SATURDAY MORNING SESSION
December 7, 1963

FIRST SECTION

The first section of the morning session convened at 9:30 a.m. Mr. Ed Davis, Ozark Nursery Co., Tahlequah, Oklahoma, was moderator.

MODERATOR DAVIS: Our first paper this morning will be given by Dr. William E. Snyder of Rutgers University.

THE ROLE OF RESEARCH IN PLANT PROPAGATION

WILLIAM E. SNYDER
Department of Horticulture & Forestry
Rutgers University
New Brunswick, New Jersey

The definition of the word "research," according to Webster's unabridged dictionary is:

"Studious inquiry or examination, specifically and usually, critical and exhaustive investigation or experimentation having its aim the discovery of new facts and their correct interpretation; the revision of accepted conclusions, theories or laws in the light of newly discovered facts; or the practical application of such new or revised conclusions."

In the area of the arts and the humanities, research is most frequently accomplished by diligent investigation, comparison, criticism and interpretation of the writings, the paintings, the sculpture, the musical scores or other products of an individual or groups of individuals whose accomplishments may be related. By contrast, in the area of the sciences, research is most frequently accomplished by experimentation. Since the propagation of plants is primarily a science, we shall be concerned with the experimental approach.

Classically, two levels of research are recognized:

1. Basic Research
2. Applied Research

Basic or theoretical research is the first portion of the definition: "that discovery of new facts and their correct interpretation or the revision of accepted conclusions and theories based on newly discovered facts." In the past most basic research, of importance to plant propagation, has been the result of studies of the botanist or plant physiologist rather than the horticulturist. In more recent years, the horticulturist has accepted a greater role in basic research. This is probably the result of three major factors:

1. the employment of technically trained scientists in horticulture,

2. the greater emphasis of training in botany, chemistry. physics and statistics by the graduate student in horticulture, and
3. an increasing appreciation by administrative leaders that basic research is the major foundation for a strong program of applied research.

The second aspect of research, applied research, is included in the last portion of the definition: "practical application of new or revised conclusions." I like to think of applied research in two phases. The first, by the horticulturalist, to demonstrate the practical application of the new information to plants of economic importance and the second, by the commercial grower, to demonstrate that the new application is both economically feasible and physically practical at his level of operation.

At the time basic research is being conducted there may be little or even no thought of the practical implications or applications of the results.

To illustrate the relationship between basic research and its practical applications, let us devote some time to one illustration

Almost one hundred years ago, Charles Darwin recorded in his book "The Power of Movement in Plants" extremely valuable experiments and reflections upon the movement of plants in response to light, that is, the bending of the growing tip toward a unilateral source of light. Darwin demonstrated that light falling only on one side of the growing tip of a plant causes some influence to be transmitted downward, thereby resulting in the bending of the stem toward the source of light. Subsequently other investigators showed that if the tip was removed, little or no growth occurred, but growth continues if the severed tip is replaced. The insertion of a gelatinous plate between the tip and the stem did not change the growth response, however the insertion of a Mica plate prevented growth of the stem. The next significant contribution was that if an excised tip was replaced on one side of the cut stem, growth is accellerated only on the side beneath the tip. It was further shown that if the sap from these stem tips is put into a block of agar, the growth is similar to growth resulting when the cut tip is replaced. By using the agar block technique, it was soon demonstrated that some substances promoted growth while other substances inhibited growth. In 1928, Dr. Fritz Went demonstrated that the agar block technique could be used as a quantitative measure for the material produced by the stem tip. This technique is now known as the Avena Curvature Test. Several years later it was shown that the substance was indoleacetic acid.

At this point, some of you may be wondering how these results of basic research concerned with the growth movements of plants are related to plant propagation. As early as 1882, Sachs, a German plant physiologist, suggested that there was a "root-forming substance." In 1915, Loeb reported that the presence of vigorous leaves on a horizontally placed *Bryophyllum* stem not only increased the bending of the stem but also increased the

production of roots. Several years later Van Der Lek reported that the presence of leaves and buds stimulated the rooting of stem cuttings. He also suggested that hormones were probably involved.

