WINTER PROTECTION OF CONTAINER GROWN NURSERY STOCK

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Damage from cold temperatures is probably the most important limiting factor in the culture of container grown nursery stock in the Northern parts of the country. To profitably produce plants in containers some form of winter protection must be included in the production program. In order to more clearly understand the reasons for using protective measures, some background on the causes of winter injury will be given.

Excepting unusual winter conditions such as floods or ice storms, winter injury may be directly attributed to either desiccation of above ground portions of plants, formation of ice within the tissues, or both.

Desiccation due to water loss from stems of deciduous plants and leaves and stems of evergreens without replacement from the soil, may be particularly serious in container plants Soil volume and root extension is limited, the medium may dry out relatively rapidly, and the soil ball may remain frozen for long periods of time. This type of damage is most common on evergreens such as yew, hemlock, and some of the broadleaf types, and is especially severe when plants are exposed to high winds or intense sun during the winter.

Winter injury due to cold temperature results primarily from ice crystal formation between or within plant cells It is not unusual for ice to form in plants when temperatures are low; however, death or damage, may or may not take place depending upon the degree of hardiness of the plant or tissue involved.

Ice forms between plant cells when the temperature drop is gradual over a period of time. If plant tissues are sufficiently hardened, damage from this type of ice formation may be negligible or non existent. Any injury that does occur is due to the removal of water from the cell resulting in disruption of the protoplasm.

Rapid temperature drop may result in ice formation within the cells with death usually the result. This is believed to have been one of the major causes of death and injury to nursery stock in the Ohio, Indiana, and Illinois area during the winter of 1958-59 In Central Ohio growing conditions were favorable late in the season and woody plants, particularly those under cultivation, had not 'hardened-off' sufficiently. During the period of November 24 to 28 high temperatures ranged from 54 to 26 degrees and low temperatures from 34 to 17. On November 29th the low temperature was 5 and on the 30th, 5 below zero. This was followed by a week or sub zero temperatures in early December. Evidence for the assumption that this was the cause of much of the severe damage was found in a group of container grown *Pyracantha* plants. Plants which were protected in mid November were undamaged, whereas plants in the same condition, which were protected the first week in December, were found to be dead when examined in the spring.

Frost resistance or hardiness is based on the survival of plants or tissues under freezing or low temperature conditions. The degree hardiness can be altered by many natural and man made conditions such as pruning, transplanting, watering, and fertilizing practices. Increase in frost resistance is spoken of as hardening and is associated with certain changes in the properties of plant cells which include lower water content, higher sugar content, and higher osmotic pressure. An attribute of container culture is that the grower has better control over factors which may speed the hardening off process, such as reduced watering and fertilization

Other variable factors which must be considered in discussing winter protection is the severity of winter temperatures, precipitation, amount, extent, and height of snow cover, and the exposure of the plant area.

As indicated earlier, winter protection is necessary on most woody plant varieties grown in containers in the colder regions of the country. Many methods have been tried and are being used. Types of protection can be divided into five types (1) mulch cover over top of the containers, (2) screen protection over or around plants, (3) temporary or permanent structure over plants, (4) plunging containers below ground level , (5) placing containers can-to-can. A discussion of some of the specific methods follows.

MULCHING CONTAINERS

Mulches insulate the soil medium against rapid temperature change, maintain higher temperatures within the container, are relatively low in cost, retain moisture in the medium, and are relatively easy to apply. A major fault is the problem and cost involved in removing the material in the spring.

Ground corncob mulch has proven to be a successful means of protecting the root systems of a wide variety of plant types in containers. It is inexpensive and easy to apply but disagreeable and difficult to remove in the spring. A layer of crushed stone in the top of the container simplifies removal of this material which often sticks to the soil surface. A polyethylene layer under the bed facilitates easier clean up of the area after mulch and containers are removed.

Crushed limestone mulch is somewhat more expensive but equally as effective as ground corncobs and is also much easier to handle. It also serves to maintain the bed area when it is left after removal from the top of the containers. On hardier plant types, a mulch of this type along the South and West sides of the bed may be sufficient.

