment from the green plant, the question immediately arises as to what benefit the green plant, drives from the fungus which penetrates its roots, or in some instances its rhizomes First, when one turns to any horticultural or botanical text one usually discovers a long discussion of root hairs in relation to water and mineral absorption. But take a good look at any illustration of root hairs one can pick up. Actually they are outgrowths of normal epidermal cells, being active and functional only near the growing point of the root. If the illustration is a drawing, it usually is schematized and inconclusive. If it is a photograph, almost invariably it is that of a young seedling scarcely out of the seed coat.

In the young seedling root hairs usually are easily seen with the unaided eye But the truth is, if one gets down on one's hands and knees and digs about most carefully among the roots of mature trees and shrubs, or around the flowers and vegetables in one's garden, one can find plenty of young, growing root tips, but is not very likely to find a single root hair, even with the aid of a strong magnifying glass. You may find structures which you think are root hairs, but if you will take the trouble to make special preparations of these roots ends, sectioning them no thicker than 8 or 10 thousandths off a millimeter on a precision cutting apparatus and then stain them with special dyes, under a good microscope one then often discovers that what were thought to be root hairs actually are the minute strands of a fungus associated with the root of the green plant.

In brief, although the seedlings of nearly all of our green plants do have functional root hairs, as they get older many seem to lose the ability to produce these structures and so must rely on the associated fungi to transfer to them the water and minerals necessary to their well-being. In certain intances it has been demonstrated that the green plant has somehow lost the ability to produce the hormones necessary for active root growth, and relies on the associated fungus for these important substances. And in a few plants there are indications that the green plant, although capable of manufacturing and storing starch has in part lost the ability to redigest it in the underground storage organs and make it again available to itself in times of food shortage, apparently the only reason that such species are still around is because they long have had a fungal associate inside their tissue which does have the ability of producing and secreting the enzymes necessary to digest this stored starch Of course the fungus takes a nip of this available food, but it is apparent that when digested there is plenty for both organisms

There is a great temptation at this point to go into the complexities of this curious association of two quite unlike sorts of plants. But Nature is so varied and her complexities so great that I would consume both your patience and time even to scratch the surface of this part of my topic. It is here important only to understand that a very considerable number of our wild and cultivated plants do have this sort of association. And while I would not imply that it always is a necessity for the well-being and growth of the green plant, we now have enough known examples of obligate mycorrhizal associations among our horticultural materials that it no longer is wise to ignore the situation.

*Distribution of mycorrhizae among plants*: It is a safe thing to say that mycorrhizae are widely distributed among the world's plants They have been found among the liveworts and mosses, in the roots and rhizomes of many ferns, and throughout all underground parts of the lycopods or "Christmas greens" The roots of cycads and conifers long have been classical examples of mycorrhizae. This is no new thing in the group for careful examination of the fossilized ancestors of the conifers which existed hundreds of millions of years ago, at a time when the Coal Measures of the Palezoic were being laid down, clearly indicates that already their roots were supplied with mycorrhizal fungi, just as they are today. And there is scarcely a group of flowering plants among the monocots or dicots which when carefully examined has not yielded clear evidence of this association in at least some if not all members

Climatically, mycorrhizal associations have been found in plants from the equatorial jungles to the last rocky outpost in Arctic regions. So far as soil types are concerned, there seems to be no limit to their distribution. Here, however, there is a curious situation. Many plants regularly occurring on acid soils are known to be unable to produce fully formed or functional root hairs in highly acid media under experimental conditions. We suspect in such instances contact with the mycorrhizal fungus must be made in nature soon after germination of the seed. Such groups as the Heath Family seem to be especially notable in this matter. European growers who raise much of their Calluna and Erica material from seed make it a general practice to incorporate soil and mulch from their established heather beds with their seed bed mixture. The usually much better germination and early development of rhododendron and azalea seedlings on relatively fresh or undecomposed sphagnum points in the same direction, for a sphagnum swamp usually also supports a variety of plants of the same family requiring the same sorts of fungus associate, and these fungi would be in the upper layers of the bog.

The foregoing regarding frequency of mycorrhizal associations in acid soils does not imply that they do not occur in alkaline types. In our alkaline soils of the Great Plains mycorrhizae are abundant, being widespread, even among the grasses. Among the legumes, everywhere abundant in this region, the root nodules with their contained nitrogen-fixing bacteria are a prominent feature. What is not generally known is that these same leguminous plants also are almost always associated with mycorrhizal fungi. It never has been studied, but my guess is that, much as in highly acid soils, the delicate root hairs of these plants find the going a little too severe in these highly alkaline soils and have given up in favor of the fungi with their more elastic cell walls and considerably more rugged protoplasm.

As one would expect, mycorrhizae are abundant in soils rich in organic material, the natural medium for fungi. However, they are curiously abundant on the roots of those plants growing in the most sterile of sands. Here the fungi might perhaps be classed as partial parasites, for almost all their food comes from the green plant; but they are not parasites since the fungus associate act as the actual absorbing system of the green plant, and in certain instances appears also to furnish root-growth hormones. Pine plantations, occasionally in this country but more often in the southern hemisphere where pines do not naturally occur, have, at times on poor soils, seemed doomed to failure until the soil about the trees was inoculated with the proper fungi. This is not a complex operation, consisting merely of taking soil from under a vigorous pine and, without letting it dry out, placing small trowels of it near the young trees and just under the surface of the soil in the unthrifty plantation. Now this may sound very distant and quite unassociated with our every-day nursery practices. But, as I will soon point out, we do precisely this same thing every time we ball-and-burlap a plant either for moving in the nursery or for sale, for the plants which we regularly move with a good root-ball, no matter what the season, are notable for their obligate mycotrophy or, in less technical terms, for being unable to thrive unless their roots are associated with at least one of these "friendly fungi."

*The roadside market and mycorrhizae:* At first glance there would seem to be no connection between my topic and roadside garden markets, every year becoming more abundant. But a curious thing is happening. These roadside outlets, whether directly connected with an established nursery, with one which carries only a few rows of growing-on stock, or whether it buys all its material directly from wholesale nurseries, all have one problem in common. They can't predict either the weather or the vagaries of customers on any particular day or week-end. As a result few items are left to be kicked about with bare roots, instead when offered they are prepared B & B or in containers so that they can be held for an indefinite time, with only an occasional watering. So much for the selling end.

