SATURDAY MORNING SESSION

December 10, 1966

The Saturday morning session began with the annual business meeting at 8:30 a.m. in the Colonial Room. The minutes of the meeting are recorded at the beginning of the business and technical sessions of the Eastern Region section of the Proceedings. After the business session a nutrition symposium was conducted. Dr. Kenneth W. Reisch served as moderator.

STU NELSON: We have a very interesting panel on nutrition this morning. The moderator for our closing session is Dr. Ken Reisch from Ohio State University.

KEN REISCH: I would like to introduce the first subject, Vegetative Propagation as Affected by Nutrition — a review by Dr. Jim Kelley.

VEGETATIVE PROPAGATION AS AFFECTED BY NUTRITION — A REVIEW

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Considerable emphasis has been placed upon studying the factors that influence the rooting of cuttings, the goal being to maintain an environment that will result in the greatest percentage of rooted cuttings in the least amount of time. Information that has been obtained has resulted in a manipulation of temperature with the addition of heat, moisture by misting, day length by shading or using additional light, application of growth regulators and others.

At the same time, little attention has been focused on factors influencing the stock plant from which the cutting is taken and how temperature, light intensity, nutrition, photoperiod, hormones treatment, moisture, and other factors might influence rooting of the subsequent cuttings.

We often think of a cutting as the beginning of a new plant, but it is really the continuation of an existing plant and what the cutting will or will not do is to some degree influenced by the environment conditions under which it developed as the shoot or stem on a stock plant.

Evidence that nutrition of the stock plant was a factor influencing root initiation and development of cuttings taken from such plants was first presented by Kraus and Kraybill in 1918 (9). They demonstrated that the carbohydrate—nitrogen ratio of tomato stems played a major role in rooting. They placed pieces of tomato stems 1 to 4 inches long and without leaves on filter paper moistened with distilled water and covered them with a bell jar. The following results were observed: yellowish stems high in carbohydrates and low in total nitrogen produced many roots and weak shoots; greenish stems containing starch and fairly high in total nitrogen produced roots and shoots and green, succulent stems without starch, low in carbohydrates and high in total nitrogen all decayed without root or shoot production.

Experiments by Schrader in 1924 (17), Starring in 1924 (19), and Garner (4), in 1944 demonstrated that a high ratio of carbohydrates to nitrogen favored rooting in tomatoes and grapes. Sarring (19) found that firmness of stems could often be used as an index of carbohydrate content. Stems low in carbohydrate are soft and flexible in contrast to those high in carbohydrates which are firm and stiff.

Knight (8) in 1926 was the first to attempt to classify cuttings according to their internal conditions. He recognized three types of stem cuttings on the mother plant: (1) leader in active growth; (2) laterals in active growth, and laterals with the terminal bud formed. He noted that firm cuttings which had ceased growth were much superior to actively growing shoots and attributed better rooting to a higher carbohydrate content.

Haun (5) grew stock plants of geranium at three levels of nitrogen, phosphorus, and potassium. He found that nitrogen nutrition of the stock plant had a greater effect on the rooting response than did phosphorous or potassium. Low and medium levels of nitrogen resulted in a higher percentage of rooted cuttings than the high level.

In work with *Ilex crenata* 'Hetzi', Kelley (7) has shown a possible carbohydrate-nitrogen relationship (Table 1. Cuttings from stock plants receiving a relatively low nitrogen application produced the greatest total root length and largest number of secondary roots while stock plants grown under high nitrogen conditions produced the least number of primary and secondary roots.

Table 1. Effect of nitrogen nutrition of stock plants on rooting of *Ilex crenata* 'Hetzi'.

