THE ROLE OF NUTRITION IN PLANT PROPAGATION

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Numerous researchers have been investigating the factors pertaining to nutrition in various aspects of propagation and some specific findings have been reported. However, it appears to me after reviewing the literature that this is a field that still offers considerable challenge to the plant propagator.

The nutrition of the stock plant prior to taking the cuttings is obviously a factor, but not much conclusive evidence is in the literature — granted that I may have missed some research reports. It appears that nutrient levels which produce reasonably vigorous growth of the stock plants, without signs of nutrient excesses or deficiencies, result in cuttings giving the best rooting responses. Either excesses or deficiencies of any element are apt to reduce rooting of the cuttings taken from stock plants grown under these conditions. O. A. Matkin of the Soil and Plant Laboratory, Orange, California, told me recently that in respect to feeding stock plants, cuttings taken from nursery stock on a good feeding program consistently out-perform those taken from less-cared-for stock. Results are faster rooting and this is generally attributed to softer wood. Crops which have demonstrated this include ivy, junipers, star jasmine and boxwood. In addition, we have experienced the same effect with chrysanthemums, carnations and poinsettias.

There has been much research in the area of nutrient mist and Dr. H. B. Tukey, Jr., of Cornell University, who is on our program, has been instrumental in conducting many of these studies. I do not intend to report on his research other than give you a summary of where we stand to date, based on the findings reported. If you wish more details regarding his research, contact Dr. Tukey directly. In the proceedings of the American Society of Horticultural Science meetings, Wott and Tukey (9) reported on the influence of nutrient mists on the propagation of cuttings. The abstract of this paper stated that hardwood, softwood and herbaceous cuttings of 29 species were propagated under a water and nutrient mist system. Cuttings increased in dry weight during propagation, softwood more than hardwood. The nitrogen, phosphorus and potassium content of cuttings under nutrient mist, particularly softwood, was higher than that of cuttings under water. Nutrient mist has little effect on root initiation, but did influence the percentage of cutting which rooted, as well as root quality. Cuttings under nutrient mist produced more linear stem growth and lateral bud growth following rooting than did cuttings rooted under water. In another paper Good and Tukey (2) reported that nutrients lost through leaching and growth of cuttings would be lessened with a feeding program, nutrition being beneficial in counteracting this effect during rooting.

Research by Kamp and Bluhm (3) in 1950 reported the effect of nutrients on the rooting responses of softwood cuttings and they concluded, in general, that nutrients increased rooting by 10 percent.

The importance of adequate nutrition prior to and during propagation was again emphasized by Good and Tukey in their report on redistribution of mineral nutrients in *Chrysanthemum morifolium* during propagation (3). Cuttings of *C. morifolium* 'Indian White' were rooted under intermittent mist (distilled water). Nitrogen, phosphorus and potassium were redistributed to new tissue as the cuttings grew, but calcium was not.

Sorensen and Coorts (5) studied the effects of nutrient mist on the propagation of selected woody ornamental plants. The abstract of their report stated that terminal cuttings of *Buxus semperviens, Ilex crenata* 'Microphylla', *Juniperus horizontalis* 'Plumosa', and *Taxus media*, taken in February, May, August, and November, were placed in three treatments: water mist, as well as two nutrient mists, each of the latter containing nitrogen, phosphorous and potassium. Cuttings of all species on all dates revealed reduced amounts of these elements under water mist at the time of callus formation and at root initiation. Cuttings under nutrient mist contained higher concentrations of these elements with increased rates of fertilization, both at time of callusing and rooting. However, all species, except *Buxus*, had more roots per cutting as well as a higher rooting percentage when the cuttings were rooted under water mist. Nutrients did contribute to a darker green color of the cutting.

In the April, 1970, issue of "The Plant Propagator", there is an excellent report by McGuire and Bunce (6) also of the University of Rhode Island, on the use of slow-release fertilizers in a propagating medium. They noted that, in most cases, studies with nutrient mists have demonstrated that root initiation was not greatly increased by the addition of nutrient mist, but once rooting took place, subsequent growth and root development was improved. They also noted that nutrient mists resulted in algae problems — thus their interest in incorporating slow-release fertilizers in the growing media. They found, in short, that in two species rooting was improved or not affected by fertilizers. In forsythia, rooting was decreased. Subsequent growth of rooted cuttings was significantly better in all treatments with slow-release fertilizers. Matkin has also reported (verbally to me from experiences at the Soil and Plant Laboratory) that cuttings stuck in a medium which includes Osmocote showed a considerable difference in growth and color 1 to 2 weeks after rooting. His growers are using 7 pounds of 18-9-9 Osmocote per cubic yard of mix.

