rate of about fifteen inches per month during the growing season. Of course, it is heavier in the summer than in the spring and fall.

We fertilize at two week intervals. We alternate a dry fertilization with a liquid fertilization. The dry fertilizer is applied by hand, just by placing it on top of the soil mixture. Liquid fertilization is done through a power sprayer. It is too expensive to put on through the overhead irrigation system. I believe that about one-third of the fertilizer is lost if applied through the irrigation system.

The dry fertilizer consists only of nitrate of soda or ammonium sulphate. The liquid applications are commercial products, such as Rapidgro, Instant Grow, etc., which ever is more readily available. We depend upon the liquid fertilizer to supply the trace elements. Since our soil is high in potash, we do not need potash in the fertilizer treatment.

Briefly, that covers our method of growing trees and plants in containers. There is, however, one thing that does not necessarily enter into the growing of container plants but really is one of the big factors. This is the harvest. It is a very easy thing to go out and lift a container plant and put it on a truck on very short notice. Handling container-grown plants is not dependent upon the weather. To us, this is a very important point in favor of container-grown trees and plants. Another important consideration which favors container-grown trees is that trees, even to ten or twelve feet in height, can be planted in July and August without wilting or leaf drop.

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MODERATOR MATKIN: Thank you, John. I am certain that you have given some valid arguments for the use of container-growing in the nursery business.

Next on the program is a discussion on container-grown conifers in Illinois, by Mr. Jack Hill, D. Hill Nursery Company, Dundee, Ill. Mr. Hill is one of your well-known members.

Mr. Hill presented his paper, entitled "Container-Grown Conifers in Illinois." (Applause)

CONTAINER-GROWN CONIFERS IN ILLINOIS

JACK HILL
D. Hill Nursery Co.
Dundee, Illinois

It is a little difficult for me to sort out the actual differences between container-grown plants in Illinois and container-grown plants in Arizona, California, Texas, or New England.

I believe the thought with which I would like to begin its the analogy of what the container actually is. I have commented to many of you here in this group that there is evidently great preoccupation with the technique of growing plants in a container. Actually, it is the same plant, whether grown in a container or in the field. And the same factors—

water, sunlight, minerals, etc.—control the growth of both. The container should properly be thought of as a package. The principal feature is that it is a package enabling easy distribution.

Another significant point with regard to container-growing, which should be noted early, is the necessity of recognizing the value of uniformity. Our preoccupation with dollars has led us toward a method of keeping track of the costs and the one thing which this cost system indicates is that the ultimate profit in any growing operation depends upon the percentage of harvest at the time of cropping. With the container-grown plants, for the very first time, we have control over many factors which, in the field, are infinitely variable. As long as we have the control, I think we should exercise it to the greatest degree possible. However there is no magic about quality in plants. You cannot take a plant of poor quality, place it in a container, and expect to have something of first quality.

The propagation of plants for containers differs slightly from the production of plants intended for field culture in that a greater emphasis is placed on uniformity. It is necessary to grade cuttings far more carefully than we had been accustomed to doing before we started this type of growing.

Our method at Dundee has followed several diverse lines of reasoning, always headed toward producing the best plant that we can for the least money. We have concluded now that we wish to go directly from the rooting bench to the container. This concept of handling the plant as few times as possible recognizes that the plant invariably sets up its own balance. A plant which is growing probably does not make one extra bit of root more than it needs nor does it make one extra leaf than it can use. It is a delicately poised, exquisitely balanced mechanism. If we accept that concept of a plant, we must recognize that we will achieve the best results by handling it just as few times as possible.

That hypothesis, coupled with economics, has led us to the belief that we will achieve our end best by going directly from the cutting bench to the container. Therefore it is necessary to produce cuttings as large as can be economically handled. For example, we know that *Taxus* cuttings of various sizes can be rooted. In fact, there is belief in some quarters that the larger the cutting the better the rooting. There is a limit, of course, to the size that can be handled conveniently in the greenhouse. We wish to direct the operation toward sticking the largest cutting that can be conveniently handled and putting that cutting directly into the container. The important factor in sticking that cutting is timing—to produce good secondary roots by the time we wish to can it.