Straw or hay mulch has been used successfully by a number of commercial producers. In addition to providing some insulation for the roots in the container it also serves as some protection for tops of the plants The cost of material and application is low, however, it makes an ideal rodent nesting area and may be a source of weed seeds.

Mulching is a very effective method for protecting the root system from damage, however, on 'top-sensitive' plants, value is limited because of damage to the exposed portions. An interesting situation occurred

where death resulted because a ground corncob mulch was used. Groups of plants of Berckman's Golden arborvitae were mulched with ground corncobs, crushed limestone, and placed under a polyethylene tent. Those in the latter two plots were undamaged whereas those in the corncob mulch plot had a split stem at mulch level and were dead. This may have possibly been caused by ice formation in this mulch material.

SCREEN PROTECTION FOR CONTAINERS

Snowfence was used in tee-pee fashion over beds of container stock. This method gives some protection from wind and winter sun and is easy to apply and remove; however, little, if any insulating effect is provided and exposed foliage of evergreens is often burned.

This method was not effective in protecting plants that are 'top-sensitive' such as firethorn and abelia and even when snowfence was used in conjunction with a crushed limestone mulch, extensive damage *and loss occurred with these plants* Asphalt paper and aluminum foil shields were added on the west side of the snowfence tee-pee to protect the plants from the sun; however, damage under these shields resulted both from contact of foliage with the mineral and from drying out because of the waterproof cover.

This method alone does not appear to have merit except in mild winters and should be used in conjunction with a mulch to assure protection of the root system. Foliage burn of evergreens is reduced; however, because of the closeness of the lath to the plants, spotty burning usually occurs resulting in a reduction in plant quality in the block.

Another screen protection technique included the use of baled straw placed two bales high on the west side of some beds and completely around others This was used during the winters of 1954-55 and 55-56 and, with the majority of deciduous plants types damage was negligible; however, losses were great in blocks of *Pyracantha* and *Abelia.* In the winter of 1958-59, losses of *Pyracantha* and *Cotoneaster* plants were high in a commercial nursery using this technique.

On the basis of observations and research results it is difficult to recommend this technique as an excellent means of protection except during mild winter, with hardier plant types, or in areas where normal winters are less severe.

TEMPORARY OR PERMANENT STRUCTURES OVER THE PLANTS

It is obvious that maximum protection for container grown stock can be obtained with permanent structures such as greenhouses, hotbeds, or coldframes, however, structural and maintenance costs would be high. One gallon size plants of *Abelia grandiflora* were overwintered with no foliage or root damage in an unheated coldframe during the winter of 1958-59; however, a large scale operation of this type would probably be cost prohibitive.

One of the most effective temporary means of protection yet developed is a polyethylene tent cover placed over beds of container grown stock. Maximum protection is provided, cost is relatively low, plants

do not dry out, and application and removal is easy No maintenance is required except regulating internal temperatures by venting the cover during warm days in the spring. Some means of support is necessary and this may be a simple pipe and wire framework or a more permanent heavy wire mesh used in 'Quonset Hut' fashion over the beds. A possible problem may exist in areas of high winds; and a sturdy means of support would be an absolute necessity.

At the Ohio Agricultural Experiment Station, 4 mil. translucent polyethylene was placed on a pipe and wire framework over beds of container stock in mid November of 1957, 1958, and 1959. The poly was held down at the ends and sides by covering with crushed limestone chips. These beds were left sealed until warm days in the spring when it was necessary to open the ends and sides during the day

A wide variety of plants, including *Abelia* and *Pyracantha,* protected by this method during these winters were undamaged This was rather significant during the severe winter of 1958-59 when plants of this type were killed in field and landscape plantings. Plants under this means of protection also flowered or began growth one to two weeks earlier in the spring.

A more elaborate semi-permanent framework has been used by the Berryhill Nursery Company of Springfield, Ohio, where wire fencing was shaped into quonset-hut shaped units and placed over the beds. Although the cost of this is somewhat greater, the structure is more stable and reusable for a number of years.

