ticeably reduced the total number of roots produced from softwood cuttings of *Ligustrum amurense*, and *Cornus stolonifera*, as compared to the control treatment.

The effect of soil conditioners on the rooting and subsequent survival of field planted hardwood cuttings was studied. Apical, basal and combination applications of Aerotil (dry form) noticeably increased rooting and survival of fall planted hardwood cuttings of *Lonicera tatarica*. Surface and combination applications of the dry form significantly increased stands of *Ligustrum amurense*. No increase in survival was obtained from applications of Aerotil (dry and wettable forms) to cuttings of *Cornus stolonifera*. The beneficial effects derived from the use of this substance on heavy soil types may be attributed to improved aeration.

CHAIRMAN MAHLSTEDE: Now our time is gone and I want to thank you very much for bearing with us this afternoon. Especially would I like to express our gratitude, and I think I speak for the group, to Mr. Hancock, who gave us one of the most interesting presentations of the entire meeting.

The assemblage arose and applauded.

The session recessed at 4:00 p.m.

EDITOR'S NOTE: Mr. H. F. Harp of the Dominion Experimental Station, Morden, Manitoba, Canada, was unable to be present and because of the lack of time his paper was not read. However, it is included in the Proceedings as was announced at the conclusion of the panel discussion of the propagation of softwood cuttings.

Root Inducing Substances

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INTRODUCTION

It is a well known fact that stems of plants generally bend towards light. Darwin (3) was the first to demonstrate that some "stimulus" was trainsmitted from the tip to a region further down the axis of seedlings exposed to one-sided illumination. The response of the plant to this "stimulus" caused the axis to bend toward light as a result of an unequal rate of growth.

To the inquiring mind, there were many questions in connection with this phenomena which were yet unanswered. It was for Boysen Jensen (1) some years later to demonstrate that Darwin's "stimulus" was a chemical substance which moved through the tissues of the plant.

In 1928, F. W. Went, (4) working with biochemists at the University of Utrecht, described a quantitative method for determining the presence

of these chemical substances, which were later to be called plant hormones, or auxins. Went's original method of using agar blocks and oat seedlings to determine hormone concentration is essentially the same quantitative method used in the laboratories at the present time.

Although the concept of growth regulators, or hormones was not advanced until comparatively recent times, horticulturists and plantsmen through the centuries have noted the phenomena of apical dominance. Many references point to the fact that lateral buds appear to be held in a quiescent or dormant state in the presence of a terminal bud; it was postulated that this was due to an inhibiting substance, of a chemical nature, which was produced in the developing apical growing point.

As a result of continued investigations with growth regulating substances Went (5) further suggested that another group of plant hormones, specific for various growth processes were active in the plant. One of these, namely rhizocaline, which is produced in the leave of plants, theoretically is required for root production on cuttings. In addition Went postulates that this substance, in order to be active, must be accompanied by other natural plant auxins, one of which is indoleacetic acid.

It has been established that the amount of leaf area allowed to remain on a particular cutting type directly influences the rapidity and extent of rooting. This, in part, is related to the production of a complex auxin system by buds and young leaves. It is evident that if this root promoting substance is manufactured in the leaf, cuttings will root more readily from leafy rather than from defoliated shoots. It is evident also, that in general, there is a downward translocation of these substances after they have been produced.

Further investigations have shown that one of these plant hormones is indoleacetic acid, which is of comparatively widespread occurrence. This chemical has since been synthesized in the laboratory, and as a result of its root promoting properties is used as one of the main constituents in many of our commercial rooting powders.

Methods of Applying Root Inducing Substances

Cuttings of *Acer japonica,* as well as cuttings of the difficult-to-root subjects have been successfully propagated at the Boyce Thompson Institute by the use of lanolin-hormone pastes. Increased rooting response was obtained by the application of the paste to stock plants some 21 days prior to taking the cuttings. The lanolin method for applying root inducing substances has also been reported by Cooper (2). In experiments with lemon cuttings the application of a paste containing indoleacetic acid (one part IAA to two thousand parts lanolin) to the lower epidermis of wounded leaves resulted in an increased rooting response.

From the practical standpoint, however, root inducing substances applied in a talc or bentonite powder has proven to be the most economical method for treating cuttings of ornamental plants. At the Morden Station cuttings are dipped in the acid impregnated bentonite immediately prior to inserting them in the rooting medium. This affords better control over

the acid intake in comparison to the less convenient and time consuming dip method of hormone application.