Paul and Thornhill (7) at the University of California, Davis, studied the effect of magnesium on the rooting of chrysanthemums. They reported that when cuttings were rooted in peat at different levels of magnesium and calcium, and when the exchangeable magnesium was greater than 80 percent, rooting was severely impaired. Mist water containing increasing proportions of magnesium caused rooting failure in both sand and peat when the percentage of total cations was 70 percent magnesium. Calcium deficiency symptoms developed in the highest magnesium mist treatment. Leaching of calcium from the leaf is indicated. The New York State Agricultural Extension Service Newsletter on **Poinsettia Production** (8), first paragraph, reads as follows:

> "Propagation: The fertilization of a new poinsettia crop should begin in the propagation bench. Propagating cuttings with fertilizer injected into the mist will result in higher quality rooted plants with faster 'take-off'. In addition, less leaf drop due to nutrient deficient leaves at the base of the plants will occur if plants are properly fertilized to the point of sale. Two ounces of potassium nitrate plus 3 ounces of calcium nitrate per 100 gallons of water is sufficient in the mist to obtain those dark green and succulent cuttings."

In speaking with many knowledgeable people on this subject of nutrition in propagation, the statement was often made — "Metabolism problems in plants so often express themselves as typical iron deficiencies." This struck me as being so true because of a problem with which I had been involved for some time that had every indication of being an iron deficiency situation but finally was proven not to be related to nutrients levels.

For a number of years, chlorosis on the older leaves of Iceland poppy, primrose, and some other plants has been noticed in bedding plant nurseries in California. The chlorosis developed on both seedlings and older plants. The difficulty was particularly severe in one nursery which used a soil mixture consisting mostly of redwood sawdust and sand approximately a 50—50 mixture. This nursery added dolomite, potassium, phosphate, nitrogen, and gypsum, then steam pasteurized the mixture before using. The chlorosis appeared as irregular spots or blotches on the older leaves. In severe cases, the entire plant had yellowed. The plant did not grow, but survived. Seedlings in seed flats and small plants in "pony packs" or pots were equally affected. Usually the chlorosis disappeared after a period of time and the plant grew normally until it was transplanted into some fresh soil mixture of the same type in the nursery.

Related to this difficulty was the loss of roots immediately following transplanting of the seedlings. The roots were killed and a new root system had to regrow before the plant resumed its normal growth. Neither micronutrient deficiencies nor micronutrient excesses were responsible for the difficulty. Manganese, iron, zinc, copper, molydenum, and boron were studied singly, and in combination.

Whenever soil mixture without redwood sawdust were used the difficulty did not appear. Iceland poppy grew well without chlorosis in a Peat-lite mixture. When redwood sawdust was added to the basic Peat-lite mixture chlorosis appeared. Leaching the redwood sawdust with water before making the mixture reduced the incidence of chlorosis.

These facts suggest that there is a soluble toxin in the redwood sawdust responsible for the chlorosis noted on the Iceland poppy, primrose, and some other plants in the bedding plant nurseries. Since not all flowering annuals showed the same difficulty, there is the possibility that some plants are more tolerant than others of this toxin. Marigold, although it was used, as well as Iceland poppy, throughout these experiments, showed very little effect from the toxin. The bedding plant nursery where this work was conducted eliminated redwood sawdust from the soil mixture and the chlorosis problem disappeared.

In summary, I hope I have given some indication of the information now available on the effect nutrition has during various stages of propagation. I believe it warrants repeating that more work is needed in this area of research. I challenge both researchers and plant propagators to develop more of this much-needed information.

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BILL FLEMER: Dick, that was an amazingly complete job done in an exceptionally short time. We will proceed now to a critique which is a new innovation in our program proceedings and we are very fortunate to have Dr. Charles Hess and Dr. Andrew Leiser who will unite these four concepts into one pattern.

CHARLEY HESS: I would like to take this opportunity to supplement Bill's historic presentation from a little different approach by relating some of the significant events that have taken place in propagation as a result of the Society's activities. Probably the most significant one was the introduction of mist propagation. I believe this Society did more to spread the use of this technique in the industry than did any other group. The concept of mist propagation and its application to a wide range of plant materials would never have taken place if it were not for this Society. The concepts of constant mist, intermittent mist, time clocks, electronic leaf, the phytotektor unit, the burlap cloud, the vapor-proof chambers, are all things which were developed over the years from 1951. These are all milestones in our history.

Other things of lesser, but still great, significance were discussions of wounding and the use of bottom heat. Now as we move into the current decade I think the concept of tissue culture will be another area which may have equal significance to that of mist propagation in the future. Hopefully we will see the spread of a rather sophisticated technique from the laboratory into commercial operations. Just last year when we were on the West Coast we saw this concept of meristem culture being used in the commercial propagation of orchids and I believe we'll be seeing more of this in the future.

