ROOTING OF SOUTHERN PINES

by

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Rooting of cuttings and air layering methods of shoots of forest trees are the important techniques necessary for the growth of forest tree improvement programs. By these techniques countless numbers of "progeny" with above ground parts and root systems genetically identical to those of their parents can be propagated. Not only is this important in correlated tree improvement and genetic studies but the methods are essential to seed orchard establishment, physiological studies, site relationship studies, and even in restocking.

The availability of great quantities of identical clonal stock provides more precise means for evaluating or testing the validity of tree selections as to their superiority, relative to specific traits, as well as their ability to produce better progeny. It also makes possible an expanded breeding program which will enable us to more readily determine the transmissability of characteristics from heterozygous parents to equally heterozygous progeny by the application of population genetic methods.

Seed orchards planted with many like individuals produced vegetatively from many superior parents, would insure the cross pollination of superior strains to produce many better progeny. Grafting has been attempted to accomplish this. Not only has this method been of limited success in its application to seed orchard establishment, but the question of stock-scion compatibility presents a problem.

A request for 1200 seedlings for plantation management studies was made recently. Seedlings from a single open pollinated selected parent are being supplied. At best these seedlings are variable. Were they the progeny of a controlled pollinated parent, they would still be a heterogenous lot. This study vividly emphasizes the need for great numbers of identical seedlings gotten only by rooting or air layering. Information derived from cultural methods, studies of site influences, and physiological investigations using such clonal material could be more accurately evaluated. The confounding factor of genetic variation characterized by the usual lot of seedlings could be ignored.

Past experience with species more readily rooted than our own native southern pines has given us some leads in the search for practical means of rooting pine cuttings. It is now recognized, that success or failure in rooting is dependent upon the age of the tree from which the cuttings are taken or upon which air layers are made. Deuber, Fields, Jacobs, Snow, Kammissarov, and Thimann and Delisle have shown that in many coniferous species, cuttings taken from young trees up to five years of age root more readily than those taken from older trees. This has also been indicated by the work of Mitchell, Schopmeyer, and Dorman with slash pine and by Cech of Texas with loblolly pine cuttings. McAlpine recently observed that the same holds true for the air-layering of loblolly pine. Studies here at Athens, though not specifically designed to show age differences, have demonstrated the successful rooting of cuttingb taken from one-year-old seedlings and consistent failure of those from older trees to root.

A second principle emphasizes the effect of position on the tree frog which cuttings are removed on their rooting capacity. The generality conveys the conception that rooting capacity of cuttings is greater when taken from the lower portions than from the upper portions of a tree. Some workers have suggested that this may be correlated with the differential distribution of natural root inducing hormones as a consequence of proximity to the roots of the parent tree.

Variation in rooting capacity between trees of the same species has been recognized. How much of our success or failure with rooting cuttings of slash, loblolly, longleaf and shortleaf pines depends upon variation in rooting capacity is difficult to say, but the possibility of its existence cannot be ignored. Equally apparent are the differences in rooting capacity between species and the different requirements necessary to propagate them.

Time of collection and the condition of cuttings affect survival and rooting capacity. Dorman and Mergen agree on October and early November collections for slash pine. Cech finds December and January the best time for the collection of loblolly pine cuttings. Cuttings should be healthy. They should be taken from the current year's branch growth.

Mechanical or chemical treatments before or after collection apparently influence both the survival and rooting. Length of cuttings as it affects survival and rooting has been a matter of controversy. In general a reduction of above ground needle or leaf area is accompanied by diminished survival and rooting. Cuttings with a heel of old wood generally intereferes with rooting. Dorman reports that bases cut in a number of ways have little effect on percent rooting. A long slicing basal wound with the object of stimulating the production of a large area of callous tissue from which profuse rooting can originate is being used here. Slash pine cuttings have responded well to basal wounding before chemical treatment according to Mergen, Pre callousing as a consequence of storage in sphagnum has been found unsatisfactory and unnecessary in the handling of slash pine cuttings. Dorman however reports 25% rooting of slash pine cuttings stored for two weeks in wet sphagnum at 85° F. Strangulation and phloem blocks in order to increase food reserves in distal portions of branches prior to the collection of cuttings has failed to stimulate rooting according to Cech.

