spread enough to interfere seriously in the production of large hybrid populations as outlined above.

MODERATOR GERMANY: Our next speaker is a very erudite gentleman who recently, I understand, celebrated the 100th anniversary of his firm. This morning he is going to give us a talk on chemical weed control in seed beds, Mr. Tom Pinney, Jr.

CHEMICAL WEED CONTROL IN THE SEEDBED

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Hand weeding of seedbed areas is a costly operation. It will reduce our firm's profits this year by $4,435.13. This figure represents only the direct labor costs and doesn't include applicable overhead items such as social security, workman's compensation, group insurance, etc.

Our cost estimating system reveals some rather interesting facts concerning the cost of hand weeding our seedlings. Although our field inventory showed we had approximately 5,750,000 salable seedlings as of August 15th, 1964, past sales records and transplant production schedules indicated that we could expect to market or use only 3,450,000 of these seedlings. This represents just 60% of our original inventory! The difference is mainly caused by: a. over production of specific items due to lack of market forecasts, coupled with inadequate preparation and use of production schedules. b. destroying of desirable seedlings in the hand weeding operation. c. weed competition. d. winter kill. Since the field inventory includes one, two and three year old seedlings, the figure of 3,450,000 was developed with the assumption of one "turn" every 2½ years. Too often costs are developed, and then quoted, based on the total plants a nursery has to sell — rather than what will *actually* be sold or used.

If we include the overhead items applicable to this situation, we would need to add 7.0% to the direct labor charge of $4435.13. The figure would then amount to $4745.59. Since we estimated that we would sell or use only 60% of our inventory of 3,450,000 seedlings, the cost per 1000 plants would be $1.38 or approximately $1.40 per year. If the item is a two year crop — the cost would be $2.80 per 1000 and on a three year item — $4.20 per 1000 plants. This often represents 20% of the selling price. Looking at it another way, we have approximately eight acres in actual seedling production which means it costs us approximately $600.00 per acre, per year, to hand weed these areas.

Other than overhead, hand weeding is our most costly expense in the production of seedlings. Therefore several years ago it became apparent that we must consider a chemical weed control program for our seedling production. The development

of such a program will help us as a firm to achieve many of our goals such as: 1. mechanization of production practices to the highest level economically feasible. 2. the development and maintenance of a "team" of well paid, well respected, permanent key employees coupled with an ever decreasing number of seasonal, low paid laborers. 3. the continual striving for the quality plant best suited to meet the needs of a particular market in addition to 4. helping improve the image of the industry.

We have worked with a chemical weed control program in our transplant areas since 1954 and it has been a great success. We have approximately 70 acres of land containing 2,350,000 transplants under this program. In 1964 it costs us $3017.16 for this program including direct labor (both hand & chemical) and applicable overhead such as machinery depreciation, maintenance, etc. Past records indicate that 75 - 80% of this stock is sold or replanted. The approximate cost to us in 1964 for this chemical weed control program on our transplants was $1.75 per 1000 plants per year or $45.00 per acre per year! This is a tremendous savings over the $800.00 - $1200.00 per acre per year it cost to hand weed prior to 1954.

There has been a great deal of information published on chemical weed control in transplants compared to seedlings. The seedling areas add some problems and certainly require a more refined program. There are three general approaches to a chemical weed control program for seedbed areas: (1) Sterilization before planting the seeds (2) a pre-emergence program (pre-emergence refers to the weeds, not the seedlings) and (3) a post emergence program.

Since I am a nurseryman and not an expert in the field of chemical weed control, the comments which follow are observations and conclusions developed through working closely with the various university personnel in this field, discussions with fellow nurserymen and actual field tests conducted at our nursery. Therefore, much I have to say may be applicable only to our particular soils, climate and operation.

The sterilization approach has been used successfully for many years. There are two general categories — steam and chemical. The chemical category is typified by products such as Methyl Bromide, Vapam, Mylone, etc. The main advantage is that some of these chemicals kill soil born organisms such as nematodes and damping off organisms in addition to the weed seeds.

There are, however, several disadvantages. Steam sterilization is rather expensive and bulky to handle. The Dutch have developed an elaborate steam sterilization program utilizing the "steam rake" and other refinements. The normal sterilization process is not selective and destroys both the desirable as well as the undesirable organisms. A recently developed concept called "areated steam" may partially overcome this disadvantage.