Grams of N per 1 gal H20	Total roots per cutting	Total root length per cutting	Secondary roots per cutting	Length of primary roots
		cm		cm
0.7	4.6	8.0	17.1	1.7
2.8	5.9	7.3	12.1	1.2
10.0	4.2	3.6	5.0	0.9

Ryan (15) recently reported that seedling stock of *Eucalyptus ficifolia* fertilized with nitrogen resulted in a reduction of successful grafts. Seedling stock with a leaf nitrogen content of 1.2 percent resulted in 100 percent successful grafts while plants with 4.1 percent leaf nitrogen gave only 13 percent successful grafts. Pregirdled scion wood also resulted in a greater percentage of successful grafts.

Pridham (13), after work with *Liqustrum ovalifolium,* concluded that the rooting of cuttings and subsequent growth of the young plant depended primarily upon the maturity and treatment of the parent.

Other investigators (2,3,11,12,18,23) have generally concluded that factors contributing to a high carbohydrate content of the stock plant favored the rooting of cuttings. The nutrition of the cutting material is of very great importance and recognized by many. This is shown by attempts to induce a high carbohydrate-nitrogen ratio in stock plants by ringing, notching, and root restriction.

Cultural factors that contribute to a favorable ratio are growing the plants in full sun, applying limited amounts of nitrogen, controlling moisture, root pruning, and other procedures that will generally restrict growth of the stock plant.

Two micronutrients, boron and zinc, have been shown to influence rootings. Samish (16) found that after fertilization of grapes with zinc, the tryptophan content of the cuttings increased and rooting was improved. Since tryptophan is a precursor of the naturally occurring auxin, indole-acetic acid, he attributed the results to a possible increase in indole-acetic acid. Beneficial results from zinc applications to stock plants have been noted in South Africa in the propagation of Marianna plum by hardwood cuttings.

Boron was first shown to play a role in rooting by Hemberg (6). He showed that when hypocotyls of *Phaseolus vulgaris,* without cotyledons, were placed in tap water or in extracts of dry leaves in distilled water they rooted but in distilled water they did not, due to the absence of boron.

Boron nutrition has also been shown to influnce rooting of chrysantheums. Tackett (21) found that chrysanthemum cuttings containing a leaf content of less than 35 ppm boron rooted poorly (Table 2).

Albert and Wilson (1) found that boron was necessary for root tip elongation in tomatoes and concluded that when boron was not available to the root the early stages of cell development were influenced within 24 hours.

Little information is available concerning the effect of other micronutrients on rooting; however, they should not be overlooked. Likewise, the information for nitrogen in incomplete, which means that much will have to be done before we know how stock plants should be handled for production of cuttings with maximum rootability.

The internal condition of the cutting is of great import-

Table 2 Effect of boron nutrition of stock plants on rooting of chrysanthemums

Boron in nutrient solution	Boron content of leaves	Total length of roots per cutting	Number of roots per cutting
ppm	ppm	cm	
.001	5.8	2.0	1.6
.01	11.4	2.5	1.8
.10	45.2	8.2	4.8
1.00	92.9	5.1	4.2
2.50	123.9	4.1	4.4

ance as shown by the foregoing references. To date the researcher has not characterized the internal conditions that favor rooting to a degree to be applicable to the plant propagator. Until more is known about the factors which combine to modify these internal conditions, propagators will continue to be frustrated with seasonal and year-to-year variations in rooting due to a lack of knowledge of how environment influences stock plant and its effect on rootability of cuttings.

It is important to remember that nutrition is only one factor that is related to rooting, but is interrelated with other factors in influencing successful plant propagation.

LITERATURE CITED

1 Albert, L S and C M Wilson 1961 Effect of boron on elongation of tomato root tips Plant Physiol 36 244-251

2 Brandon, R 1939 Seasonal variations in the starch content of the genus *Rosa* and their relation to propagation by stem cuttings. Jour of Pom and Hort Sci 14 233-253

3 Dhillon, B S 1963 Influence of stock plants treated with various levels of nitrogen in combination with day-length on rooting of black currant stem cuttings Indian J Hort 20 34-37

4 Garner, R J 1944 Propagation by cuttings and layers Recent work and its application, with special reference to pome and stone fruits Imperial Bur Hort and Plantation Crops Tech Commun 14, 80 p