We are doing our canning on a powered conveyer. It is not a machine, it is simply a conveyor which permits an adjustment of an accurate rate of flow of material toward and away from the focal point of work. If you were working with a gravity conveyor it would be quite difficult to arrange the flow of the plants to and from the actual canning operation.

The economics of going from the bench to the container involves me in a discussion with the preceeding speaker. It is the difference between going from the cutting bench to the container and from the cutting bench to a two and a quarter inch pot. Obviously, the pots can be spaced much

closer together. Consequently the requisite culture can be applied to that confined area with less expense than to the same number of plants in one-gallon containers. A square foot is required for each four containers, whereas about twelve pots can be placed in this area. Therefore, there is an economic difference.

We have chosen to emphasize the importance to the plant of the lack of handling. We know that even in transplanting from a pot to the container that there is a certain amount of shock to the plant. We are willing to incur the extra cost of maintenance in order to eliminate the additional shock obtained by the transplanting from the pots. It is really a problem of economics and recognized plant welfare.

One point that I think needs examining is the matter of transcanning, that is, shifting the plants to larger containers. It is our present belief that it is not practical to shift from the one-gallon to the two-gallon container. There is not a sufficient increase in volume of new soil in the two-gallon container to justify the cost of the two-gallon container and the labor of making the move. However, we do consider it is entirely practical to move plants from the one-gallon to the five-gallon container. It may easily be that as our technique improves, we will start the fast-growing plants directly in two-gallon containers. This, again, in deference to the feeling of not wishing to move the plant and not wishing to handle it any more than is absolutely necessary.

The problem of selection of the growing medium or mixture has already been very thoroughly covered. I am in complete accord with the principle of the mixture described by Mr. Matkin. The principle that lies behind it is inviolate. Adequate mixing, however, was perhaps not stressed quite enough in the earlier discussion.

We encountered a problem when we added our mixture of fine sand and peat moss. We found the ordinary tumbling barrel type of mixer was far from adequate in getting the thoroughness of mixture which we regarded as necessary. In order to come up with a rule of thumb criterion for determining when a mixture was sufficiently mixed, we simply saturated the material with water. If the peat moss floats to the top, the material is not sufficiently mixed, however, if the peat moss stays in contact with the sand, then there is adquately mixing.

Aeration and drainage have already been given considerable attention. I will simply suggest that there are no two factors which we consider of more importance in the selection of the medium than drainage and aeration. I must confess that I do not know just where one begins and the other ends. There is such overlapping of the factors of drainage and aeration that we have come to use the terms synonymously at Dundee.

Late this Fall, after three years of experimenting with the various soil mixtures and having behind us only one year of experience with the sand-peat mixture, we are converted to the sand-peat. Perhaps I should explain why we have decided on the sand-peat mixture.

The medium which we chose in the Fall of 1952 proved to be entirely inadequate. *Taxus,* in particular, never did become established in it. After we recognized the problem of drainage-aeration, we modified the John Innes mixture and adapted it to the non-porous container. We found at the end of a year's growing that there were many more lateral breaks from the main roots. These branch roots, upon reaching the edge

of the container, produced a good root system. A number of plants, even the ones which we considered rather intolerant to low level of aeration such as *Taxus,* rooted very heavily along the outside of the container. We were producing what amounted to a hollow cylinder of roots. The roots were not thoroughly using the total soil volume. Now, after one year of experience with the sand-peat mixture, we have found that the roots grow throughout the container. There is no tendency to develop the hollow cylinder of roots which was evident with the other mixtures.