To economize on space, it is possible to stack plants under the polyethylene This has worked effectively with two layers of plants and studies are underway using this technique.

Another means of protection involving a structure is the use of barns or similar buildings for storage. A nursery in Ohio is stacking containers 10 and 12 high in a barn this year

PLUNGING CONTAINERS

The practice of plunging containers in the ground is laborious and impractical although it does provide an excellent means of protection for the root system. In studies at the Ohio Agricultural Experiment Station it was found to be effective with some plant types but less advantageous with others In heavy soils, drainage and heaving may be problems. John Mahlstede has used previously plunged tile as a means of plunging container stock with the plants simply dropped into the tile.

CAN-TO-CAN PROTECTION

This method of protection, although minimum, is superior to spaced plants and affords good protection to plants in the interior rows of the beds. Drying out is a problem and some watering may be necessary during the winter. During mild winters this technique is adequate with plants such as forsythia, juniper, and deutzia, however, during the severe winter of 1958-59, these plants were severely damaged when handled in this manner. This technique will be difficult with large spreading plants.

TEMPERATURE STUDIES

In November, 1958 a detailed study was begun at the Ohio Agricultural Experiment Station to observe the effects of three protection practices on overwintering of *Pyracantha coccinea 'Lalandi,'* to determine the effects of sand-soil-peat and peat-perlite mediums on the temperature in the medium, and to determine variations in medium temperatures under the three means of protection and in unprotected containers.

Twelve to fifteen inch plants were planted in one gallon containers in September along with copper-constantan thermocouples placed in the center and edge of the containers. The containers were placed in the center and at the west side of four plots with ground corncob mulch, crushed limestone chip mulch, polyethylene cover, and unprotected plants placed can-to-can. Temperature readings were taken with a potentiometer at 8 A.M., 12 noon and 5 P.M, from December 8, 1958 to March 30, 1959.

The results on winter injury were rather striking where all plants were killed under no protection and those under the polyethylene cover were undamaged. In the mulch treatments root damage was negligible and shoot damage ranged from 50 per cent dieback in the center to 70 per cent dieback on the west side of the bed.

Temperatures in the containers under the different treatments varied as follows Temperatures under the two mulch treatments were uniform with little fluctuation and remained at the highest level of all treatments. Temperatures in containers under the polyethylene cover were slightly lower but higher than those in the unprotected plot Medium temperatures under the poly fluctuated to a greater extent than did those under mulch protection. The temperature in the unprotected containers fluctuated directly as the air temperature and reached lower levels than in any treatment.

The type of medium did not have a marked effect on temperature over the period of the study, however, temperatures were higher in the sand-soil-peat medium in most of the treatments on the 6 coldest days of the winter.

In general, the results of the study indicated the value of mulch and polyethylene cover treatments in maintaining higher medium temperatures and also the value of and need for top protection on plants such as *Pyracantha.*

SUMMARY

Winter damage is the greatest limiting factor in the culture of plants in containers in colder regions, and, regardless of the protection method employed, partial success is not acceptable. Undamaged, plants of healthy appearance and condition should be the goal of a program of winter protection.

Great variations in hardiness exist among plants and therefore, varying degrees of protection are necessary. Unfortunately, plants such as firethorn and low cotoneasters which are ideal types for containers, are rather tender and maximum protection is required. If the cost of winter protection is too great for the production program involved,

then it is not practical to grow plants requiring this potection in containers. The problem is not complex but simply means providing some form of artificial protection where natural means such as snow cover are not dependable, or adequate. This protection may range from placing plants can-to-can to using permanent or temporary structures to cover the entire plant. Regardless of the method used, a plant in the healthiest possible condition is the first step to assure successful overwintering.

Variation in winter temperatures and weather from year to year indicate that methods which are effective one year may not be the next; therefore, to assure plants of consistent high value and quality, a standard maximum protection program should be set up for each area and for the type of plants that are being produced.