Then along comes Joe Blow, out for a drive with the Missus and the kids, who just happened to stop to "look around" Joe has had experience buying plants for his little paradise in the treeless flatlands of Suburbia and looks with a jaundiced eye on nursery materials. After all, he hasn't had much luck with the stuff he has bought in the past from a couple of mail-order houses. Whether he knows it or not Joe's yard consists largely of raw mineral soil dug out of his cellar hole, and covered wth a thin veneer of material dubiously called "top soil." Joe isn't much of a plantsman and what he has done in the past is to dig some sort of indifferent hole, stuff his mail order bush into it, and slap the dirt back, with maybe a dribble of water on top for good luck With the proper know-how, Joe might have saved most of these mail-order plants, lacking it, all but the forsythia were lost. But in the roadside market his Missus has convinced Joe that he should buy a blue spruce, a small azalea, and a couple of rose bushes. Loading these into the back seat with the kids, Joe goes home, digs holes in what passes for a lawn, takes off the wrappings and drops the stuff into the holes and slams as much of the dirt as possible back in with them And, curiously enough, these plants often thrive

Now I would not here cast either aspersions or stones at the legitimate mail-order nursery business. It has its place, but it is operating under certain definite handicaps, so far as assured success of the material is concerned when planted. The newer plasticc-coated wrappings have helped a great deal in getting material to the customers in good condition. But the parcel post nature of much of this business demands that the plants be sent not only bare root but these trimmed to the quick. Thus the plants were delivered essentially devoid of their associated mycorrhizal fungi, for these occur primarily with the growing ends of the roots, the part cut off before shipment, or dried out in transit.

In contrast, the material at the roadside market, with its burlap wrapping, was lifted from nursery soil already abundantly supplied with the proper culture of fungi and necessarily kept moist In the case of those plants in containers, the soil preparation might have been supervised by a nurseryman with some training, and while it may not be the best soil in the world, it still is far better than that in Joe's yard and even is likely to have been so mixed, perhaps by accident, that it also contains an assortment of mycorrhizal fungi, one or several of which may already have set up housekeeping with the plant in the container. Thus the roadside market, with its emphasis on B&B and container materials not only supplies a bit of soil suitable to the plant, which usually is lacking in the average suburban yard, but at the same time almost automatically delivers a culture of the requisite fungus, should it be the type of plant which requires it. Now this is a very roundabout way to get at an idea but it points up a thing of increasing importance in the nursery business — the need to get more and more of our materials to the customer with a reasonable sample of the soil in which the plant was grown, and in which the proper micro-organisms are present.

I am fully aware that old, experienced nurserymen are going to raise their eyebrows at all this and legitimately ask the question. If this is so important, why was it not known and practiced in the past? Now it so happens that an established nursery is about the last place in the world to discover the acute need of certain plants for their fungus associates. In the first place, a nursery rarely is established on poor sterile soils devoid of organic material And if there are deficiencies, the first thing done is to correct them. Finally, through exchange of stock, every nurseryman, quite unknowingly, has built up a veritable living museum of otherwise often quite rare mycorrhizal fungi which are spread throughout the place not only by shifting plants, but by machinery and others means, even on the boots of the workmen. This explains why certain plants can easily be shifted from place to place in the same nursery, or taken from one nursery to another with but little loss, but are notoriously difficult to establish as bare-root transplants in the average suburban yard.

Looking at the thing in perspective we also will have to adjust ourselves to present conditions. There was a time, not so long past, when the ground is less disturbed during house construction, and when the phrase "top soil" meant something to a building contractor. With the advent of the bulldozer in cellar digging and final grading what one usually finds for soil when planting a yard would be as great a puzzle to the soil scientist as to the gardener. To the nurseryman accustomed to bare-root planting of the bulk of his material, it often is a baffling problem. On a guaranteed contract job the best thing to do is to dig the proper size hole and fill in with good soil. But if you're selling retail to Joe Blow the Suburbanite, there is no point in explaining to him how to dig the hole, put some well rotted cow manure in the bottom and then fill in with good garden soil as the plant is set. In the first place Joe doesn't keep a cow, and doesn't know anybody who does. And as for "good garden soil" he doesn't have it, and wouldn't know it if he saw it.

However, as pointed out earlier, in order to maintain and protect his stock in a roadside garden market, the retail nurseryman without knowing it has taken the first step in achieving better success under the trying planting conditions which now so often confronts us. This first step is to supply the bulk of our materials either B&B or in containers already growing in a reasonably ample amount of the proper soil, at least sufficient for primary establishment of the plant, and also with the required mycorrhizal fungi if the plants be those which require them.

*From bed to pot*: Now if in all this gabble about merchandising and customer relations, I seem to have lost sight of another of the propagator's problems you are mistaken. While you were busy stooping over your propagating benches probing into their innards for the first signs of young white roots at the base of the cuttings, we merely sneaked out for a little business talk and a couple of quick ones with our old friend "Mike O'Rhisa" Let us now suppose that, in the meantime, the cuttings or seedlings have come along and are ready to be potted up. Currently, few of us would think of exposing these young tads to the dangers lurking in unsterilized soil. And so we get our supply of clean flats or in the case of cuttings an ample supply of 2-and-a-quarters or even 3's and go to work, after moving over to the bin of thoroughly sterilized soil. Talk to an old propagator and usually you will discover, while he freely admits that he doesn't have quite so much trouble with damping-off and similar ailments as he used to experience, the plants don't seem to take hold quite so well or look so well on the bench as they did when potted up in soil wheeled in directly from the old-fashioned compost pile, sifted, and used just as it came Pressed for detail, the Old Boy will admit that this statement is not true for all items, but he will grumblingly maintain that for some things they just don't start off like they used to in the good old days when propagators also were gardeners and still smelled of manure And for some things the Old Boy is right.

In completely sterilized soil, no matter what its texture or feel and no matter what synthetic fertilizers it contains, there still are none of the normal soil micro-organisms slowly converting the raw organic materials into substances usable by the plant. There are no bacteria supplying extra amounts of vitamin $B_1$ to nearby roots. And, unless already infected in the propagating beds, there are no living fungi to start a healthy, normal mycorrhizal association. And it takes a long time for the soil in a pot inside a greenhouse to acquire a supply of such organisms, travelling in as they must on flecks of dust or by wind-blown spores And when they do come in they are not all present in a community of organisms living in biological balance in that soil There are no organismal checks and balances and the first to arrive may, by unlimited growth, produce an unbalanced soil condition which, while it may not be pathological, may still be undesirable. Fortunately it will not be long until these young plants will be placed outside in nursery beds where natural conditions prevail and so ultimately will hit their normal growth stride

Now I would not for a minute say that we should throw away our soil sterilizers, nor would I necessarily advocate going back to the expensive and time consuming construction and maintenance of the old-fashioned compost pile. But what I do say is that we should be looking forward to the time when we know what constitutes a proper balance of essential micro-organisms for "healthy" soils and introduce cultures of these organisms into our regularly sterilized potting soils, just as we do certain bacteria when we plant legumes.

Today there is no place where one can obtain such cultures, and for the simple reason that nobody knows exactly what the organisms are, let alone how to produce them in mass culture. But I maintain that here is a field of research for our scientific experimenters in horticulture which will yield returns far beyond many projects being worked on today.

The mycologist, the botanical student of fungi, has been very remiss, for as yet he knows almost nothing about which fungi are associated with which green plant in the various mycorrhizal associations. All we can say is that we suspect that the more common of our fungi often are responsible We do know that, in the main, the mycorrhizal fungi of our garden and field crops usually belong to different groups from those associated with our woody materials. Nor do we know how specific the relationships really are. What we suspect is that in various instances different kinds of fungi are capable of forming mycorrhizae on the same species of green plant What I personally suspect is that in certain soil types particular species of fungi are more efficient as mycorrhizal associates than others. Lacking a certain fungus a species of green plant seemingly gets along as best it can with other species of fungi which may happen to be avavilable. But in the long run, this would not seem to be the most efficient way to grow our plants once we know more of these intricate biological associations.