Another serious drawback is the "blow in" problem. There

is no residual effect to a sterilization program and thus the area treated may be re-inoculated by wind or other means. Most of the products used require, or give the best results, when tarped. Although this process is now mechanized, it is still costly.

Another disadvantage with chemicals in our area is that they must be applied when soil temperature are quite high, such as July and August, and left tarped until used in November, to prevent "blow in." The cost per acre of these chemicals and their application is $300.00 - $700.00 per acre and we can observe little control of weeds past the first year. It appears to us that this method at present is not too well suited to our particular seedling production program.

Our successful transplant chemical weed control program is basically of a pre-emergent type. It has the excellent advantage of being inexpensive. If we were able to secure somewhat near the same degree of control with chemicals in the seedling program as in the transplant program, it would cost us approximately $ .15 per 1000 per year as compared with $1.40 for the hand weeding operation. A further advantage is that the material can be re-applied as the residual decreases. The residual factor could be a disadvantage too. This can be largely overcome by laboratory and field experimentation which will determine the residual properties of a specific chemical. This means that one must then carefully select the proper chemical for a specific job.

Another advantage is that most of these chemicals have little effect on the soil organism "balance." Again this can be a disadvantage if it is necessary to control the pathogenic organisms present in the soil. A final advantage is the flexibility of such a program since there are more chemicals and combinations to choose from. It appears to us that this approach to a chemical weed control program in seedlings has some real advantage.

The third approach, post emergence, attempts to kill the weeds after they have germinated and started to grow. Stoddard solvent is a typical example. This approach has several disadvantages. One group of these are contact killers which burn off the young weeds and generally will burn most deciduous seedlings as well. Also this group has little or no residual effect. The second type, which generally kills by interference with some metabolic system of the plant, is not sufficiently selective to differentiate weeds from desirable seedlings.

Although we have continually experimented on a small scale with chemical weed control in seedlings, our first real concentrated effort was begun last summer. We gradually developed a plan of attack by first eliminating sterilization methods since they were rather expensive and difficult to program into our operation at the present time. It thus appeared that a combination of pre-emergence and post emergent method offered us our best avenue of approach.

The first step will be to eliminate all existing weed vegeta-

tion, especially perennials, by good rotation methods which in our case is a series of green manure crops of silage corn. This means we are planting into an area in which any future weed population would have to come from seed rather than existing roots.

Once the seeds were planted, and up to the time they germinated, the weeds would be controlled by a very powerful post emergence contact killer which has no significant residual properties to hinder germination of the seedlings. The chemical we plan to use in this phase is Paraquat at ½# - 1# actual per acre.

The second phase begins when the desirable seed germinates and the straw is removed, exposing the delicate seedlings. From this point on we will make use of a pre-emergence type chemical. Here is where most of our experimentation was centered last summer and fall. There is a wide range of chemicals to choose from. We selected five pre-emergence chemicals for study during the summer. Dacthal, Vegatex, Eptam, Propazine and Diuron. Dacthal should be applied at rates of 4 - 8# per acre. (all rates are actual) It is prepared as a 50 or 75% wettable powder and requires constant agitation. It has a very short residual and works best when soil moisture is adequate. Incorporation into the soil is of no benefit.

Vegatex (CDEC) should be applied at rates of 6 - 12# per acre. It contains 4# per gallon. It too has a rather short residual and works best when soil moisture is adequate. Incorporation into the soil may help.

Eptam should be applied at rates of 4 - 6# per acre. It contains 6# per gallon and performs best when worked into the soil. Treatment results have often been erratic.

Propazine should be applied at rates of 1# per acre. It is prepared as an 80% W.P. and needs constant agitation. It has a much longer residual than either Vegatex or Dacthal. Since it is slightly soluble in water, it doesn't move down into the soil where it could be absorbed by the desirable seedling roots.

Diuron should be applied at ¼ - ⅓# per acre. It is prepared as an 80% W.P. and needs constant agitation. It, too, has a rather long residual and doesn't readily move in the soil.