In the 1930's, it was found that crude extracts from pollen, bacterial preparations and urine, when smeared on intact plants. stimulated the production of roots along the stem. In 1934 it was discovered that these extracts contained indole acetic acid (hereafter designated IAA). Laibach and co-workers reported that IAA, produced in the organic chemical laboratory, markedly stimulated the production of roots when applied in a paste to the stems of intact *Coleus* plants. In 1935. Cooper and Zimmerman and Hitchcock, working independently, reported that IAA applied to stem cuttings resulted in significant increases in rooting.

It is now known that many compounds related to IAA are also affective in the stimulation of rooting of cuttings. Because they have been shown to be more effective than the naturally produced IAA, the two most widely used compounds are naphthalene acetic acid and indole butyric acid.

Thus years of basic research relative to the phenomenon of directional growth of plants resulted not only in the development of proof of the hormonal control of plant growth, but also to the many applications of the use of growth regulators in the production of agricultural crops.

Following the discovery of the effect of IAA on the rooting of cuttings in 1935, hundreds of papers have been published. Many of these were applied research, concerned with the application of this new information to a wide range of plants and plant parts, with the method of application, with the possible interrelationships with established practices and techniques and with the testing of related chemical substances. One bibliography includes 274 references to papers published between 1934 and 1946. The list of species and cultivars which have been tested for the effects of auxin-type growth regulators on the stimulation of rooting of cuttings is well over 1,000.

We in the Plant Propagators' Society are well aware that the knowledge of why and how roots are initiated is incomplete. We know that there are many species which remain difficult-to-root regardless of whether or not root-stimulating chemicals are used. We have been fortunate to follow the investigations of one of our members, Dr. Charles E. Hess, relative to the role of co-factors in the rooting of cuttings. These studies are basic and when identification of one or more of the co-factors has been made a series of research projects will be needed to determine how co-factors actually are involved in the stimulation of rooting and to apply these new findings to the rooting of difficult-to-root species.

Research in plant propagation has not been a series of outstanding discoveries and the application of new ideas, but rather has consisted of a gradual verification of techniques established

many years ago, of occasional modification of these techniques and very occasionally of significant discoveries.

Many common methods of propagation are fundamentally the same as those practiced and described several centuries ago. Modern writings, however, have largely deleted irrelevant matter and superstitions stemming from the Middle Ages. Seventeenth Century propagators believed that yellow roses, rare at that time, resulted from budding on barberry understock. The understock may exert a significant effect on the scion, but today we know that yellow roses are the product of selective breeding of roses, rather than the use of a special understock.

Early propagators depended largely upon seeds and grafts: cuttings were employed primarily with those species which readily rooted from dormant cuttings. The importance of cuttings as a means of propagation of ornamental plants is of relatively recent advent. Improved techniques for control of the environment have contributed to the increased use of softwood stem cuttings. Consider the advancement in the control of atmospheric moisture between the bell jar and the intermittent mist. Humidistats, thermostats, electronic devices, solenoid valves, automatic ventilation, electric heating cables, washed air-cooling and timing mechanisms are just a few of the recent advancements in common usage to control the environment of the propagation structure. These are contributions of research of many individuals at many different research stations.

Research may reach a point where additional effort is relatively unproductive until a new technique or procedure is discovered. Polyploidy, a condition in which the organism contains more than the normal number of chromosomes, is frequently of considerable value in breeding programs. The discovery of the effect of colchicine on the induction of polyploidy resulted in a technique of major value to the plant breeder. Chromatographic techniques in chemistry have made possible the study of materials which are present in plant tissues in very small quantities. You will recall that this is the technique used in the studes of co-factors.

The two methods of propagation of ornamental plants which have received the major attention of the research men are the rooting of cuttings and germination of seeds, especially the problems of delayed germination. Budding and grafting have received the major attention for fruit crops. Studies emphasizing the propagation of fruit crops by cuttings and stock-scion relationships for ornamental crops are needed.

