very demanding. This method adapts to our total production cycle.

LITERATURE CITED

1. Hoogendoorn, C. 1971. *Viburnum dentatum* as an understock for *Viburnum carlesii* or *V. carlesii* 'Compactum'. Proc. Inter. Plant Prop. Soc. 21:384–385.

VOICE: Have you tried *Viburnum lantana*?

DIXON HOOGENDORN: We do not use it because it is susceptible to a leaf spot disease that weakens the plants in late summer.

ABNORMAL GROWTHS ON MICROPROPAGATED RHODODENDRON

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At last year's IPPS meeting in Chicago I participated in a panel discussion focusing on industry sensibilities from the perspective of a new plant introducer. We considered the values of new introductions along with potential problems, especially in relation to tissue culture propagation. My part of the presentation also outlined my views of the propagator's particular obligations relative to new plant introductions.

During the past year I find that my situation as an introducer of new rhododendron cultivars has become affected by an alarming development. Micropropagation of many of the cultivars my nursery has introduced is apparently producing significant numbers of plants that have characteristics different from those of the parent plants.

Let me first note that the vast majority of micropropagated plants now in the market appear to be normal. It is not my intent to discredit responsible use of the micropropagation technique. However, I am very concerned that the problem of abnormal plants produced during micropropagation, now very evident among some growers, be addressed immediately.[1]

[1] Knuttel Nurseries, East Windsor, CT grows over 90 rhododendron cultivars on 57 acres and produces 100,000 plants a year. In 1985 Anna Knuttel was forced to quickly rebuild her supply of plants after experiencing a problem with incorrectly manufactured fertilizer that destroyed much of her crop. She chose to rely upon micropropagated plants as a major source of stock because of the large numbers she needed on short notice. She estimates that she has lost to date over $59,000 in revenues on the plants that are abnormal and cannot be sold.

The following abnormal growth conditions have been observed in micropropagated plants. Foliar variation in size, shape and color of leaves appear, as well as apparent increased susceptibility to disease and stress problems. Flowers are sometimes affected by added or subtracted parts, or refusal to flower normally. Plant growth itself is often altered. In some plants the root-stem connection is weak and the resulting plant is not properly supported. Dwarfing, "brooming", or contorted stems and branches occur in others. Susceptibility of the entire plant to disease has also been reported.

It is possible for variations to be induced by factors involved with growing the plants, such as herbicides, fertilizers, soil conditions, or other environmental variations. However, among the growers I know experiencing similar problems, the only consistently common factor seems to be that these plants were propagated by tissue culture.

One of my personal horticultural interests is searching for mutants and variants, such as witches brooms, that occur occasionally in natural populations. If variations such as I am describing occurred in nature I would be very excited and interested in propagating them to see how they perform as individual plants. Perhaps this is a possibility with these as well, and it is interesting that these abnormalities can apparently be tissue-culture-induced. But the fact that they are being improperly sold as a clone of the original creates a moral dilemma for every nurseryman who handles them. I also believe it poses a serious long term challenge for our entire industry.

Many of the cultivars now exhibiting abnormalities were developed by my father, Ed Mezitt, and introduced by our nursery. They are all the result of many years of breeding, selection, testing, and evaluation. One of the primary assets of any business is its reputation. If the cultivars we developed turn up in the market different from what the customer expects, there is a high potential for damaging the name and reputation of our nursery, thereby threatening our future business.

In addition, every unsuspecting grower is also a big loser when plants that are not true-to-type are grown. Both short term profit and long term reputation stand to be diminished. If the plants are not recognized as different from what they are supposed to be and sold as usual, a grower becomes an unsuspecting perpetrator of the problem. This can affect how customers perceive a grower's competence and expertise. If a grower does recognize a problem, a number of questions arise: is this really the right cultivar or not; did I do something wrong; how serious is the problem; will it correct itself naturally; and should I sell the plant anyhow?

These and many other perplexing questions soon compound and become entangled with economic considerations. The question

then becomes one of obligation and increases in complexity as long as it remains unresolved. Who is responsible for the problem? What should I do to correct it? Does the lab know there is a problem? What recourse do I have? What should I do with the abnormal plants if I can't sell them? Should I be buying tissue culture propagated plants at all?

Examples of the type of problems I have seen include the following.

1.) A white-flowering *Rhododendron* 'Sidestep' that we mistakenly micropropagated for what we thought was a pink-flowering cultivar. The explant tissue was taken from the wrong plant and the mistake went unrecognized for over three years. By then we had over a thousand plants growing in our fields. Examples of mistaken identity are relatively common in any type of propagation. They are also easy to correct providing communication is properly handled once the situation is recognized.

2.) *Rhododendron* 'Henry's Red' exhibits petaloid flowers on a micropropagated plant. The normal plant has single flowers.

3.) Tissue culture propagated *Rhododendron* 'Scintillation' is more compact than normal and exhibits cupped foliage. *Rhododendron catawbiense* 'Album' has shown variegations in the leaf and apparent susceptibility to disease. Even though neither of these two cultivars are our introductions, they are standards in the industry and commonly grown by many nurseries.