Looking some distance into the future one can envision a potting bench stocked with various types of sterile potting mixtures Nearby on a shelf will be a series of containers holding cultures of living microorganisms. By experimentation it will have been discovered that certain combinations of organisms with a certain soil mixture yields the best results for magnolias when potted out of the propagating bench The same soil mixture with another culture may work best for beech (the same combination likely will be used for oaks and chestnuts if one is doing other than seed propagation). Still another series will be used with the heaths, the rhododendrons and azaleas and the rest of their kin, and so on This all may seem unnecessarily complex, but one never should predict too far ahead just what competition in a field will do toward forcing ever more efficient methods of production. Let us recall that there once was a time when a 50% loss at the first transplanting was taken in stride by many nurserymen. Today such losses, if continued, soon would throw many nurseries into bankruptcy.

And so, in conclusion, it all boils down to two basic questions. What is the most ellicent and economical way to produce the various plants with which the propagator and nurseryman must deal? And, how can these materials be best brought along in the field and delivered in a satisfactory manner to the customer? It is unnecessary to tell you that the answers to these questions are not simple ones. They involve a series of exceedingly complex biological and economic siuations. Today I have touched on only one phase of the problem. I have chosen this phase, not because we fully understand its importance, but simply because we don't know how important it yet will prove to be.

Let us truthfully admit that the bulk of our standard horticultural materials in the trade today are common and widespread primarily because they are easy to propagate and grow in nurseries, yet in many instances these do not represent the potentially best ornamental materials in their groups. The problem seems one primarily of learning how better to propagate and grow these other materials. Perhaps it is only learning which mycorrhizal fungus to supply some of these plants This would seem to be a very simple thing to ascertain. But it may be more complex than we suspect for it probably also involves learning just what type of soil as well as other soil organisms the necessary fungus will tolerate. This we have had to learn the hard way with our rhododendrons. In all of this there is, however, a note of comfort for the experimentally minded plant propagator. The latest publication on plant propagation, just off the press, has not told the whole story. There is much yet to be learned, and we will not soon work ourselves out of jobs.

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PRESIDENT SCANLON: Thanks, Louis, for doing a fine job in reading Dr. Camp's paper. It is not the policy to have papers read by other than the writer, however, in this instance we thought that the information warranted the deviation of our policy.

The session recessed at 12:00 following several comments by various members of experiences relating to points in Dr. Camp's paper.

# SATURDAY AFTERNOON SESSION

## December 1, 1956

The final session convened at 2:00 p.m., President Scanlon presiding.

PRESIDENT SCANLON: The first speaker this afternoon will be Dr. J. P. Nitsch, Department of Floriculture and Ornamental Horticulture, Cornell University, Ithaca, New York. His subject is "Light and Plant Propagation."

DR. J. P. NITSCH: May I first say how pleased I am to be with you again this year. I enjoyed my first meeting with you last year and am quite pleased to come again. Secondly, I feel quite honored to have become a member of this Society.

Dr. Nitsch presented his paper entitled "Light and Plant Propagation." (Applause).

## LIGHT AND PLANT PROPAGATION

DR. J. P. NITSCH
*Department of Floriculture and Ornamental Horticulture*
*Cornell University*
*Ithaca, New York*

The subject of "Light and Plant Propagation" is a very broad one, as you well realize, so I will have to limit myself to some aspects only of the effect of light on plants.

Every one of us knows, of course, that plants need light in order to grow. We should also be aware of the fact that plants are much smarter than we are, in that they capture light energy and use it to synthesize many complicated chemicals which the best chemist can possibly obtain only with high temperatures and very complicated apparatus. As a matter of fact, we should realize that, without the plant and without the energy it receives from the sun, life on this planet would be impossible.

### I — PHOTOSYNTHESIS

The process by which green plants use light energy in order to synthesize chemicals from water and the carbon dioxide of the air is called "photosynthesis." This process requires a relatively high level of light energy. This energy, which normaly comes from the sun, can be replaced by artificial light. Plants have been grown to flower and fruit in rooms without any sunlight whatsoever.

There are three major difficulties in using artificial light for adequate photosynthesis in higher plants at the present time Firstly, it is difficult to manufacture light sources of intensities approaching that of sunlight. Carbon arc and mercury vapor lamps are among the sources which can give the most intense light. However, and this is the second difficulty, the composition of the light which they produce does not match exactly that of sunlight. This is an important point, as we will see later. It is, necessary, therefore, to use a combination of different types of artificial light to obtain a somewhat balanced "spectrum." Thirdly, the cost of growing plants under completely artificial light is prohibitive One of the cheapest combinations, published in 1937 by Arthur and Harvill of the Boyce Thompson Institute (2), consisted of four 10,000 lumen sodium vapor lamps, mounted in the form of a square, 2 feet on a side, with a small 85-watt capillary mercury arc lamp placed in the center of the square. Good results were obtained when the sodium vapor lamps were left on 24 hours and the mercury lamp turned on 2 hours each day. Such a combination was estimated to cost at that time 3c a square foot a day Other installations, involving banks of fluorescent tubes supplemented by a few incandescent bulbs are in use in the "Phytotron" at the California Institute of Technology, Pasadena, California, but only for research purposes.

For all these reasons, I will not talk today on artificial illumination as a substitute for sunlight. Rather, I will limit this exposé to the use of artificial light as a *supplement* to normal sunlight. For the action of light is manvfold. Light does not only provide the bulk of the energy necessary for plant growth. It also acts in a more subtle manner to regulate this growth. It is in this connection that, I think, nurserymen can use light to advantage.

## II — REGULATORY EFFECTS OF LIGHT

In contrast to photosynthesis, the regulatory effects of light are obtained with low intensities, that is intensities which are barely above that given by the full moon on a bright night Let us review briefly the various types of these light effects.

1) *Light and seed germination.* We are accustomed to bury slightly seeds into the soil in order to germinate them and, therefore, think that seeds do not need light for germination. Now we have heard this morning that seeds of various trees and shrubs, including conifers, need a preliminary cold treatment. This treatment is of the order of two months duration. I may astonish you by saying that this treatment may, sometimes, be completely omitted, and that two hours of light may replace two months of stratification Let us take three examples. The first one concerns birch seeds. Both Black and Wareing in England (3) and Vaartaja in Canada (13) have reported that *Betula pubescens* and *B. verrucosa* can germinate at 20° C (68° F) if they are given light (about 300 ft. c.). Continuous light seems to yield the best results. These same seeds, when germinated in the dark, need about a month of pre-chilling at 1-4° C. Recently, Toole and co-workers (12) have shown that unchilled seeds of Virginia pine (*Pinus virginiana*) do not germinate in total darkness. When these same seeds are first moistened, left for one day in darkness at 5° C (41° F), then exposed to red light, and returned to complete darkness, they will germinate very well at 25° C (77° F), poorly, however, at either 20° C (68° F) or 30° C (86° F). The third example is taken from the work done at Cornell University by Mr. S Waxman (16) on the germination of *Sciadopitys verticillata,* the umbrella pine. These seeds are difficult to germinate and take

many months to come up. It was found that daylength markedly influenced the germination of these seeds left uncovered, under mist. However, the effect was inverse to that reported for birch seeds, in that the short daylengths (about 9 hours of light) promoted germination, whereas long days (18 hours or more of light) or continuous light inhibited it. In fact, Mr Waxman found that if about one hour of incandescent light was given around midnight to cut the dark period into two moieties, germination was delayed. If these preliminary results can be confirmed and extended, they will constitute the first case of seeds acting like "short-day plants," that is, in which germination is promoted by short days but inhibited by long days.