The use of growth substances has been looked upon with favor in the rooting of cuttings. It has become standard procedure. Failures resulting from its use have been ascribed to time of treatment, concentration of the growth substance, method of application, or propagating conditions. It has been said that in general the more difficult a species is to root, the higher will be the concentration that is required. The application of this premise should be tempered with caution. High concentrations may prove toxic, where low and medium concentrations may be effective. Optimum rooting varies with the substance and carrier used; with the species, age and condition of the cutting; with the time of year; and with the method of treatment. Not only does treatment with growth substances increase the number of cuttings that are rooted successfully but it also increases numbers of roots, root length, and survival. While some measures of success has been acheived in the use of growth substances we cannot anticipate results since certain treatments have not been consistently productive from trial to trial and with different species. Concentrations used in the propagation of other pines have been found unsatisfactory for slash pine.

Treatments with additives other than growth substances have been found beneficial. Mirov has recommended the use of warm water to remove oleoresin and improve water absorption by the cutting. Cech observed no benefits resulting from water soaks used to remove possible inhibitors. Evanari, and Thimann and Delisle have suggested that the use of sugar may be of value in improving the rooting capacity of cuttings. The applications of honey, vitamin Bi, potassium permanganate and other substances have been recommended. Mergen observed no benefit from applications of pyrodine, thiamine, pentachlorophenate, or nicotinic acid. Exposure to ethylene has been ineffective in the stimulation of rooting according to Cech.

In general, rooting media giving optimum propagation conditions will vary with the species and its requirements in respect to aeration, heat, pH, moisture, and available nutrients. Sand, sand and peat with varying proportions of each, vermiculite, perlite, styrofoam, redwood bark, pea gravel, forest duff, charcoal-sand mixtures and other media have been used. Dorman has favored the use of a sand medium over sand-moss medium and has rooted slash pine cuttings in pure and mixed media of redwood bark. Mergen found sand and vermiculite promising, McAlpine and Zak have been using a sand-peat medium. Washed sand of unspecified grade and local origin is being used at the University of Georgia. For no other reason than to avoid confounding an already confused situation. A mixture of sand and charcoal is also being tried. However, survival of cuttings in this medium has been no bitter than in pure sand. Of course there are other modifying factors which may be responsible for this poor initial performance. Grigsby has had excellent results with perlite, alone or in mixtures with coarse sand. He attributes this success to good aeration and drainage. Cech's trials with sawdust, vermiculite, forest duff, sandy loam soil, sand, sand vermiculite, panaloam, pea gravel, and redwood bark as rooting media have been inconclusive. While sawdust was superior at one place he found sand better in another for the same species.

According to most workers light intensity should be reduced. It is not clearly stated whether this recommendation is based upon the deleterious effects of full sunlight itself or the heat which the light produces. Shading of propagation benches here seems to improve survival during all seasons. The tolerance of slash pine cuttings to full sunlight seems greater than that of loblolly pine. Grigsby has gotten good rooting results with loblolly pine cuttings in full sunlight. The increase of day length by artificial light has shown some promise and should be investigated further. Rooting of cuttings is unaffected when removed from plants exposed to supplementary red, and far red light according to Cech.

Emphasis has been placed on the retention of high humidity over propagation benches, However there is some controversy. Dorman concludes that high humidity does not compensate for water sprays or mists. Grigsby has used intermittent misting with a readily drained medium to good advantage. McAlpine has found that mist is disappointing and he has simply used daily watering with a hose in the propagation of shortleaf and loblolly pine. Results of Mergen's studies on the use of a sweat box or propagation frame demonstrated its unsuitability for rooting slash pine cuttings. Nor did the sub-irrigation of the bases of cuttings show promise. At the University of Georgia misting improved the survival of both slash and loblolly pine cuttings in propagation benches under shade in the greenhouse. Mist applications will be continued. Tentatively a schedule of intermittent misting will be used during the heat of the day in the summer. During the cooler seasons when it is necessary to heat the greenhouse an intermittent misting schedule will be used over a 24-hour cycle. Our currently poor survival of cuttings in the greenhouse may be attributed at least in part, to the insufficiency of the current misting schedule and possibly inadequate drainage from the medium in the bench.