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MODERATOR CHADWICK. I think we will change the procedure a little bit and not give you a stretch right now. If John Mahlstede, Bob De Wilde and Jack Hill will come up, I think we will go directly to the panel and have their discussion

Bob has a lot of notes in front of him. We will ask him to give us his method of winter protection first.

MR. ROBERT DE WILDE: Winter protection of container stock is, of course, a very critical factor in the production of container material. As Dr. Reisch brought out, one of the most important things is the fact that what works one year doesn't work the next, unfortunately.

Until this afternoon I thought one of the best methods of overwintering was to first start to harden the plants off around the end of August by decreasing our fertilizer application and by limiting our irrigation. Natural irrigation is allowed to provide our water supply except in the case of drought

The first step that we take is to group the cans together. We close them up in the bed, can-to-can, where the tops will permit. The next thing we do is to mulch with salt hay This is a marsh hay that is readily available in our area and it serves the same function as a corncob mulch. As the plants are mulched they all receive a teaspoon of Uramite, which has been proven to aid in the overwintering of our plants. This provides the nitrogen factor which DuPont has claimed will aid in overwintering.

After mulching the sides of the containers are all heavily mulched with unchopped hay, about two foot long usually, which is piled up along the sides. Over the top of each bed, that is, in the open area, a snow fence shade is placed. Now our location permits us to eliminate any further snow fencing over top because we are located in a woods area, which provides us with natural shade.

Around the sides of our container division we are placing for the first time this year, reed mats to cut down on the wind velocity. Some of the plants, such as junipers, do not require this much elaborate pro-

tection in our area We can just group these plants, bank them with salt hay and leave the mulch over.

We also spray every plant with Wiltpruf We are going to try polyethylene this year with our young material that we pot during the winter. We feel this has probably shown the most promise of any method. We have a number of beds set up now to receive the polyethylene cover and we hope this will give us as good results as it has given Ken.

Our damage consists of the same thing that you saw in the slides, particularly a dying of the outer edges of the canned stock, as well as some burn on the top. We have eliminated a lot of the burn by using shade in our area but we still do get a certain amount of wind burn which we hope we can eliminate by the use of the reed mats.

I would say that in general a lot of times the plants that look killed in the outer ring aren't killed, but rather are slowed down considerably and aren't saleable when we would like them to be

That is about all I have, Dr Chadwick.

MODERATOR CHADWICK. Jack, we saw a little of the winter protection you practice, but will you tell us more about it?

MR. HILL: The picture that Dr. Reisch had, was made three years ago. Our thoughts along the line of protection has been to perhaps over-protect. We were still seeking that very minimum degree of protection that would just do the job for us.

With this in mind we have each year for the past eight years, reduced the degree of protection that we have provided. Last year, being this winter of 1958-59, an extremely tough one, we found that there was no difference between the plants which had been mulched and those just provided with a vertical snow fence with snow paper stapled to the bottom. With that we have come up with a reasonably economical means of protection. Snow fence paper is readily available. We have the snow fence on hand.

The cans are first placed can-to-can wherever it is possible. However, in the case of large spreading plants, such as Pfitzer juniper in the egg can, we have not put those cans close together. The reason we have not grouped them closely this year is that in the past we got very serious disfiguration. After you spread them out you have essential branches broken and it just didn't look like it was worth it. This year, wherever the foliage cover was adequate we have left the cans on the growing spacing, which in the case of junipers I would guess was every 30 inches. All our one-gallon cans are placed right can-to-can. As I say, whole beds of them are surrounded by vertical snow fence and 20 inches of snow fence paper stapled to the bottom of the snow fence. The purpose there is to keep the wind off them.

Our whole purpose of protection is to reduce the temperature fluctuation. We do not feel that with the plants in the category we grow at Dundee, literally where the water mains are seven feet in the ground and freeze occasionally that the temperature itself is really the factor that produces the damage, it is the rate of fluctuation.

I would like to bring up something here just hypothetically and see if anyone in the audience or perhaps on the panel can answer. There has been expressed the thought that perhaps some of this injury which we have seen in the past on container plants and not infrequently manifested as a typical little slit in the outside of the corky bark of the plant, right at the soil line can be traced to ice formation.