2) *Light and rooting*: After seed germination, the second item of interest to the plant propagator is the rooting of cuttings. Several people have studied the regulatory effect light can have in this case Recently, Snyder (10) published the results he has obtained with *Taxus*. Sarting with dormant cuttings taken from November to January, he found that daylength had no effect upon rooting itself, but had a clear-cut influence upon bud break. An 8-hour day kept buds dormancy, whereas an 18-hour day caused them to grow out. In this case, the retardation of bud break was beneficial, because the cuttings without new growth survived better transplantation into the field. On the contrary when using softwood cutings taken from dogwoods in full growth in June, Mr Waxman (16) obtained a very beneficial effect of long days upon rooting. All the cuttings rooted under mist, but the number of roots per cutting was larger under long days than under short days These results may be of general interest to nurserymen because they emphasize the importance of timing, which many speakers have stressed, in preparing softwood cuttings Cuttings made in June will root faster and more abundantly than cuttings taken when days are shorter Of course, other factors may modify the validity of this statement in the practice For example, it may not be feasible to root certain softwood cuttings in June because they are too soft. On the question of the quality of the additional light that may be best to increase rooting, I may refer you to the studies of Stoutemyer and Close (11) who found that, in the case of *Ligustrum ovalifolium*, for example, pink light was better than white light, and white light better than blue light, when equal intensities were used

3) *Light and flowering*: One of the best-known regulatory effects of light is the control of flowering in certain herbaceous plants. In the case of woody materials. much research has yet to be done Experiments at Cornell on *Weigela* showed that flowers appear first on plants grown from cuttings under 24 hours of light, then on those under 21 hours, then under 18 hours, then under 15 hours, finally on plants grown under 9 hours plus one hour of light in the middle of the night. On large pink flowering dogwoods, flower buds were produced eventually on slow-growing side-shoots under all treatments. Long days (18 hours) given during flower initiation produced leaf-like bracts, they caused elongation of the peduncle when given during flower opening (16).

4) *Light and vegetative growth*: Most striking was the effect of daylength on the vegetative growth of certain species. As reported last year, long days stimulated certain species such as *Weigela, Cornus florida* and *Viburnum opulus* to grow continuously, whereas short days (less than 13 hours) brought growth to a stop and induced dormancy There seem to be several ways in which dormancy is brought about. In all cases, growth in length of each shoot stops This is apparently all that happens in *Weigela*. But in *Populus* or in *Viburnum opulus,* for example, the young leaf primordia, instead of developing into leaves, become scales which enclose and protect the terminal meristem. In other cases, such as that of catalpa which was reported by Downs and Borthwick (8), and that of the staghorn sumac (*Rhus typhina*) which I have observed this year, the onset of dormancy is accompanied by the abscission of the very tip of the shoot.

5) *Light, fall colors and leaf drop*: Long days retard the development of fall colors and also leaf abscission, keeping the leaves green You may have noticed this on trees growing near street lights. At Cornell, I have observed it during this warm fall on elm (*Ulmus americana*), red oak (*Quercus borealis*) and maple In each case, branches under street lights had still green leaves on November 5 The other branches of the same trees had no more leaves ( in the case of the elm) or yellow leaves that were falling (in the case of the maple). This effect can be obtained experimentally, as shown by the dogwoods grown by Mr Waxman (16), the leaves of which turned red and dropped much earlier under short days than under long days, even when the night temperature was lowered to 40° F.

All the above-mentioned examples show how varied the regulatory effects of light can be. Let us now examine in somewhat greater detail the effect of light on vegetative growth in woody ornamentals.

## III — SPECIAL STUDY OF THE REGULATION OF GROWTH BY LIGHT

By "growth" is meant here the increase in size of the plant by both an increase in the number of nodes and leaves produced, and a lengthening of the internodes

1) *Timing and quality of illumination*. The effects on growth which I have described are all obtained with a light of relatively low intensity which supplements a day of normal sunlight. In this situation, two points are of particular importance: the time at which this supplementary light is given and its quality.

a) *Timing*: One can get just about the same growth in height by subjecting a *Weigela* plant to a natural day of 16 hours or by giving it 8 hours of sunlight plus 8 hous of artificial light of much lower intensity. This indicates that it is the length of the day and not the intensity of the light which is the decisive factor in this case. Also, if we supplement a basic 8 hour day of sunlight with 7, 10, 13 hours of artificial light, we can observe that the height of *Weigela,* dogwood or *Viburnum opulus* plants progressively increases with the length of these light periods. There is a limit to this, however. In several cases, it was found that giving no night at all was detriemental, that is a 24-hour light period gives less growth than a 20-hour light period (at least when using incandescent light). Actually, it is not so much the length of the day than the length of the uninterrupted dark period which is the decisive factor. This can be demonstrated by cutting a long night in its middle by a short period of light Thus, a *Weigela* plant does not grow under a 9-hour day, but, if the night is interrupted in its middle by an hour of light, then it will grow as well as if it had received about 15 hours of light In both cases, the periods of *uninterrupted* darkness are similar (7 and 9 hours). On the contrary, if the extra hour is given immediately following the 9 hours of light, so as to make 10 hours of light and 14 hours of straight darkness, then the *Weigela* will not grow. Any uninterrupted dark period longer than 12 hours will cause it to become dormant. Physiologists try to interpret these observations by assuming that a sort of chain-reaction, ending in the formation of a growth-inhibitory principle, takes place during the long night During the first part of the night, the first links of this chain are made. These are sensitive to light and can be destroyed by it. Towards the end of the dark period, the first compounds are transformed into different ones which are not destroyed by light any more The first steps of the chain-reaction must be very sensitive to light for a very short light-break can offset the effect of a long night. In the case of shrubs, we have found that 30 minutes of light to 20 ft. c were just as effective as 1 hour. One could probably go much below this value. *Viburnum opulus* did not seem to respond well to a one-hour light-break when the night temperature was 50° F, but did respond when it was 70° F. (16). This indicates that temperature may modify the effectiveness of the light-break treatment.

b) Light quality: The type of light used is important also. Following Dr. Borthwick's experiments on the flowering of the cocklebur (4), red and far-red lights have been tried in a light-break studies What I call "far-red" is a light which is beyond the bright red in the light spectrum, towards the infra-red region. It has a wavelength of about 7,200 angstroms It was found that red light interrupting a long night caused growth and flowering in *Abelia grandiflora;* far-red light did not cause any flowerinig and supported only a small amount of vegetative growth. In addition, ½ hour of far-red light reversed completely the promotion of flowering caused by ½ hour of red light, provided the far-red light was given immediately after the red light (16).