Slash, loblolly, shortleaf and longleaf pine cuttings can be and have been rooted. Twelve percent of 420 loblolly pine and 20% of equal number of slash pine cuttings taken from one-year-old seedlings have been rooted here. Grigsby of Mississippi via personal communication reports the rooting of 10% untreated and 46.3% treated loblolly pine cuttings. For another group of 22 cuttings from a single tree he reports 68% successfully rooted cuttings. The trees from which these cuttings were taken were 25 years old. These are the best results reported to date. Cuttings rooted by Dorman have grown into sizeable trees. Nevertheless we cannot repeat what has been done before nor have we been able to improve upon it. The majority of successes have been with cuttings of young trees. Unfortunately the characteristics we seek have not been recognized in seedlings or in young trees.

Needle bundles have been rooted by Thimann and Delisle with white pine, Toda with Japanese red pine, Jeckalejs with red pine and more recently by Zak with shortleaf pine. Needle bundles have also produced buds. Potentially here is the method whereby hundreds of small plants could be produced from a single branch of a parent tree.

A recent communication from the experiment station at Lake City reports that air layering is much more successful than rooting of cuttings on slash pine. Consequently their vegetative propagation work during the last two years has been done using air layers and some grafting. Air layering though successful does not hold the promise of plenty that rooting of cuttings does. However, as employed by McAlpine in determining the effect of age on rooting it can be used to gather information which is applicable to other rooting methods.

Using a modified air layering technique Zak is able to root needle bundles. The root originates from the small slab of stem tissue to which the needle bundle is attached.

In conclusion, empirical studies undertaken thus far have netted one major contribution, namely that difficult to root pines can be propagate vegetatively. But, the successes have been few and large numbers of rooted cuttings still cannot be produced upon demand. Consequently the emphasis must shift to more basic investigation devised to give information which can be used in the precise manipulation of cuttings so that they can be made to root.

Root initiation and development, and the physiology involved are the primary considerations in this approach. The predisposition of living parenchyma cells in stem tissue to divide and to differentiate into roots needs further investigation. The agent or agents of stimulation should be identified, Their activity in relation to other metabolic processes which are ultimately expressed in growth and form must be understood. Seasonal fluctuations in food reserves probably exert their profound effects on rooting and must be examined.

Water relationships inside and outside the cutting influence survival and rooting. Cuttings are so much less successfully rooted than airlayers, presumably air layers differ only in that they have a water bridge of xylem which connects it to the remainder of the tree. This is lacking in cuttings. Is it the water alone or is the water a vehicle for some necessary constituent, such as nutrients or food or food derivative. If water alone is the critical factor what then is the water balance inside the tissue necessary to insure survival and growth? How may this inbalance be remedied? Does misting or other means of maintaining a high relative humidity reproduce this balance or is transpiration and an adequate water supply in the medium sufficient to promote root growth.

Photoperiod, light intensity, and light quality inasmuch as they profoundly influence the growth and reproduction of whole plants may likewise affect cuttings.

Species and even different individuals within a species may vary as to their capacity to root. What are the differences between cuttings from those which will root and those which will not root?

Rooting capacity also apparently differs between cuttings or air layers from young and old trees and even when taken from different positions in the same tree. Are there differences in age? If the reproductive capacity of living tissues is different in younger and older trees or different in tops and bottoms of individual trees, what are the intrinsic differences in these tissues? What then is aging in plant tissues?

Environmental factors, temperature, media etc., which influence not only survival but also growth warrant examination.

Until the solutions to some of these problems are uncovered the tooting of southern pines may remain unpredictable and unreliable as a tool, in its application to forestry research and practice.