In the spring of the year, on a thawing day the can itself remains frozen but the top of it actually thaws so you get free water, perhaps a half inch, actually standing. It cannot go through because the bottom of it is solid ice. This subsequently freezes up solid, so that when you look at it again the plant is growing right out of a disc of ice which sits on the top of this metal can.

It has been wondered many times in Dundee whether or not the freezing action of that ice actually applied sufficient physical pressure to the outside of that bark to at least initiate the tissue damage in the form of splits If anybody has any information on that, I would certainly like to hear from him.

In the end, plant economics alone will determine how far you can go in the range of protection of a greenhouse to give the plant complete protection or no protection Some place between those two extremes will be found protection which should be adequate.

Those of you who have watched field nurseries operate for many years know it is not infrequent that a severe winter will occur that will render many plants entirely unsaleable. We saw it at Dundee last winter So I think a lot of this concern over the protection of container stock is in the category of looking for an excuse.

Relative to the cost, Frank Turner quoted of 4.4 cents, we have gone, for example, to half of that figure last year. I don't know what our figures are this year, since we have eliminated all the straw. I think this year our cost for winter protection will be something just under two-tenths of a cent, perhaps even as low as 1.8 cents.

MODERATOR CHADWICK: I think we might throw this comment in here that Bob and Jack are growing somewhat different types of plant materials. Jack, your procedure is primarily on junipers, yews and a few arborvitae. Bob, I believe, you have some broadleaf evergreens and some shrubs, which does bring in a difference as far as the need and extent of winter protection.

John, may we have your comments?

DR. MAHLSTEDE: I think we will all admit that if we could have a good heavy snow cover during the entire winter period, as they have in certain parts of Canada, this would probably be an adequate mulch for most of our conifers. If we could keep it on there for the entire winter and if the evergreens were normally hardy, I think you could safely say we could get most of our stock over-wintered on the top of the ground.

Over-wintering container grown nursery stock is probably the one limiting factor to the production of some of the so-called tender ornamentals in the North The expense involved in the erection of lath and polyethylene tents and in the consolidation and mulching of con-

tainers in convenient sized beds can be a major cost item limiting large scale container production in many areas of the United States.

In Iowa, we have successfully carried arborvitae, yews, junipers and phlox over winter the first year by consolidating the containers and literally plunging the units in redwood sawdust In the middle of December the entire area was covered with soybean straw which was removed on April 1, the following spring. This was an expensive operation. Three-year-old arborvitae growing in a variety of soil mixes were also successfully held under an overhead story of pines by simply plunging the containers in sawdust, and erecting a 3 inch high, reinforced polyflex enclosure around the area This again was a costly operation.

Arborvitae, junipers and Norway spruce either plunged in containers in the field or growing in tile overwintered without protection successfully, i e., over 90 per cent stands. *Taxus,* however, because of the particular winter and the exposure gave only a 45 per cent stand. This plant, under our conditions needs to be carefully handled to prevent undue losses.

MODERATOR CHADWICK· We will now ask for questions again and I would say let's confine our remarks first to this matter of winter protection. If we run out of questions on that phase we will come back and pick up any others you may have

MR. A. JAN RADDER: I would like to ask Mr. Hill what he uses for protection on banded liners

MR. HILL: Our protection on the banded liners which you put in beds is a simple shade over the top We actually double it Last year for the first time we encountered a strange response from this, we got smothering The snow sifted through and partially melted. This was followed by more snow and finally we just got a layer of solid ice under those shades. Because it was double, it didn't melt off, and we didn't notice it until too late. We got considerable smothering. We had never, up until last winter, had any difficulty.

MR. C. DE GROOT (Oakville, Ont): I would like to make one comment on overwintering. Lots of methods were shown for protection but I didn't see any hedges mentioned for protection. We have our containers placed on the east side of a hedge We get that good eastern snowfall and that snow stays there three to four weeks after the other snow is all gone. That is the best protection you can get

The first year we used sawdust, corncobs and straw. It didn't make any difference whether we used them or not because they were covered up with snow which we got from the east. We soon discovered that we did not need to cover them at all.