4.) *Rhododendron* 'Molly Fordham' at Knuttel's Nursery in Connecticut. This nursery bought 2,000 micropropagated plants from a tissue culture propagator in 1986; 929 of them are growing in an abnormal manner with leaf distortion and "brooming", and 477 have already died. Only 597 of them appear normal. Of 2,000 *Rhododendron* 'Algo' micropropagated plants purchased in 1987, only 430 appear normal. The remaining 1570 plants show varying degrees of congested branching and abnormal foliage.

5.) *Rhododendron* 'Milestone' has shown severe stem contortion and compression, and deformed foliage.

6.) *Rhododendron* 'P.J.M.' shows variations in growth, "brooming" of stems and branches, as well as apparent increased susceptibility to root disease problems.

Why does our industry face this situation now? It seems to me there are three major reasons. *First,* tissue culture, by its very nature presents new types of decisions that are probably foreign to us as propagators. The particular pressure of very large numbers of

plants being rapidly produced from tiny bits of plant tissue magnifies the problems exponentially. This is a tremendous acceleration in the rate of propagation over the traditional propagation techniques. It is extremely difficult for the propagator to effectively compensate for errors that might occur, especially if their nature is unknown. By the time a problem is recognized, thousands upon thousands of plants may already be "in the pipeline".

Secondly, is the newness of the tissue culture technology itself. Within less than 10 years we have created an entirely new industry for woody plant propagation. It has supplanted many times over what could have been produced by conventional means. It seems some propagators may be pushing the technology to its limit (and perhaps beyond). Many unknowns are involved and the methods are open to experimentation, conjecture, and improvement. Many questions must be answered, such as: what parts of the parent plant are still best to use, what chemicals are most effective, how many plantlets can be produced from a culture, what is the "life-span" of a culture, at what stage might alterations of characteristics appear, what characteristics might be unknowingly altered in the tissue-culture-propagated plant that appears "normal"?

A *third* consideration probably embodies the greatest threat. We are seeing new tissue culture labs being started by individuals unfamiliar with horticulture and often with little previous association with the industry. These people are lured by what appears to be a great untapped potential for success in a fledgling industry: seemingly insatiable demand from anxious buyers for new plants; easily replicable production methods; relatively small initial investment; and a relatively short payback period. New entrants to this industry operate with minimal resources and have not yet developed any major assets or reputation to maintain. Thus their customers have little recourse if an error occurs.

The number of units produced is so high that the value per unit (and thus the relative importance of each unit) seems to be negligible to them. The grower who is supplied by them thereby bears the brunt of the cost because any problems that develop often take several growing seasons to become evident.

Obviously, it will not take many years for the market itself to eliminate imprudent and dishonorable business people; but by then a lot of damage will have already been done to our industry.

I believe many of our problems have occurred because we are trying to accomplish too much too quickly. For us as propagators, especially those of us who are "old school", this unbridled enthusiasm that seems to dominate some aspects of micropropagation is quite out of character. The nursery industry and professional propagators are, by the nature of the business, quite conservative and committed to the long term. It seems that short term considerations of profit and productivity may be becoming overly dominant

here. Perhaps setbacks, as we are apparently seeing here, will cause us to approach new technologies, such as micropropagation, with a bit more caution.

Over the years the International Plant Propagators Society and other professional groups have excelled in their efforts to educate their members. I believe this same approach must now be applied to the problems that are developing as a result of micropropagation. We must focus upon the positive benefits of this technology and also learn how to deal with the negatives to create a solution that benefits us all.

It seems to me the real issue comes down to one of ethics. In our haste to keep pace with what is happening around us we have not taken the time to effectively define why we do what we do, and what we believe in. The developments I have just outlined deliver a clear message: the time has come to write down the goals, values, and ethics of our industry. Perhaps this exercise will only restate what most of us already know and believe and practice. But for those of us who are new to the industry or perhaps unaware of its underlying precepts, it will form a clearer guide for acceptable practices. Failure to effectively self-regulate our industry will most certainly initiate enforcement of standards from outside our industry.

ANNA KNUTTEL: I used to deal with six tissue culture propagators, now I only deal with two. I use those that grow their product so if I have a problem I can go back and talk to them and they understand what the problem is. It is also important to know a plant *before you grow it so you can tell if it is growing properly.*

HARRY SCHWARZ: Some of the changes you see in tissue-cultured plants can be related to genetic changes, some to growth phase changes, and others to susceptibility to agricultural chemicals used in the nursery business. Tissue-cultured plants appear to be more susceptible to agricultural chemicals, such as herbicides, and some of the changes you mentioned could be induced by such chemicals. We just don't have enough information on such possible interactions.

WAYNE MEZITT: You are saying that some of the changes we see could be for reasons that we do not understand and not genetic in origin.

HARRY SCHWARZ: The point is that we need to watch the agricultural chemicals we are applying because micropropagated plants are more sensitive. With strawberries, when we see offtypes we find that if we use them as parents in breeding, they tend to throw the same offtypes in their seedlings. Such changes may indicate a genetic weakness in that type/cultivar and it should not be propagated by tissue culture.