Finally, I think that we will also be seeing the use of the systems approach in nursery production. We have seen examples of this on the East Coast with Dick Vanderbilt's production of rhododendrons with all of the steps of production fitted into a precise pattern. And on the West Coast, George Oki has applied business management techniques These, then, are some very significant aspects of our history and I feel Society has made to the nursery and florist industry.

Our first speaker on the symposium program spoke on water relations. One aspect of his paper, which I would like to point out, is the dual role of water applied as mist which not only maintains turgor but also provides a cooling effect by the evaporation of the water film which covers the leaf. Another aspect of water which I don't fully understand, but I'm seeing more and more reference to, is the importance of the film of water at the base of the cutting and its role in stimulating rooting. Whether this is stimulating gaseous exchange or aiding the entrance of growth regulators into the cutting is not known, but it does seem to be essential that the base of the cutting be covered by a film of water. Perhaps the technique of putting the cuttings tightly into a sand medium has some relationship to the continuity of the water film. This is an area which would seem to have some research potential.

ANDY LEISER: One of the things which impressed me most from Dr. Kozlowski's paper is that we often forget in the day-to-day production of plants is that there is a very rapid and rather large fluctuation in the water relations within the plant or cutting. There is the old axiom 'take cuttings from plants early in the morning before plants are wilted', and this was dramatically shown by Dr. Kozlowski's presentation.

The effect of water on growth even after rooting can be very dramatic. Some recent work in California has shown that a constant dribbling irrigation produces a much greater dry weight gain in chrysanthemums than does irrigation twice a day. The soil in the twice-a-day irrigated plants never dropped below field capacity. Thus, theoretically there was always ample water; yet, apparently the water relations were not as good as with the constant drip irrigation. This is probably a more critical factor than we have realized in the past. With some look to the future, I would like to see some work done on the water relations of the stock plant and their effect on the rootability of cuttings.

At this time I would like to open the questioning with one of my own addressed to Dr. Kozlowski and that is—are there any effects of water deficits on the seed quality in fruits produced under severe water stress?

TED KOZLOWSKI: In general terms, yes. Any type of water stress which affects vegetative growth will in turn affect the growth of reproductive structures and seed development. The effect would be both on the quantity and the quality of the seed produced.

JIM WELLS: I'm wondering if there would be, on the basis of what we've just heard, any reason to consider going back to constant mist. I'm thinking in terms of the very fine mist nozzles which put out very small amounts of water, around one-tenth to one-fourth gallon per hour; perhaps Ted would like to reply to this briefly.

TED KOZLOWSKI: I believe that what is needed is some in-depth research on the different kinds of mist and what effects these have on the internal water deficits of the cuttings. This is the best way to get an answer to this question.

CHARLEY HESS: The second paper dealt with light relations by Sid Waxman. I would like to make one comment with respect to one type of light control which Sid did not cover and that is the absence of light or etiolation. This is a very important aspect of propagation because there is a powerful physiological effect of etiolation on enhancing the ability of cuttings to root. Cuttings which are nearly impossible to root can sometimes be rooted by etiolating the shoot before-hand. This is a negative aspect of light but a very powerful one.

ANDY LEISER: In respect to light control I'd like to tell you of some work we did on the West Coast. After looking over the older literature on light experiments, we felt that we could speed up the growth of several plants. We began a trial using genera and species which had not been used in the previous reports. We started the plants from seed and found that several plants did not respond to supplemental light, at least in the seedling stage. Looking to the future, I think we need to screen large numbers of plants to determine those which will respond to supplemental light, particularly at the seedling stage.

I would also like to re-emphasize Sid's comments with respect to the effectiveness of different wavelengths of light on growth and that there is no need to purchase special lamps which screen out certain wavelengths because much of this light can be and is used by the plant. You have to pay for the wattage of the lamp anyway so why pay extra for a special lamp, especially when some of this light which would be removed is beneficial to the plant.

CHARLEY HESS: We are about out of time and so all questions will have to go into the Question Box. I felt our third speaker, Dr. Kester, did an excellent job of covering the subject and I will defer any comments to Andy.

ANDY LEISER: My only comment is to emphasize the point that all of the factors of the environment interact and we need to consider all of them simultaneously.

CHARLEY HESS: I have only one comment in regard to Dick Maire's paper and that is that there are only two minor elements which have been associated with rooting. One is zinc, which is involved with tryptophane synthesis as a precursor of indoleacetic acid which is involved in rooting; the other is boron which seems somehow to be involved in oxygen relations in cuttings and is most efficient when there is an oxygen deficient condition in the cuttings.

We are out of time and so I'll turn the program back over to the program chairman, Ralph Shugert.

RALPH SHUGERT: Thank you, Charley and Andy. You did an excellent job. Our morning session is now adjourned.