QUESTION: I wonder if Frank Turner would comment on the cost and the results he has had with the polyethylene tent?

MR. FRANK TURNER (Springfield, Ohio): I would presume that you might not be able to stand the 4.4 cents cost per can for overwintering red barberry, whereas, you might find plenty of good plant materials that would stand that application of the cost of overwintering.

We are quite well convinced on the structure. It is not a new

thing. It is simply the Templeton structure on a new dimension. Our original tryout was with two of them seven feet wide, 60 feet long. In these two units we tested the possibility of using the second layer and occasionally a third layer. This worked so successfully in what appeared to be about as much of a test winter as we would receive for a long time that we said to ourselves that if we don't have a dozen or fifteen of these structures next year we are missing a good bet.

The only thing that I can think of is a little matter of principle in the handling of this material that has not been quite clearly explained thus far We are quite discriminating about the category of plants that go on each layer We will say, for simplicity, that the bottom layer are usually young plants and in a variety that has to be there to survive. Now we would like our second layer to be a plant that would come off and sell first. It should be the first size we are going to use, as we open up in the spring We don't say that the second layer of plants in the structure has to be a plant that positively has to have that kind of protection. As an example only, we would like it to be of plants like *Euonymus vegetus,* etc where the employment of a shelter adds to the eye appeal of the plant and gives it an earlier start. These are the sort of factors that pay for the care that has been given to them.

I think that is all unless you have some questions.

DR F J. NESBIT: (Asheville, N C): I would like to ask Bob De Wilde about his use of Wiltpruf Did this come just as an added lick in hopes that the whole thing is better or is it based on the results of experimental work that proved you did get any protection from it.

MR. DE WILDE: It seems to be one of those variable type things that is, the use of Wiltpruf. Sometimes you think you get great benefits from it and it really works and then other times you are not so sure and you get down to the point where you are afraid not to use it. That seems to be the case right now. We have tried it experimentally, and yes, we thought definitely we got better results, but of course it might have been a function of the winter, too

MR. LESLIE HANCOCK: This is not exactly a question, but rather is a comment.

Jack Hill raised the question of splitting in his rather large Pfitzer cans. There is no question in my mind that the splitting of stems, whether small or large is due to the upward thrust of the soil against the cambium and an immediate freeze. I would think this is one of the prices he has to pay for fast growth where you have a very lush cambium in a large Pfitzer. It occurred to me when you were speaking about that very subject, apparently no one is trying the old-world method of laying the pot on its side, in which you won't have ice form in there after the severe freeze-up starts.

I was wondering whether the pot on the side in winter might not possibly save space also.

MR. HILL: I have never thought about laying the pot on its side. That might possibly be the answer. Our splitting did not take place on the junipers as much as on both yews and arborvitae.

MODERATOR CHADWICK· We have tried, the matter of laying the pots on their side in all our tests. The plants have not come through as well laid on the side as when they were upright. I can't tell you the reason why.

MR LOWENFELS. We are using oak leaves for mulching since they are available and don't break down all winter The first question I would like to ask is, if anybody is using an oak leaf mulch? Second, everybody is talking about the Templeton method and I think Harvey puts straw around his. If he doen't use straw in the winter, maybe a word from Mr. Templeton might be good at this time.

MR HILL: I think what we are talking about is the Templeton structure. As an actual fact, maybe I can add something here. We are, of course, testing the polyethylene igloo. We are also testing the use of saran on the top. We are planning to use that structure in more than one way We are using it for the winter protection of our container material by placing the saran shade on top of the polyethylene. That is, first the wire reinforcing mesh, then the polyethylene, and then the saran cloth on top of that, tied down with "S" hooks and springs on the bottom.

