RESEARCH AT THE NURSERY LEVEL

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I shall illustrate with slides some of the types of applied research which we as nurserymen can carry out in the course of our daily business. For those who are not in attendance at this meeting, a description of these projects will make up this article.

I feel that in order to upgrade the industry, basic research from institutions all over the world must be translated into applied research within the institutions and within the industry. A free exchange of information in detail amongst teacher and students, research scientists, and members of the industry is very important. A seemingly insignificant detail found in research may prove to be the missing link which may bring success to a practical plantsman. Or close daily observation in the field can bring to light valuable insights to be pursued further by the scientist or student.

The industry needs to cut down the lapse of time between research and practical application in the nursery. Organizations such as our International Plant Propagators' Society can help prevent this lapse of sometimes as much as thirty years between basic research and application. As nurserymen we cannot afford to wait, but should set up controlled research plots to check out problems which come up under our own conditions which may be a little different from those of our fellow nurseryman a few miles away, or from the basic research that was done under laboratory conditions.

ROOTING IN AIR

The rooting chamber which I described to you several years ago (1, 2) is now used in conjunction with a vacuum tank which we built to introduce various liquids into the cuttings. This rooting in air allows daily observation and may help to answer such questions as:

A. *How does wounding a cutting increase roots?* A review of this was given in 1962 by James Wells (3). A research project in The Netherlands (4) indicated that not only does wounding increase hormones in the plant, but may at that time, reduce the inhibitors being produced. By repeated trials, we found that the introduction of plain water by the vacuum system increased rooting. This also proved true of restuck cuttings of *Picea pungens* 'Glauca' and *Rhododendron.* Those which failed to root in the spring were retreated in a number of ways to find why the few remaining ones did not root like the others. Again, water forced into the cuttings was the best treatment. This would seem to point to the introduction of water as a major factor in the results obtained from wounding a cutting.

B. *What is the relationship between the location of the cutting wood on the stock plant and the concentration of hormone needed to obtain best rooting?*

C. *What are the best hormones for specific plants and what are the best concentrations to use?*

With the air chamber and vacuum tank, we have tried replacing the normal liquids in the cutting with hormones, plant food and other elements. We have also tried to bring about certain chemical reactions in the cutting with cold storage treatment.

A basic rule is that to get the same results each time, you must repeat the same procedure exactly as you did it before. As you can see, it is a wonder that we ever repeat our results in rooting, as we now have so little control over the factors involved. Maybe someday we will be able to work out details on all that is needed for optimum rooting of various species. Then perhaps we can produce an indicator by tissue color, or possibly by electricity, to measure the proper time to take the cutting and the proper way to treat the cuttings.

EXPERIMENTS WITH CHEMICALS

To compete in this mechanized age, nurserymen can well look into the possibilities of a greater use of chemicals to cut down labor. Chemicals can kill weeds, prune plants, improve sanitation, control pests and diseases, and retard or enhance growth, flowering, and fruiting.

We can sometimes borrow a chemical from another industry for a similar use in our own industry. However, we must use extreme caution to check out interreactions between different chemicals applied to the same plant, such as fertilizer, herbicide, insecticide, fungicide, etc. Bad reactions are apparently showing up in our area between ammounium sulphate and 16-20-0 fertilizers used with herbicides. Calcium nitrate used as a form of nitrogen together with chlorinated water, ties up the chlorine so that no free chlorine is available.

If we are to continue the unrestricted use of chemicals, we must obtain more information regarding their effectiveness, their safety, and their impact on the total environment. Even now as we are faced with increased controls or loss of the use of DDT, we may later be faced with increasing doubt as to the place of agricultural chemicals in our society. Individual research under widely varying conditions should help to produce some of the needed answers.

USE OF INDICATORS AS SAFETY MEASURES

Under our conditions with a heavily organic soil mix in containers, we found that all the chemical weed killers applied in the summer broke down or were tied up in 30 to 40 days, with the exception of Casoron. We used seeds of rye, lettuce, or radishes as indicators to determine when an additional application of the herbicide was needed and would be safe. Even

Atrazine applied at 5 lb/A to kill certain weeds, left no residue to damage rye planted 30 days later. *This year almost all* of our 500,000 containers as well as our fields were treated with chemical weed killers. Using these indicators put us in control — we could measure toxicity and keep plant damage to a minimum.

A NEW PROBLEM WITH WEED KILLERS

To have just one weed killer which does a good job is not enough. We find ourselves working with at least 10 different weed killers, using them for a special plant or condition at a given time. This year we encountered the one thing we have always feared — that of weeds building up an immunity to a certain chemical.

In 1958 we first used Simazine and until two years ago, it remained our basic chemical on some 80 acres of field stock. Then some fields were changed to Atrazine in an attempt to get better control of grasses in areas that we had intended to dig out. Groundsel began to appear last year in places, but we were not too concerned as Simazine was to be used again this spring for control. On new plantings as well as old, in the spring of 1969, Simazine up to 3 lb/A alone, and in combinations with other chemicals was used, with no control of groundsel.