For softwood stem cuttings of deciduous plants and hardwood stem cuttings of evergreen plants, the major areas of investigation have been concerned with the effect of the environment — light, temperature, moisture, pH, media, etc. The roles of moisture, temperature and light in overcoming rest have been studied for many seeds. Studies of the effect of the environment on propagation should be continued and will undoubtedly prove productive, however what is really needed is a greater

emphasis on studies of the chemical and physical processes which occur within the plant. Studies of this nature will, in my opinion, result in the most significant advancements in plant propagation. Detailed basic studies of the chemical stimulation of adventitious buds on leaf and root cuttings, on the chemical and physical causes of delayed germination of seeds and of the many problems of stock-scion relationships of ornamental plants should prove to be very valuable.

It is not to be expected that every new technique or procedure will be available for every commercial group. Even such an universally adapted technique as the use of intermittent mist has definite limitations and may not be advantageous in certain instances. Several years ago an interesting procedure involving the use of cutting-grafts was described. Adaption of this method of propagation should be determined by the crops being propagated, the success of the new method compared with the established procedure being used by the nursery, and the propagation schedule. The research man cannot determine whether a new procedure should be adapted; this is a responsibility of the commercial propagator.

On occasion the research man has been criticized because of the small number of plants used in a project. The scientists have devised techniques whereby accurate information may be obtained even with the use of relatively small numbers. For example, if a coin is tossed in the air, there is a 50-50 chance that it will show heads or tails. If the coin is tossed ten times, the probability of heads showing five times is slight, but possible. If, however, the coin is tossed one hundred times the probability of heads showing half of the time is greatly increased. Statisticians have developed systems by which significance, or validity, of experimental results can be tested. If the probability is 19 to 1, the results are acceptable and if the probability is 99 to 1, the results are considered to be highly significant.

Significant findings, however, may not prove to be practical. In other words, the differences may be valid but of such small magnitude that it would not be economically profitable to warrant changing. It is this practical testing, with large numbers of plants and under various propagation schedules, that the commercial propagator has and can continue to make valuable contributions. Again, what is practically adaptable for one situation or propagator may not be for another.

At most state agricultural experiment stations, research, including research in plant propagation, is supported largely by state funds. These funds may be augmented by allocation of Federal funds authorized by the Hatch Act or from special agencies such as the National Science Foundation and the Public Health Service. On occasion support may also come from private commercial sources or from commodity organizations, such as nurserymen's associations. There are undoubtedly instances in which an increased support for research in plant propagation would be helpful.

It must be remembered that many individuals who are currently conducting research in the area of plant propagation are also responsible for other areas of research with ornamental crops, with teaching, with advising undergraduate and graduate students and, in some instances, with administrative duties.

The results of basic research with plants are published in a number of scientific periodicals, such as the *American Journal of Botany, Plant Physiology, Botanical Gazette* and *Physiologia Plantarium.* The results of applied research are found in other periodicals, for example, *Proceedings of the American Society for Horticultural Science, Proceedings of the International Horticultural Congress,* and similar publications. These reports are prepared for the scientist and are of limited use to the commercial propagator. Results of research reach the commercial propagator through the activities of the extension specialist, reports at meetings of commodity groups, the trade publications, and certainly at meetings of this Society.

If there is any purpose for this discussion, it is two-fold: first, a compliment to this organization for the opportunity for teachers, researchers and commercial nurserymen to discuss formally and informally the problems of plant propagation and second, an earnest plea that each of you encourage and support both basic and applied research at instiutions throughout the country.

MODERATOR DAVIS: Thank you, Bill. Our second paper will be given by Dr. Ken Reisch, Ohio State University.

DISEASES INITIATED IN THE PROPAGATING PHASE WHICH LATER CAUSE PLANT LOSS

K. W. REISCH
Department of Horticulture
Ohio Agricultural Experiment Station
Wooster, Ohio

The incidence and spread of disease organisms in the propagating phase is probably far more critical and costly than most propagators realize. We know that disease or insect infected wood can readily be a source for infection and spread, but the contamination of previously "clean" stock is a problem with which all plantsmen should be concerned. Many growers on the West Coast have recognized the seriousness of some of these problems and have taken positive steps to correct them, through sanitation and disease control programs.

We are all familiar with fungus diseases such as those causing damping-off and we can readily diagnose the cause and take steps to prevent or correct it. If all diseases initiated in the propagating phase killed the plants at this time it would be fine, but the initiation of pathogens, which are evidenced later in the life of the plant, can prove to be very costly. The decline