Light quality is important not only in the case of the light-break I have said that supplementing with artificial light an 8-hour day of sunlight is as effective, as far as growth in height is concerned, as subjecting the same plant to 16 hours of pure sunlight. This depends on the quality of the supplementary light In this respect, incandescent light is much more effective than mercury light, in fact, it is even more effective than sunlight itself as shown by Roodenburg in Holland (9). This effect of incandescent light has been traced down to its content of far-red light. Thus, Downs (6) at Beltsville caused bush beans to elongate like pole beans by supplementing long normal days with far-red light. On the other hand, the Dutch workers Wassink and Stolwijk (15) have observed that 4 hours of violet, blue or far-red light added to 8 hours of sunlight caused lettuce plants to elongate as if they were going to flower. Green, yellow or red supplementary light was inactive. The opposite was found in the case of spinach in which violet, blue and far-red light inhibited flowering and kept the plants in the rosette stage. No doubt, one will have to do much more work in the field of light quality in order to understand all these effects.

2) *Types of plant responses*: This last example brings up the fact that different species respond differently. I think that we could avoid confusion by trying to classify the plant responses into different types, such as the following ones (which are, of course, very tentative):

a) The response to long days is continuous growth: This seems to be the case of various dogwoods (*Cornus florida, C. kousa*), of *Weigela, Viburnum opulus, V. Carlesi, Populus, Salix repens, Thuja occidentalis,* etc. In these cases, an 18-21 hour day seems to be better than no night at all, except for *Salix* and *Populus*, *V. opulus* and *Thuja* which grow well under vontinuous light. With Professor Chouard in France (5), we might distinguish in this group two sub-sections according to their reactions to short days, namely: that of plants which stop growing completely under short days (all of the above-named species, except, *Thuja,* and that of the plants which grow continuously, although at a very much reduced rate, even under short days, such as *Junipers horizontalis* and *Thuja occidentalis* (16)

b) The response to long days is growth in spurts: We have observed this sort of growth on red oak seedlings. The plants seemed to beome dormant after having produced the first leaves. A few months later, however, a second flush of growth occurred, under long days only Three such flushes of growth could be obtained on some of the seedlings in one year (16). Similar results have been reported by Downs and Borthwick with the Scotch pine (8).

c) Long days cannot prevent the onset of dormancy Lilac, boxwood, *Viburnum prunifolium* do not seem to grow much more under long days than under short days. Long days may somewhat retard the onset of dormancy in lilac but, sooner or later, the shoots stop growing, bud scales are formed. Only a cold treatment will start the buds growing again.

d) Long days are detrimental to growth· If you try to grow a tomato plant under continuous light, it will die (1). It is not quite clear if this is an effect of the length of the day as such or if it is due to the type of artificial light used to supplement the normal day. In anv event, certain plants do not thrive when the lights are left on continuously at night. *Weigela*, for example, grew less under 24 hours of light than under 18 hours (16).

3) *The locus of light perception*: Which is the part of the plant through which light exerts its regulatory effects? An obvious possibility is the foliage. As I have indicated, a *Weigela* plant does not

grow whatsoever under 9-hour days. Now if one removes all the leaves, one will observe that the tip of the shoot will start growing, producing new leaves. When these leaves reach about their full size, growth stops again. By removing the leaves as soon as they reach about ¾ of their mature size, Mr. Waxman was able to keep *Weigela* plants growing for over two months under short days. After the plants had exhausted all their food reserves, however, they suddenly collapsed. It is interesting to remark that old leaves have a very reduced effect and that a *Weigela* can be kept growing for a few months under short days by removing only the young leaves when they are ½ - ¾ of their full size (16.) These young leaves, therefore, seem to be the active receptors through which light exerts its effect on growth. Another experiment also illustrates the controlling effect of leaves. It deals with the growth of axillary buds when the terminal of a dogwood is removed. You know very well that, when the tip of a shoot is broken, the nearest lateral buds develop This is true with dogwoods grown under long days, but not under short days. In fact, when the whole plant is kept under long days, if short days are given to a single top leaf, this one leaf may be sufficient to inhibit the growth of the nearby axillary buds (16). Not all plants respond in this manner. In *Betula pubescens*, for example, the light-sensitive organ of the plant may be the terminal bud itself (14).

## III — POSSIBLE PRACTICAL USES

As you can see, the mechanisms through which light works are rather complicated and may vary from species to species in their details. You will also realize that much more fundamental study on the basic mechanisms involved is necessary. May I merely point out certain problems which may be of direct interest to you.

1) *How to keep growing a plant that is growing*: If you make a dogwood cutting in June or July and leave it exposed to the natural daylight conditions, it may make a few inches of growth possibly but, rapidly, it will stop growing and stay in a dormant condition until May of the following year. If you want to keep it growing, you may supplement the normal daylength with incandescent light, so as to give a total daylength of 18 hours throughout the fall, winter and spring. Of course, this necessitates the use of a greenhouse kept around 70° F. The following August, you will have a tree five to six feet tall, whereas the cutting left under natural days will be only one foot tall.

2) *How to cause a dormant plant to grow*: The previous example concerns plants that are actively growing. If you have plants that have already stopped growing, the story is different and varies according to various factors, such as the presence of reasonably young leaves. Let us distinguish two main cases:

a) The plant has good leaves on: You can get it to grow again, even under short days, by defoliating it. I very well remember horse-chestnut trees in my home town, Mulhouse, France As a boy, I used to go to the out-of-doors market with my mother. After a hot and dry summer, most of these horsechestnut trees would have yellow leaves or practically no leaves at all. In late September, after a rain, these trees would grow green leaves and bloom, as if it would be spring. Of course, if you defoliate the plant and leave it under short days, it will soon stop growing again. It is necessary to give it long days to keep it growing. If you place a leafy dogwood which has become dormant under long days, it takes about two weeks, as found by Mr. Waxman, to get it to grow again.

b) If the plant has no more reasonably young leaves on, or if it has shed all its leaves in the fall, then two cases might happen In the first one, which seems more general, only an appropriate cold treatment will bring this plant out of dormancy This is the case for lilac and catalpa, at least in the fall. Other species, such as the European beech (*Fagus sylvatica*) will break buds and start growing without any cold treatment, if they are subjected to continuous light

3) *How to induce dormancy*: In the practice, we do not grow trees indoors, but out-of-doors, and the winter would soon kill tender growth. It is necessary to know when to stop the long-day treatments in order to induce hardening and dormancy This study has barely begun. In the case of the pink dogwood, it was found that already two weeks after having shifted the plants from long days to short days (9 hours of light), growth had completely stopped (16). But defoliation and the formation of good scales to protect the buds in various species would take longer. Experiments are in progress at Cornell along this line.

## CONCLUSION

Do not mind the chaotic situation in which the study of regulatory effects of light seems to be today. So many new facts are discovered each year that it is difficult, sometimes, to understand why a given treatment works in one case, but does not in another It is simply a new field which is growing up. It is an exciting one, and I hope that you will share the enthusiasm of the research men who are working in it.