To check further on this lack of control of groundsel, we set up a weed research block using some 10 varieties of plants in 1 gallon containers. We also attempted to test other factors such as effect of the time of the day and method of application, amount and method of applying water, granular versus liquid application, effect of liquid fertilizer and chlorination, and degree and length of control and toxicity.

On checking with the Western Washington Research and Experiment Station at Puyallup, Washington, we found that Simazine was still giving control over groundsel there. We began to suspect that we had developed a strain of groundsel resistant to Simazine. Dr. George Ryan at the Research Center obtained from us some seed of our form of groundsel to test against his form in a controlled research plot. From his programmed data, he found that his form of groundsel could be killed with ½ lb/A of active Simazine while our strain showed resistance to 16 lb/A (5). Further work on this problem is continuing.

ETHREL POTENTIAL

This last summer we experimented with applications of Ethrel (2-chloroethylphosphonic acid) to see if it might improve rooting of cuttings. When Ethrel was applied to corn to reduce the foliage for fungus control, roots appeared on the stalks of the plants. We ran many experiments with Ethrel alone and in combinations to try to produce roots on cuttings — all with very few results. Feeling that to produce roots, Ethrel should, perhaps, be applied to the stock plants, we tried it in late August (afternoon temperatures of 74°F) at the rate of ½%, wetting the tops of the plants. Under our conditions at this rate, both cotoneasters and heathers responded with a retarded growth, darker foliage, but no leaf abscission.

With these results, we then felt that perhaps Ethrel might have some merit as a growth regulator. From reports at the ASHS meetings at Pullman, Washington last summer (1969) there were mixed results on fruits and vegetables from the application of Ethrel and Alar, separately and in combination. No work was reported on ornamentals. However, it was reported that Alar would modify Ethrel-induced abscission.

Under our conditions, a 1% solution of Alar alone applied on actively growing azaleas and rhododendrons helped in bud formation, but did not adequately check two-vigorous vegetative growth. We plan to test further to see if a combination of Alar with Ethrel may produce the desired results of a good bud set and a more compact plant.

SANITATION

Sanitation at the nursery level still needs much attention in the way of better chemicals and improved methods.

Water is sometimes an unsuspected source of infection. The lake from which we pump our irrigation water appears very clear and the water tests show little chemical or salt content. However, we were noticing a loss of plants in the summer apparently from water molds, a root rot infection commonly due to *Phytophthora*. On the recommendation of O.A. Matkin of the Soil and Plant Laboratory, Orange, California, we tried chlorination of the irrigation water.

We installed a gas injector to chlorinate the water at 1 ppm at the lake, giving us ½ ppm at the sprinklers. This was enough to destroy the bacteria and fungi in the lake water and still give us ½ ppm of free chlorine. We were encouraged to find that plants already showing injury to the root system responded very well when transferred to an area being treated with chlorinated water. The chlorine seemed to retard further growth of the root rot.

We could find little data available on plant toxicity from chlorination, so we experimented with various strengths. In one test, we applied 10 ppm chlorine in irrigation water to the tops of gallon cans and found 1 ppm free chlorine in the water taken from the bottoms of the cans. The soil did not take away all of the active chlorine as the water moved downward. Some free chlorine appeared from the bottom of the containers even at the reduced rate of application of 5 ppm.

A sanitation program needs to be somewhat comprehensive to achieve noticeable results. Why fumigate a field or sterilize a soil mix and then later contaminate it with nematodes and harmful pathogens by the irrigation water? A complete sanitation system would include clean facilities, clean plants, soils treated with chemicals or aerated steam, and clean irrigation water. Ideally, it would prevent problems from developing. Why apply a certain fungicide to a pathogen, for example, some of our water molds, that can be killed only by heat? Fungicides, insecticides and other chemicals could be used to correct temporary problems which may still arise. It would seem, though, to be of doubtful value to use repeated applications of chemicals merely to hold down a condition of *Phytophthora*, only to grow plants dependent on the chemical for survival. Such a practice would seem to have merit mainly on plants sold for a short-lived use, on cut flowers, on food plants, or on rare plants or those in short supply needed for propagating stock.

THE FUTURE

In the future, we may look forward to improving sanitation through the principle of inoculation, such as have been used on humans by vaccination for many years. Dr. Kenneth F. Baker, of the University of California, Berkeley, has been working on this principle in Australia during this past year.

The future holds much promise for our industry. We have just begun to scratch the surface. The key to our future success lies in research. Let us as teacher, student, research scientist, and nurserymen continue to put basic and applied research together to unlock the potential of the now still unknown.

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CHARLES HESS: Bruce, thank you very much for a very inspiring talk. Our next speaker is Mr. J. D. Murphy from the University of Illinois and he is going to talk to us about direct rooting media.

COMPARISONS OF VARIOUS INDIVIDUAL MEDIA FOR DIRECT ROOTING OF CUTTINGS

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The vegetative propagation of ornamental plants presents many problems. Some problems result from the number of times cuttings must be handled. They must be taken, made up, and stuck into a rooting medium. After the cuttings have rooted, they must then be removed from the rooting medium,

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