In that part of the spring of the year when we are moving rooted cuttings from the bench into the one-gallon cans we will use this same igloo structure, and eliminate the poly. We will pull the saran cloth over the wire until the plants are established Later in the season when we wish to propagate perhaps softwood cuttings directly into those containers, the first season we will just reverse the poly and the saran, putting the saran cloth next to the wire mesh and the poly over that, thereby coverting all the heat we can under the sheet and getting more use out of the structures than just a 100-day winter per year

MODERATOR CHADWICK: One question on the use of oak leaves as a mulch Any comment on that from the panel?

MR DE WILDE· In our woods area our trees happen to be oak and hickory and we definitely make use of all the leaves which fall and *supplement it with chopped hay. It works very line.*

MR VERKADE· When you laid those cans down, did you put salt hay over the can or did you just lay them down?

MODERATOR CHADWICK: They were not protected with salt hay; they were laid over on their side; sort of shingled so they were at an angle of roughly a little less than 45 degrees. There was also protection from corncobs around the sides of the cans.

MODERATOR CHADWICK: Where is the next question?

MR. ROLAND DE WILDE: I was going to ask the gentleman who used the polyethylene tent whether he used black polyethylene to take care of his heat problem Would that help?

MR FRANK TURNER· We used the clear polyethylene. We depend upon the ventilation to take care of the heat and we think that we have as good a control over our structure as you would normally have over an ordinary cold frame covered with hot-bed sash.

MR. DE WILDE· That doesn't quite answer the question, but I think I can see how it works.

We in the past have had quite a lot of trouble with splitting and we found that this was aggravated in the days when we used mulch, especially during the summer months. You will get a lot of good out of the summer mulch because the plants will grow better when you keep the soil cool. We found when it came time for the first frost, that your interchange of heat between the soil and the air was, of course, shut off by the insulation from your mulch As a result the least little bit of frost would kill your flower buds and also would cause splitting, sometimes all the way down to the stem. So what we have found is best now is to either use no mulch or just use it very little during the summer. Where we use it for winter protection we don't put it on now until after we have had a fairly heavy frost at a time when we feel the plants are dormant and we don't have to worry about splitting. I do not know whether that applies to the canned stock.

MR. HILL: I have heard that explanation. It is a very interesting effect It is that the winter air above a mulch gets appreciably colder than the same air over an area that is not mulched. I think there was a paper on that by John Creech, who had that same trouble with azaleas.

MODERATOR CHADWICK: Are there other questions?

MR. RICHARD BOSLEY (Mentor, Ohio) · Ken, would you care to comment on Dave Dugan's idea of putting canned material in the darkness? Sometimes you have structures available but you wonder wonder what effect you might get from keeping an evergreen or broadleaf in an environment such as this.

DR. REISCH: I have asked the same question.

MR. DAVE DUGAN (Perry, Ohio): We have not been able to obtain a definite answer to this question but we are going to shoot the works. We are putting some in complete darkness and some in a cellar which has some light coming in from a north light high in the roof. We are stacking everything from one can high to around 8 or 10 cans high.

I guess you will have to come to Cleveland next year and we will tell you what happened. I have good evidence from growers that you can put evergreens in complete darkness and also excellent evidence that you can't.

MR. RALPH M. FISHER (Morrisville, Pa.): When storing broadleaves in complete darkness I will predict that they will be pretty yellow toward spring We used to store as high as 30.000 *Daphne cneorum* a year and unless you gave them some light they weren't very saleable in the spring. That has been my experience year after year. I think you will get some chlorosis.

MR. DUGAN. Up to this year we have stored our cans by plunging them up to the surface of the can. Sometimes the fellows doing the mulching get a little excited about it and the sawdust got piled up and over the top of the plants in both the holly and firethorn groups. Those which were completely buried with sawdust came through the best. There was no windburn, and I am sure there was no light.

As I say, we are shooting the works. I was asked back here whether this storage was going to freeze The one is a bank barn. We get a little bit of frost in that one. The other one is an old nursery storage, and that one gets cold to the point where maybe the water hydrant will thaw out if you burn a newspaper under it. They have been in these conditions about a month now and are still green.