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PRESIDENT SCANLON: I think we will proceed with the report of the activities of the Field Trials Committee. This report will be made by the chairman, Dr John Mahlstede, Department of Horticulture, Iowa State College, Ames, Iowa.

## REPORT OF FIELD TRIALS COMMITTEE FOR 1956 — PHOTPERIOD STUDIES

JOHN P MAHLSTEDE
*Chairman*

During the meetings last year, as well as on the questionnaire circulated this spring by our program chairman, Mr. Louis Vanderbrook, considerable interest was expressed on the effect of light on plant growth, as it in turn is related to plant propagation. It was because of this interest that your Field Trials Committee, composed of Vincent Bailey, John Roller, Harvey Templeton, John Vermeulen and myself

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PRESIDENT SCANLON: I think we will proceed with the report of the activities of the Field Trials Committee. This report will be made by the chairman, Dr. John Mahlstede, Department of Horticulture, Iowa State College, Ames, Iowa.

## REPORT OF FIELD TRIALS COMMITTEE FOR 1956 — PHOTPERIOD STUDIES

John P. Mahlstede
*Chairman*

During the meetings last year, as well as on the questionnaire circulated this spring by our program chairman, Mr. Louis Vanderbrook, considerable interest was expressed on the effect of light on plant growth, as it in turn is related to plant propagation. It was because of this interest that your Field Trials Committee, composed of Vincent Bailey, John Roller, Harvey Templeton, John Vermeulen and myself proposed the study as outlined by the NEWSLETTER solicited by Dr. Snyder on April 10th of this year. It was the primary objective of this study to determine what plant type could be maintained in a continuous state of growth by simply interrupting the normal dark period by two hours of light. In addition, by positioning the plants at varying distances away from a primary light source it was also hoped that some information could be obtained about the effect of light intensity on the growth of plants. It was not our intension to develop a program which, at the end of one year would see all propagation nurseries lit up like a Christmas tree between the hours of 12:30-2:30 A.M. every night during the growing season.

More important, this project was proposed to screen plant materials in an effort to see which would be responsive to light, and which would not respond With this lead, we could progressively carry on the program until such a point that it could conceivably fit into he propagation picture No one in the audience will doubt the importance of light to the floricultural industries, and especially to those growers producing a year around chrysanthemum crop.

At this point allow me to digress a moment. Yesterday we had quite a lively discussion about the timing of *Syringa* cuttings. Some propagators advocated the collection of cuttings prior to the date of full bloom, others suggested that laterals be collected two to three weekks after blooming, while Mr. Nordine stated that at Lisle, in tests this past year with many as 71 lots of cuttings, timing was of little consequence in the final analysis. Dr Chadwick has noted that they are working on the relationship between flowering, blossom bud differentiation, and rooting of softwood cuttings of lilac. Now, if by the proper manipulation of the light period we can prevent the differentation of blossom buds the previous season, the formation of the so-called rooting inhibitors associated with flowering may be prevented, thereby giving the propagator a vegetative stock plant that will produce no flowers, but will yield a number of cuttings with a high rooting potential over a relatively long period of time

The procedure which you received was checked before final printing by Dr Borthwick in order to insure that the procedure was correct and the general experiment of possible value. Since the instructions designated that any and all trial plants be placed in containers, the fact that it was necessary for the nurseryman to setup the facilities at a time when he was probably the busiest, and the prevalence of late spring freezes in the East, wet weather in the Lake states, and drought in the Midwest led to very little project participation. However, the data that was obtained from those who carried on the studies was most interesting. I would like to divide this presentation into two segments, ie., one which gives the results of this year's Field Trials Committee's activities, and the second which is devoted to the results obtained with five species of Viburnums by Dr. Downs and the staff at Beltsville.

## PART I. 1956 FIELD TRIALS RESULTS

As I have already mentioned, the program as outlined was not highly patronized Mr. Art Buckley, Curator of the Dominion Arboretum at Ottawa, John Roller, Verhalen Nursery Company, Scottsville, Texas, and myself were the only three whom reported results The physical plant for this project consisted of a line of 200-watt reflector lamps spaced three feet apart in a line. Twenty or less plants were then to be placed in containers at right angles to this line of lights. A time clock hooked into the circuit was so set as to turn the lights on at 12·30 A.M. and off again at 2·30 A.M. The lights were to be maintained approximately three feet above the height of the tallest plant in any one segment. The number of height measurements was left to the descretion of the cooperator, although an initial height reading at the time of planting and one at the time the lights were turned off would be all that would be required to arrive at a growth increment Additional notes relative to branching habit, flowering etc. were also encouraged In order to compare the growth of plants under light as against normal expected growth, it was suggested that the cooperator plant an addditional five plants away from the main light planting.

Art Buckley handled the six plants which he tested in containers as outlined in the instructions John Roller also grew the ten plants he tested in containers. Our tests at Ames with 17 plants were handled by direct field planting of material furnished by Darrel Holmes and Ted Sjulin The data was summarized by 4 increments of 5 plants spaced along 25 foot of row. Light intensities were measured in the center of each of these four areas.

As would be expected from a study of this type, the results obtained were quite variable Lilacs, for example, both at Ottawa and at Ames, given light in the middle of the dark period generally made poorer growth, or at best were unaffected as compared to those plants not given the light treatment. *Prunus besseyi,* on the other hand under a high light intensity of 120 foot-candles made approximately one and one-half times the amount of growth that was made by plants not under light. However, at lower light intensities the results were not significantly different from the non-lighted plants The common Smoke Tree. regardless of light intensity or position in the row was stunted as compared to those not given light.

At Ottawa, *Kolkwitzia amabilis,* the Beautybush, under lights made a 329% increase in growth as compared to 233% increase over the original height for the non-lighted plants. At Ames, light intensities of 120, 30, and 2 foot-candles resulted in growth increase of from 5 to 9 times that of plants not under lights. In our trials, one of the most outstanding examples of the effect of lighting was observed on *Caryopteris* Blue Mist, which as you know is one of the few ornamentals which flowers in late summer or early fall Early in the growing period it was quite clear that plants directly under the light were going to be stunted and were generally less prone to spreading as compared to those at the lower light intensities. The final results are tabulated in table 1 which shows the stunting effect at a light intensity of 120 foot-candles and a general increase to 2 fc. More impressive was the spread of the plants, that is, one could almost draw two converging lines from the 2 fc exposure to the plants directly under the lights. The plants continued vegetative growth throughout the period of lighting as compared to normal flowering of plants without light. *Spiraea frobeli* was another plant which performed well at the lower light intensities, giving plants which had as much as 4 times the amount of growth under light as compared to the non-lighted plants

**Table 1. Percent Growth Increase**

| PLANT | 120* | 30* | 12* | 2* | No Light |
|---|---|---|---|---|---|
| Caryopteris | 50 | 176 | 154 | 193 | 171 |
| | 20** | 25** | 33** | 39** | 31** |
| Kolkwitzia | 197 | 198 | 273 | 173 | 32 |
| Spiraea frobeli | 27 | 75 | 192 | 146 | 35 |

* Light intensity in foot-candles
** Final spread in inches

Two very significant effects of lighting were demonstrated by the results submitted by John Roller. The first one was noted on Crapemyrtle which at intermediate light intensities (120 foot-candles) set and produced blossoms approximately one month earlier than they would have ordinarily in containers. This was in direct contrast to those plants under higher light intensities (320 foot-candles) which were delayed in blooming (Table 2).