I believe that irrigation is carried out on a different basis at Dundee than elsewhere. Recognizing the necessity for keeping all factors uniform which affects plant growth, we looked into numerous watering systems. We considered the possibility of the fixed rotating head or simple spray the amount of water applied from the source outward to the edge of the head and quickly learned that there was a distressing disparity between coverage. Generally most of the water fell about the middle. The inside and outside received considerably less water. We finally chose what was regarded by many, including myself, as a sand box toy. It is the self-propelled Rain King Sprinkler. The radius of the spray is adjustable. It is designed for the home owner and is available at most garden stores. The machine pulls itself along on a very thin stainless steel tape. The mechanism has proven entirely reliable.

When to irrigate is a question that is quite frequently raised. We examined many methods. We have tried moisture blocks, copper electrodes, and potentiometers. We have investigated the determination of the water content in relation to field capacity. This latter method is very accurate but quite laborious. Finally we have come to a method at Dundee which depends upon putting a finger in the can up to the first knuckle and seeing how it feels. We do think simple observation of the rate of water usage is probably the most reliable. The best and most scientific plan in the world is quite limited if you cannot apply it to your operation conveniently.

The feeding program which we have followed is quite simple in its concept. We were accustomed to seeing damage to plants grown under field conditions whenever they were subjected to a sharp, violent change of soil chemistry. The classic method of the nurseryman is to watch his block of trees and apply fertilizer the moment he sees signs of distress.

The analogy I have often used is the matter of deciding how to feed a starving man who has been picked up on the Sahara Desert. That man needs food. If you give him a steak dinner, as badly as he needs the food, he cannot use it. It would quite likely kill him. You could, however, provide him a cup of soup every hour for three or four days and restore his whole system to a level where he could use the steak dinner.

It is easier for our purpose to keep the plants on a cup of soup, so our entire principle is to feed very little but often. We tie the frequency of feeding with the necessity of watering. By that, I mean when the plant is actively growing it obviously needs more food. It uses more water and it needs more food. Conversely, when we run through a period of low temperature during mid-summer, with more cloudy days than bright ones, the plant is not as active, and therefore it requires less water and food.

The last thing I want to cover is the matter of winter protection. Our findings parallel exactly those discovered in experiments elsewhere. We believe at Dundee that our plants are not damaged by the absolutes in temperature. I feel that most of the conifers which we are growing are tolerant to temperatures which they are likely to receive in Dundee. But the damage that does occur, whether it is great or little, is almost invariably associated with rapid and violent fluctuations of temperature. The fact that you have detached the soil parcel from the ground, where it would be affected by the leavening influence of the earth's crust, subjects it to frequent changes in temperature. In Dundee, those changes, rapid as they may be on a clear night in June, are all within the growing range of the plants. In contrast, the changes that take place in the winter are beyond the range of growth, and the plant roots can actually be injured.

I think it was pointed out quite rightly that the degree of winter protection which is necessary is determined, first on an economic basis, and second by exactly what performance you want of the plant the next year.

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MODERATOR MATKIN: Thank you, Jack. It is obvious that you have an interesting ability to make observations and to express them in words that are understandable.

Last, but not least, certainly, is a report of a container growing operation in the East. This is at Corliss Brothers Nursery, Gloucester, Massachusetts. Mr. Clifford Corliss will describe the methods used by that nursery.

Mr. Clifford Corliss presented his paper entitled "Container-Grown Shrubs In Massachusetts." (Applause)

CONTAINER-GROWN SHRUBS IN MASSACHUSETTS

CLIFFORD CORLISS
Corliss Brothers Nursery
Gloucester, Mass.

Being at the end of the program and following these able speakers on container-grown material, I think the task would be a lot easier for me to tell you what we don't know about growing container stock than what we do know. However, as you well recognize, California is one situation, Texas another, the Midwest another, and we, in Massachusetts, have another.

I am going to tell you what we have done. We were one of the very first people to grow small shrubs, especially roses, in Cloverset pots years and years ago. We never got very far with shrub material because if the pots were carried over for a year, or occassionally for two years, that was an expensive operation. But we did very well with roses.

Our experience with metal containers is this. I, for one, could not see using a container that had to be cut and until the advent of the Plantainer and the Nursery Can, we did not enter the container business. We used some Plantainers, and after some experimental work, shifted to the