MODERATOR CHADWICK. Before we take these next two questions, is Vince Bailey in the room? Vince, I think you have had some experience on packaging of evergreens in the fall and putting them into storage where they have been in complete darkness. What has been your experience there?

MR VINCENT BAILEY (St Paul, Minn.): Our experience in storing transplanted evergreens and liners has been very good. We have had no discoloration whatsoever. They have come out in the spring in very good color. You would never know they had been stored in complete darkness These have been stored under a temperature of 32 degrees until about the middle of December when the room went below freezing. In the middle of March it thawed out and was kept at 32 or 33 degrees until planting time.

I just wanted to comment on the stacking of these canned goods, also. We have done that for three or four years but not with coniferous or that type of material. We have piled them up about 12 or 14 high, and have had very good results.

MODERATOR CHADWICK: Vince, before you leave, what kind of evergreens do you store?

MR BAILEY: Colorado spruce, Blue spruce, Ponderosa pine, Pfitzer juniper, Andorra juniper, and arborvitae.

MODERATOR CHADWICK: No broadleaves?

MR. BAILEY: No.

MR. HUGH STEAVENSON: We have a very large and dark cave, which is available to us and we stored broadleaves in variety last winter, and they seemed to come through all right. In fact, they looked pretty good.

I would like to take this opportunity to comment on one point while I am up here. I think there is misconception that has crept into the discussion on this matter of liquid feeding versus dry feeding of the organics.

I know that all the panel members are well aware that for many years many growers in the parts of the country where they have been growing a long time have been dry feeding, with results equal to the best of the liquid feeding techniques. And, of course, when you dry feed, it does bring the slow pay-out organics into the picture. The cost consideration is irrelevant as far as the materials are concerned, of which we are all aware, because you are talking about a small fraction of a cent for a container at best. As a matter of fact, when you sprinkle on the inorganics you are using a lot more fertilizer and feed than the dry application.

I would like to say something, too, on handwatering versus sprinkler watering. A lot of us feel the best possible way to water is by hand.

Therefore, it is a matter of cost. Now this year we have 100,000 cans. Two men did the watering, spacing and pruning. The cost of actual salary was $2,000 which came down to two cents per can per season. Now we couldn't cut it more than a cent, so it is a case of whether a cent extra cost isn't worth the difference in quality and insurance of a good job. I don't think as growers we have to throw out the idea that we have to have sprinklers and we can't hand-water and/or that we can't use a liquid feed. There is plenty of opportunity for the smaller operator who is not dry feeding and is hand-watering.

DR. WAXMAN: Just to get back to the overwintering of evergreens and storage of evergreens in darkness, I think it is really a matter of temperature. If they are brought in too early in the season and we have a warm fall and the temperature gets rather hot, then you might get a fairly high rate of respiration and you get yellowing. This might occur if you have a warm spring. You are taking a chance. If you are lucky enough to have a cool fall, then you are safe. I think it is mainly the rate of respiration, if you are concerned whether an evergreen gets yellow or not.

MODERATOR CHADWICK: Hans Hess has a question.

MR. HANS HESS: I would just like to offer this as far as the storage of evergreens is concerned. We have been concerned with the storage of seedlings for a long time and last fall, about November, I put in plastic bags a number of different varieties of bare root seedlings. The bags were tied and put in a refrigerator maintained at 34 degrees F. I took them out in the spring, planted them and got normal growth without yellowing. Now among these were hemlock, various pine varieties, Norway spruce, arborvitae, and many other conifer varieties. We also tried certain deciduous material such as Mountain ash which were 50 per cent successful Oaks were a complete failure. *Viburnum* varieties came through well, although dogwoods and magnolias did not survive.

MODERATOR CHADWICK: Ladies and gentlemen, we have been going just about six and a half hours on this question of container production of nursery stock. I am sure that we have not answered all of your questions, but I hope we have answered a few.

Before we break up the session I think first of all you should give these panel members, a good hand. They have put in a lot of time on it. (Applause)

The session recessed at 5:00 o'clock.