**Table 2. Performance of Crapemyrtle as Influenced by an Interrupted Night Period**

| Approx Light Intensity | Plant No | Height of Plant and Flowering on May 2 | June 5 | July 7 | August 5 | September 5 |
|---|---|---|---|---|---|---|
| 320 | 1 | 6″ | 9 | 17 | 23½ few buds | 26″ 75% bloom |
| | 2 | 6″ | 13 | 19 | 22 full buds | 22 |
| | 3 | 6 | 11 | 16 | 19 bloom & buds | 18 50% bloom |
| 120 | 4 | 6 | 13 | 17½ | 19½ bloom & buds | 19 25% bloom |
| | 5 | 6 | 8 | 18 20% heavy | 18 seeds | 18 |
| | 6 | 6 | 9 | 15 bloom | 17 buds | 17 |
| | 7 | 6 | 13 | 21½ heavy bloom | 22 seeds | 21 |
| 50 | 8 | 6 | 11 | 14 | 16½ bloom & buds | 16½ |

Another development reported by John Roller was observed during the course of the experiment with plants of *Forsythia intermedia spectabilis.* All plants located approximately 4-8 feet away from the light source in an area having light intensities from 120 fc to 50 fc died between July 7th and August 5th. These same plants were generally the ones which had earlier in the season put on the most growth.

Since the number of plants tested was relatively small it will be possible to record a number of intermediate responses which under normal circumstances would probably be omitted for the sake of brevity. The overall results of this study then can be summarized as follows: (1) Plants giving a general increase in growth at all light intensities over non-lighted plants — *Caragana arborescens, Euonymus nana, Kolkwitzia amabilis, Ligustrum lucidum compactum,* (2) high light intensities generally increase growth over low or no light — *Forsythia suspensa, Lonicera claveyi nana, Lonicera "purpurea," Prunus besseyi,* (3) plants stunted by high and low light intensities: normal or increased growth at intermediate intensities — *Elaeagnus angustifoldia, Fraxinus pennsylvanica, Philadelphus virginalis,* (4) medium and low light intensities generally increase growth over no light — *Spiraea frobeli, Weigela vaniceki,* (5) plants stunted by high light intensities; normal or increased growth at intermediate and low intensities — *Berberis thunbergi, Caryopteris* Blue Mist, (6) plants generally stunted by light period — *Abelia grandiflora, Cornus "nana," Choenomeles lagenaria, Cotinus coggygria, Ilex cornuta burfordi, Syringa 'President Grevy,'* (7) plants not responding to light period — *Deutzia lemoinei, Gardenia fortunei* (observed to be better branched under lights) *Rosa* (Red and White varieties), and *Syringa vulgaris varieties.*

## PART II. RESPONSES OF SEVERAL VIBURNUM SPECIES TO DAYLENGTHS

R. J. Downs and A. A. Piringer, Jr.
*U S Department of Agriculture*
*Beltsville, Maryland*

During 1956 plants of five Viburnum species were grown on various daylengths to determine their effects on growth The growth measurements reported represent net increases during the treatment period in length of the shoots of main and lateral branches whether due to increased number of nodes, increased internode length, or both of these.

Uniform cuttings, rooted the previous summer and overwintered in the field, were provided by H. M Templeton[1]. The species were *V. burkwoodii, V. juddii, V. chenaultii,* and *V. plicatum forma tomentosum (V. tomentosum-plicatum)*. Three replicates of five plants each of the five species were subjected to photoperiods of 8, 12, 14 and 16 hours.

The study was begun March 5, 1956. Plants on all daylength treatments were maintained in the natural light of the greenhouse for a basic 8-hour period, from 8 a.m. to 4 p.m., after which they were moved into ventilated light-controlled chambers, where they received the necessary supplemental light to complete the given photoperiod. The source of the supplemental light was 100-watt incandescent-filament lamps, which proved approximately 30 foot-candles of illumination at plant level. The greenhouse experiments were terminated August 20, when final growth data were collected. Plants were maintained on their respec-

[1]Winchester, Tennessee

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tive photoperiods after this date until moved at 4-week intervals to the field for additional study.

During the greenhouse experiments all species showed marked response to daylength. The main axis and lateral branches in each species made relatively little growth on 8-hour days Leaves of plants on this shortday treatment were darker green than those of plants on the longer photoperiods Growth of both the main axis and the lateral branches was greater on the longer daylengths, but the number of laterals, except on *V. juddii,* was not greater. During 24 weeks of treatment the total growth increase, that is the sum of growth made by both main axis and lateral branches, was more than twice as great on 16-hour days as on 8-hour days for *V burkwoodii* and *V. chenaultii* Similarly, on the longer daylength, plants of *V. carlesii* produced three times as much growth, *V. juddii* about five times as much growth, and *V. plicatum f. tomentosum* more than four times as much growth as plants of the same species on 8-hour days (table 1.) In general, this is in agreement with the results that Sidney Waxman reported to this Society last year. He indicated increased vegetative growth of plants of *V. carlessi* and *V. opulus* on long days. *Viburnum prunifolium* reportedly did not respond to photoperiod.

**Table 1.—Mean increase in length of the growth[1] of Vbirnum Plants in the greenhouse during 24 weeks on various photoperiods.**

| Species | Increase on indicated photoperiod 8-hour | 12-hour | 14-hour | 16-hour |
|---|---|---|---|---|
| V. burkwoodii | 49 | 60 | 81 | 113 |
| V carlesii | 34 | 45 | 85 | 117 |
| V chenaultii | 47 | 57 | 77 | 108 |
| V juddii | 10 | 15 | 25 | 47 |
| V plicatum f tomentosum | 15 | 19 | 26 | 69 |

[1]Mean of 15 plants Growth was measured as total extension of both the main axis and the laterals L S D for means between photoperiods for a given species 43 at 5% level, 61 at 1% level.

On plants of three species grown under our greenhouse conditions and treatments, flowers buds were apparent in June regardless of the photoperiod. Thus, photoperiods did not seem to control floral initiation However, marked differences in the extent of flower-bud formation did occur among the species. *Viburnum burkwoodii* and *V. chenaultii* formed at least one flower bud per plant, *V. carlesii* formed flower buds on only one-fourth of the plants, and *V. juddii* and *V. plicatum f tomentosum* had not formed any visible flower burs by August 20. At this time, the flower buds that did form appeared to be single ones tightly subtended by bracts. Actually, in the axils of these bracts were minute flower buds which remained compressed and inconspicuous throughout the photoperiod experiment.