Some general observations from last summer's experimentation with the above chemicals indicate (1) Dacthal and Vegatex must be applied soon after germination of desirable seedlings since they are effective only on newly germinated weed seeds. Also one application apparently will not "hold" for the entire season. (2) Eptam gave good control in two year old seedlings that were cleaned of weeds and the chemical then applied. However, it had an effective residual of only two months. Also a later application of the same rate, and under generally the same conditions, was completely ineffective. (3) Propazine apparently works rather slowly as does it's relative Simazine. When Propazine was applied to the clean weeded two year seedlings it was slow to take effect. At first the Eptam looked excellent, but after two months the Propazine looked better and held it's

effectiveness through the entire season. (4) When ¼# of Diuron was added to the 1# Propazine, the results were much improved and even afforded some control of existing perennials weeds which had come from roots remaining in the soil after the weeding operation. (5) It appears that much more study of the timing aspect of the pre-emergence chemicals is necessary so as to secure maximum weed control with a minimum of injury to the desirable seedlings.

At this point it would be well to note that presently there are no outward manifestations of phytotoxicity with any of the rates mentioned on conifer seedlings. Most of the applications were made, however, only after the seedlings had gone through one winter. One deciduous item (*Eleagnus angustifolia*) showed leaf burn and reduction in stand when the ¼# Diuron was added to the 1# Propazine.

It is important to remember several factors which are vital to the success of this type of chemical weed control program. (1) Be sure that all machinery has been *properly calibrated* so as to apply the correct amount of material. (2) Begin experimentation on a *small scale*. Never spray more plants than you are willing to *kill* for experimental purposes. (3) Apply at three rates, ½ the recommended, the recommended and twice the recommended rate. (4) *Record* and *analyze* your data. (5) Have at least three years experience with a specific chemical, rate, time of application, variety, etc. before placing large areas under such a program. (6) Never say it can't be done—just visit your progressive fellow nurseryman.

Since most of our observations are based on only one year's work, it would be best not to list the varieties we observed to be tolerant since someone is sure to go home and spray a large area only to find that one year's work does not supply sufficient data on which to base major decisions.

We are sure that within 5 - 8 years we will have a full fledged chemical weed control program for our seedbed areas. We have been challenged to cut the cost of production of seedlings in view of absolute necessity of increasing profits in our industry — and we are planning and intend to meet this challenge.

MR. CASE HOOGENDOORN: What colors would you use in crossing Rhododendrons to obtain a good yellow?

DR. MEHLQUIST: If I knew the answer to that question, I would be millionaire, because everybody wants yellow. The trouble is that there is not a single yellow that is even relatively hardy. I would suggest crossing the clearest and hardiest yellow you can get your hands on — it will not be any hardier than H-3 or H-4 — cross it with something that is very hardy such as catawbiense. Now catawbiense album is recommended as is La-Bar's white. I am not absolutely certain that it makes any difference which one of the catawbiense you use, because your first generation hybrids will not be yellow in any case, I don't think.

Then select the best out of those first generation hybrids and intercross them and self them and I guarantee that you will get some yellows back. You may not get the yellow color with the degree of hardiness or shape in the first try. It may take very large numbers because there may be three of four genes for color and three or four genes for hardiness, and three or four genes for shape and habit. Bear in mind that if you have only 3 genes involved your recessive segregates will occur only once in 64 times. If you have four genes once in 256 times. So you may have to raise large numbers. But if you raise limited numbers from the best selections for a few generations, you will have your hybrid I think. You must realize that either you or I may not see the results. Many of the finest hybrids we have today were bred by people who have long past to their just reward.

CASE HOOGENDOORN: Do you have any history of the Dexter Rhododendrons?

DR. MEHLQUIST: No, I don't think anybody has much of a history except that which they have been able to reconstruct from the behavior of Dexter hybrids in breeding programs, together with what little information Mr. Dexter left behind. Unfortunately, Mr. Dexter made a large number of hybrids involving many species and then he gave away large numbers of these species. Most of the Dexter hybrids we have today were developed in that group which he gave away with little information. Most of the people who received these seedlings have already passed away, so we can only reconstruct the probable path of progress.

CASE HOOGENDOORN: I have a yellow Dexter, a real good yellow, and I wonder if you have any history on its crosses or how he arrived at this selection?

DR. MEHLQUIST: I'll come over and get a couple of plants for breeding work.

CASE HOOGENDOORN: Try and get them!

DR. MEHLQUIST: All fooling aside, Case, the yellow breeding program is probably the most complex part of Rhododendron breeding we can underetake. We have found in many plants that the clear yellow colors are recessive to all other colors. That means quite a bit of work. It took me thirty years to work out the breeding of yellow carnations. Now I can breed them at will, but I still haven't produced a single yellow carnation that is as good in other respects as the Sim's carnation. But it took a whole life time to breed the Sim's carnation.