Results of Early Trials Using Root Inducing Substances

Early experimental trials at the Dominion Experiment Station at Morden, Manitoba, with greenwood cuttings re-emphasized the fact that the difference in rooting potential between genera, species, and even between varieties of the same species were marked. Repeated attempts to obtain a satisfactory stand of the American Elm (*Ulmus americana*) from cuttings resulted in failure. It was observed that, in general, the cuttings lost their foliage after a few days in the rooting medium, although occasionally a few cuttings were found to be well calloused. Subsequent experiments using root inducing substances gave a slight increase in the number of cuttings rooted. A further improvement was observed when defoliated cuttings were removed from the medium, and subjected to a second hormone treatment. It was found that by careful selection of cutting material, as well as the application of two chemical treatments at about ten day intervals, stands as high as 40% could be obtained This was significant in that the genus as a whole is particularly difficult to root from cuttings.

Observations over a number of years show that results obtained from using the same formula on identical varieties will not give consistent results. In this connection there is a difference in response by identical varieties from year to year. Varieties of *Syringa vulgaris,* for instance, show a considerable variance in their response to root inducing substances. In extensive trials over a three-year period no correlation between suckering habit and rooting ability of clones of the common lilac could be observed, although the two phenomena were originally believed to be correlated.

Results of Recent Trials Using Root Inducing Substances

Indolebutyric acid, and naphthaleneacetic acid, compounds having similar root inducing properties as indoleacetic acid have been tested singly and in combination at the Morden Station. In addition extensive trials with a number of commercial preparations including Auxilin, Hormodin A, Hortomone A, Indanol, Auxan, and Rootone have been carried on. The preparation known as Auxan has been found to be the most satisfactory commercial form of hormone tested to date. Of eleven of our own rooting preparations, two have given us consistently good results. These preparations contain: (1) one part indoleacetic acid to one thousand parts bentonite, and (2) one-half part each of indoleacetic, indolebutyric, and naphthaleneacetic acid per hundred parts of bentonite.

In this season's trials the usual collection of greenwood cuttings was inserted in sand in the period June 18-20, 1953. All material was treated with the commercial root inducing substance, Auxan, prior to insertion in the medium. The season was considered to be normal; all plant materials were in a satisfactory stage of growth for propagation at the time of sampling. After collection, cool weather conditions prevailed and con-

sequently a minimum of use was made of the portable lath shade system. Leaf spot was somewhat more troublesome than normal and was responsible for defoliation of some varieties prior to rooting; where this was severe the stand of cuttings was considerably reduced. By the end of the season transplanted cuttings had become well established in open frames.

Table 1. Response of Greenwood Cuttings to Auxan Treatment

Plant Name	Percent Rooted Cuttings	Plant Name	Percent Rooted Cuttings
Pachystima canbyi	*100*	*Prunus cistena*	33
Rose Harison Yellow	6	Prunus triloba fl. pl.	90
Rose Hansa	70	Potentilla purdomi	100
Rose Blanda Hybrid	48	Potentilla Farreri	86
Phıladelphus Snowflake	80	Viburnum carlesi	60
Philadelphus x *Silvia*	66	Viburnum *trilobum*	*100*
Spiraea Vanhouttei	70	Weigela Eva Rathke	100
Spıraea rotundıfolia	70	Syringa Rotha magensis	50
Spiraea prunifolia	100	Syringa Nocurne	100
Lonicera spinosa	80	Ulmus pumila	100
Lonicera spinosa alberti	40	Weeping Elm	4
Caragana spinosa	80	Cotoneaster lucida	20
Caragana Chamlagu	100		

Conclusions

As a result of more than ten years work with indoleacetic, indolebutyric and napthaleneacetic acids, used either alone or in combination, in concentrations varying from one half part to one and one half parts per thousand parts of bentonite, one preparation has been consistently outstanding as a root inducing substance for greenwood cuttings. This preparation, referred to as Formula No. 4 is compounded by mixing one part indoleacetic acid with 1000 parts bentonite. While there has been a higher percentage of cuttings rooted in some years, as a result of using one part of naphthaleneacetic acid per one thousand parts of bentonite, this has not been consistent.

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