For the field phase of the experiment, a complete replicate consisting of five plants of each species, except *V. plicatum f. tomentosum,* from each photoperiod was transplanted to the field on August 20, September 17, and October 15. The small flower buds that were already visible expanded and appeared as enlarged clusters of buds on plants of each group 6 weeks after it was moved to the fall field conditions. Certain of these buds on *V. carlesii* that had been on 8- or 12-hour days developed until the corolla tube was expanded and colored; often erratic opening of individual corollas followed. By December 11, 1956, marked differences in total flower-bud formation were noted. *Viburnum carlesii* and *V. juddii* formed no additional buds after they were moved to the field However, the numbers of flower buds on plants of *V burkwoodii* and *V chenaultii* nearly doubled. Some of these seemingly new buds might have been initiated in the greenhouse, but since the plants on longer daylengths were producing leaves at that time, the majority of the new buds probably were initiated after the plants were moved to the field.

It was also noted that leaves of plants of all species, regardless of the previous photoperiod treatment, turned the typical wine red or bronze color expected during the fall. Plants of *Viburnum chenaultii* retained their foliage in the field better than those of the other species tested.

The field experiment is being continued to study the effect of previous daylength treatments on winter injury and subsequent growth of the plants in the Washington, D.C., area.

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PRESIDENT SCANLON: We now have time for a few questions.

DR. CHADWICK: How many days after your lights were turned off did Caryopteris Blue Mist flower?

DR. MAHLSTEDE: The plants, regardless of position in the row, flowered almost immediately after the lights were permanently turned off.

MR KEN FISHER. Was *Viburnum opulus nanum* used in the studies?

DR. NITSCH: We have just now started to propagate this plant. For this reason we do not have any results that we can report at this time.

MR. BUCKLEY· Dr. Nitsch, I would like to know whether you noticed any difference in the growth habit of plants when using, say, 1000 foot-candles as against using 25 foot-candles of light?

DR NITSCH· I should first state that we didn't work with different light intensities. We used the same light intensity throughout our studies We were using incandescent light, which, if I remember correctly was about 50 foot-candles. I should say I was quite interested in the results showing that the intensity of the light has quite a lot to do with the response . I think it is quite a new angle

MR. BUCKLEY: We have noticed a definite response of plant materials to varying light intensities. Recently I went over to see the experiment we carried out using 1000 foot-candles supplementing normal sunlight on birch and caragana and also those given 25 foot-candles of light for an 18-hour day. With the 25 foot-candle light supplement we obtained very long, weak growth which measured about six foot on White Birch, and which had to be supported. The plants given normal sunlight supplemented with 1000 foot-candles of incandescent light made stronger, bushier growth. There seemed to be quite a difference in the branching habit and the ability of the plant to stand up without support under the higher light.

DR. NITSCH: I see Under the high intensity light then you get photosynthesis entering the picture. We endeavored to use low intensity because we didn't want to study this effect In addition to this you observed a stunting effect at the higher light intensity?

MR. BUCKLEY: Yes, that is true The seed of these plants was sown about the last of May. We did notice an inhibiting effect of supplemental light on the growth of germinating white pine seedlings, but this was almost immediately overcome and the seedling grew normally

DR. NITSCH: If you remember, Downs and Borthwick say with Scotch pine a better result is obtained with 14 hours than with 16 hours of light Of course, I haven't given you all the possible types of responses, but it looks like certain plants actually do much better under short days. For example, apple grows better under 12 hours of light than under 18 hours.

MR. HOOGENDOORN: I don't like to make this more confusing than it is already, but would you say that most plants will grow better with a longer light period?

DR. NITSCH: Well, we haven't explored all the plant kingdom, so I can't say definitely. However, a good number of them, at least those that we have tried will do better with a longer light period.

MR. HOOGENDOORN: Well, the 21st of June is your longest day. After that, the days become shorter I was wondering then, how you would explain why we get our best growth, in general, on shrubs from the first of August until the middle of September.

DR. NITSCH: What plants are those?

MR. HOOGENDOORN: Evergreens and shrubs.

DR. NITSCH: Did you observe this on dogwood?

MR. HOOGENDOORN: No. Take for example, Cotoneaster Up to the first of August they don't do much but they put on a terrific growth from the first of August until the middle of September.

DR. NITSCH: Well, I don't know how Cotoneaster responds. Maybe it grows better under intermediate light or temperature, or there even may be other factors operating.

MR. BRUCE VANDERBROOK: We have observed the same thing. I wonder how much of that response is due to when you fertilize, and how much rain and fog you get.

MR. HOOGENDOORN: Whether you get rain or no rain, that is the time a lot of these plants make up. Of course, if you get rain they will get that much bigger.

MR. JIM WELLS: Case, are these plants to which you refer transplanted in the spring?

MR. HOOGENDOORN: Yes.

MR. WELLS: Isn't it perhaps due to the fact that the plant requires a certain amount of time to reestablish its root system? This occurs during the early summer and then by fall you get that flush of growth

MR. HOOGENDOORN: All right, you take established plants and you cut them back. They do the very same thing, that is they put on most of the growth late in the summer.

MR. WELLS: I concede defeat. I wanted to ask Dr. Nitsch if any work had been done or whether he thought it would be advantageous to apply supplementary light to young cuttings of such plants as deciduous azaleas, Japanese maples, or Viburnums which have proved difficult to over-winter. It seems that if a cutting can be induced to make vigorous growth after rooting, it can probably be over-wintered more successfully. Would supplementary light after rooting be of value?

DR NITSCH: Well, it depends first of all on how much time you have left until the first frost. This will depend on the location of your nursery, that is if it is in the North, or the South. If you use supplementary light you will get soft growth which will take time to harden off and become dormant. I am sure that in the South you could probably do it In the North, you may have to shorten the days artificially. I should say we don't yet know how to get plants hardened off enough to stand the winter. This is one of the next things to be studied.

MR. McDANIEL· I have one question to ask. You didn't mention anything about the prevalence of insects under your lights, particularly leaf hoppers Did you notice them?

DR. MAHLSTEDE: No, since I was never at the Horticulture farm at 12:30 A.M. when the lights went on.

MR. McDANIEL: That possibly might be one of your influence affecting slower growth of plants directly under the lights. Take Sophora that Mr. Flemmer talked about the other day Reduced growth might be traced back to toxins which the plant receives from the leaf hoppers.

DR MAHLSTEDE: As far as insect damage on the plants in concerned, I am certain that none existed. As for large populations of insects cutting down the amount of light reaching the plant, I am inclined to think that this was not the case.

PRESIDENT SCANLON: We are indebted to Dr. Nitsch for this excellent discussion and to Dr. Mahlstede for his concise report of the photoperiod trails sponsored by the Field Trials Committee.

We will now preceed to our Annual Business Meeting. (See page 9).

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## SIXTH ANNUAL BANQUET

The newly elected president, Mr. Louis Vanderbrook, presided at the Sixth Annual Banquet.

A gavel was presented to each of the former Presidents of the Society Each gavel was inscribed with the individual's name and the year of office. Those honored included:

James S. Wells, President, 1951 and 1952

L C. Chadwick, President, 1953

Richard H. Fillmore, President, 1954

Edward H. Scanlon, President, 1955

Following a period of entertainment, Professor Frank A. Pearson, Agricultural Economist, Cornell University, Ithaca, New York, addressed the group on the subject. "That and That."

The Sixth Annual Meeting of the Plant Propagators Society adjourned *sine die* at 10:00 p.m.