ROLAND DEWILDE: I may have missed part of what Dr. Mehlquist said, but I got the idea that he advocated the growing of a number of hybrids from seed. They would be produced by definite crosses and that they could be sold.

DR. MEHLQUIST: Yes, to replace the large amount of collected material that is now being sold, most of which is not what it could be. It's not difficult to raise them from seed.

ROLAND DEWILDE: I realize that, the only problem that I

want to point out is that you get a large variation in hardiness in hybrid seedlings.

DR. MEHLQUIST: Not if you always use for one of the parents one of the hardy species. If you use catawbiense or maximum you will nearly always get hardiness, particularly if you use catabiense because that one is almost homozygous for hardiness.

ROLAND DEWILDE: That's true enough. But to get any kind of a color that doesn't contain too much of the catawbiense you have to pick your seeds from the hardiest reds. And even then about 10% of the population in my climate tends not to be bud hardy. And the hardiest ones tend to be the ones with the poorest color.

DR. MEHLQUIST: That is because there is a linkage between catawbiense characteristics and hardiness. In other words the gene for hardiness also carrys that bluish color you are trying to get rid of. But if you cross catawbiense to one of the really red hybrids such as vulcan and then intercross these hybrids, you soon get good reds. You will have varying degrees of hardiness but these first generation hybrids will be very deep pink and will serve your purpose for reds just as well in my opinion as nova zembla until we get good clones. Now, I have no doubt that for the future, Rhododendron plantings will be based on fine clones. But since it takes 10 - 15 years to put a clone on the market and get it generally established — it takes time to propagate them and one or two bad winters to really find out what is really hardy — in the meantime we would have something that would be, in my opinion, far superior to the usual forms of catawbiense and maximum that are now being offered to the public.

ROLAND DEWILDE: This may be theorically true, but I do not know whether I agree with you from the economics standpoint. I've already found out, for one thing, that I can raise a rooted cutting of a red clone considerably cheaper than I can raise seedlings. I think a two year seedling on the average will cost me somewhere between 25 and 30 cents and for that I can root a one year cutting and may be even a little cheaper from a production standpoint. And at the rate of two year plants I am going to have a plant a lot bigger and a lot better with no more cost than I would have if I grow a two year seedling. I feel we already have some pretty good red hybrids such as nova zembla which is a very reliable red in most areas of the country and kettle drum that are fairly hardy. All in all I find it hard to beat these clones with hybrid seedlings.

DR. MEHLQUIST: I would agree with everything you say except your cost figures. If you can raise rhododendron cuttings for 25 cents then you should be in business doing that and nothing else. The market price for the varieties you cited runs from 40 to 90 cents in limited lots. I have never seen them offered for less than 40 cents even in very large lots. If you can produce them that cheaply, by all means do it. But there

are may people who persist in selling the collected plants of catawbiense and maximum. It is primarily to these that I am directing my views of growing hybrid seedling populations.

RICHARD FILLMORE: Occasionally in the south you will find isolated areas of catawbiense with as few as 50 - 75 plants in an acre or less of land with no other indigenous catawbiense for 40 or 50 miles around. Are these catawbiense likely to be exactly like the ones in the mountains, for example, with respect to heat resistance?

DR. MEHLQUIST: I wouldn't know. There is only one way to find out and that's to try them. Generally speaking, the plants which grow on the mountain tops have higher cold resistance and it seems rather peculiar that they would also have higher heat resistance. The reason they acquire the heat-resistance growing on a mountain top where it is normally cool, is that they are exposed to drying winds. Any plant which through evolution becomes adapted to withstand drying winds is usually heat resistant. But the fact remains you have to try them.

Now, most of the people I have been observing in the nurseries have some nice catawbiense and maximum sitting around which they thought were too good to let go for the price which these plants brought. So they kept the best ones at home, properly so. These plants are the ones which they should use in their own breeding program — plants which have good looks and have withstood the conditions in their nurseries for some time. You will bear in mind that I said when it comes to knowing the plant material, it ought to be observed for a number of years before you make up your mind about it.

MODERATOR GERMANY: We have reached the end of our time. It's been a pleasure to be your moderator today, I think we have finished a very fine program. I will now turn it back to President Roller.

[*Editor's Note*: President Roller conducted the business session and introduced the new president, Mr. Vincent Bailey.]