5 Haun, J R. and P W Cornell 1951 Rooting response of geranium (*Pelargonium hortorum*, Bailey var Ricard) cuttings as influenced by nitrogen, phosphorus, and potassium nutrition of the stock plant Proc Amer Soc Hort Sci 58·317-323

6 Hemberg, T. 1951 Rooting experiments with hypocotyls of *Phaseolus vulgaris* L. Physiologia Plantarum 4 358-369

7 Kelly, J D Unpublished data

8 Knight, R C 1926 The propagation of fruit stocks by stem cuttings J Pomol 5 248-266

9 Kraus, E. J and H R Kraybill 1918 Vegetation and reproduction with special reference to the tomato Ore Agr Exp Sta Bul 149

10 Murray, R H, G Taper, T Pickup, and A M Nussey 1957 Boron nutrition of softwood cuttings of geranium and currant in relation to root development Proc Amer Soc Hort Sci 69 498-501

11 Pearse, H. L 1943 The effect of nutrition and phytohormones on the rooting of vine cuttings Ann of Bot, N S 7·123-132.

12 Preston, W H, J B Shanks and P W Cornell 1953 Influence of mineral nutrition on production, rooting, and survival of cuttings of azaleas. Proc. Amer. Soc. Hort Sci 61:499-507
13 Pridham, A M. S 1942 Factors in the rooting of cuttings and the growth of young plants Proc Amer Soc Hort Sci 40.579-582
14 Riehl, G 1952 Manured mother-plants do not always produce excessively well-fed cuttings Zierpflanzenbau 2:143
15. Ryan, G E 1966 Grafting *Eucalyptus ficifolia* The Plant Propagator 12: No 2, 4-6
16 Samish, R M and P Spiegel 1957. The influence of the nutrition of the mother vine on the rooting of cuttings Ktavim 8 93-100
17. Schrader, A L 1924 The relation of chemical composition to the regeneration of roots and tops in tomato cuttings Proc Amer. Soc Hort Sci 21 187-194
18 Sen, P. K and R N Basu 1960 Effect of growth substances on root formation in cuttings of *Justicia gendarussa* L as influenced by varying levels of nitrogen nutrition of stock plants Indian J Plant Physiol 3:72-83
19. Starring, C. C 1924 Influence of carbohydrate-nitrate content of cuttings upon the production of roots Proc Amer Soc Hort Sci 20 288-292
20 Suntarasing, Charat 1950 Rooting response of California Privet (*Ligustrum obalifolium* Hassk) cuttings as influenced by nutrition and nutrition-indolebutyric acid interaction Unpublished Master of Science Thesis, Univ. of Md
21 Tackett, A 1962 Effect of the initial boron content of *Chrysanthemum morifolium* 'Yellow Delaware and the interaction between boron and 3-indoleacetic acid on the initiation of adventitious roots Unpublished Master's Thesis, Univ of Kentucky
22 Weiser, C J and L T Blaney 1960 The effects of boron on the rooting of English holly cuttings Proc Amer Soc Hort Sci 75 704-710.
23 Winkler, A J 1927 Some factors influencing the rooting of vine cuttings. Hilgardia 2 329-349

KEN REISCH: The next paper is prepared by two gentlemen. Dr. Meyer is now at the University of Illinois. Dr. Tukey will present the paper.

NUTRIENT APPLICATIONS DURING THE DORMANT SEASON

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Spring is not the only time for nutrient applications to nursery plants, and it may not even be the best time. However, nursery plants in temperate regions grow rapidly during the spring and early summer. It is only natural to suppose that nutrient applications during this period would be most beneficial, and spring applications are common nursery practice.

However, many workers have shown that nutrients applied to woody plants during the spring and summer often produced no additional growth the year they were applied, but rather were absorbed and stored within the plants. The year following the nutrient applications, important growth differences were noted. Thus, the spring growth of woody plants is dependent to a large extent upon nutrient reserves