HARDWOOD SEEDLING PRODUCTION - A TREE IMPROVEMENT TOOL

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INTRODUCTION

The title of this paper perhaps implies an unjustified minor role to the importance of seedling production in planning for sustained management of our southern hardwoods. This, however, is not my intent, but merely reflects my lack of ability in pulling together two somewhat different operations, each of major importance, in artificial regeneration of hardwood sites. I especially don't intend to play down nursery production from my present position before a group of nurserymen.

If we are to apply genetic improvement for our several hardwood species -- the goal implied by the use of the term 'tree improvement" -- we must look at the genetic upgrading by seed orchards, seed production areas, or what have you, as one operation and nursery production as a second - each dependent upon the other. The task of uniting these two operations has been assigned me and is the area I will discuss for the next few minutes. As might be expected, there are many facets of tree improvement and nursery practices for which we now have insufficient information. Many of these are common problems with which many of you daily cope. Others are more subtle and will require special effort aimed at their solution before satisfactory answers are developed.

HARDWOOD PLANTING - HOW MUCH?

Perhaps the first hazard in developing both tree improvement and nursery facilities lies in defining the size of the hardwood planting job. This question must be answered whether we are concerned with an individual landowner's holdings, a state, or the entire region. I think we will all agree that at whatever level we are accustomed to thinking, a given minimum-sized planting need must be seen before either seed orchards or nurseries can be justified. We cannot define this minimum need; a great deal of additional silvicultural information for the several species and sites must be developed before this can be done.

Within the 40 or more million acres classified as southern hardwoods are many millions of acres which can be most efficiently managed by some system of natural regeneration© Techniques of management will vary dependent upon species, sites, markets, and classes of ownership, but irrespective of this variation, natural regeneration will prove to be a most efficient method for obtaining regeneration on a vast acreage. Other sites -- for example, those on which it is both

desirable and possible to convert to more valuable species, those so mishandled in the past that natural seed supplies are scant, and those being returned to hardwood production after being used for other purposes -- may be most efficiently brought into full production through artificial regeneration means. It is for these classes of lands that seed orchards play an important role with nursery-produced seedlings needed for that portion not direct-seeded.

It is not my intent to cite acreage figures necessary to justify hardwood seed orchards. Certainly they will be desirable when considering seed necessary for an entire geographic province, or state. Within each of these, orchards may be developed for particular sites or site groups. For an individual ownership, justification must be based on the size of the planting program envisioned and the needs within each species and site classification used.

Of equal or greater importance in determining the size of the planting job is the amount of genetic gain to be expected through the use of seed orchards. Ideally, we would like to have this gain expressed in terms of increased yields per acre in cords or thousands of board feet at the end of a rotation. Such figures will ultimately be available, but not until we have grown superior strains through the better part of a rotation. We have heard figures ranging from 5 to 15 percent improvement cited for pine, these are estimates based on far better heritability data than we currently have for hardwoods. Logical reasoning, however, leads me to suspect that gains of the same magnitude can be expected in hardwoods, particularly when the improved material is used in conjunction with better management practices.

It hardly seems necessary to remind you of the influence of seed source on growth and development of the planted or seeded stands. We are all very familiar with this concept from past work with the pines. Although we do not as yet have definitive information on seed zone boundaries for our hardwoods, we recognize the need for them. They will determine to a large degree the amount of seed to be produced from wild-type collections or seed orchards and the numbers of acres to be annually planted will govern the nursery production to be anticipated.

If you will accept the premise that the nursery is the intermediate step between seed and well-established plantation, and the seed orchard to be the source of superior raw material for the nursery, it then is well to consider the problems of these two independent but interrelated operations.

HARDWOOD TREE IMPROVEMENT

In considering a tree improvement program for any species or species group, the first question one must ask concerns the advantages to be

gained from such an approach. Justification is normally made from the improvement to be secured by upgrading the genetic potential of seed derived from parents having traits of highest economic value to the forest enterprise. These traits can, and do, vary from one organization to another, dependent upon the tree and wood properties of greatest value to the final product manufactured. Individuals exhibiting the traits of highest value are propagated vegetatively or through a sexual cycle and set apart to be managed solely for the seed they will yield.

A second justification for seed orchards might be the assurance of a continuous supply of seed if a continual shortage is seen or anticipated. This could be a special reason for establishing orchards for the heavier seeded hardwoods, such as the oaks or blackgum, which present many problems when attempting to obtain large quantities of seed. Assurance of a seed supply could be very important where pulpwood rotations are envisioned, the short rotations possibly precluding heavy seed yields.

Parental selections for orchards are made on phenotypic worth of the individual, as determined from a mathematical rating applied to candidate trees. Genotypic evaluation must await progeny testing in carefully planned, statistically designed studies. Seed production areas similarly are designed to produce genetically superior seed supplies, but with this approach only the phenotypic value of individual parent trees is normally determined and the rigors of selection are not nearly so great as with seed orchards nor must vegetative propagation be resorted to.

In establishing hardwood seed orchards, each step presents problems different from those of establishing and managing pine seed orchards. These problems are not insurmountable, but may require new approaches in our thinking and perhaps in techniques as well. I will attempt to point out several places where lack of information does not allow us to be specific in outlining best techniques for hardwood seed orchard establishment. You will think of others and perhaps have thoughts on some problems which I propose.

An incomplete knowledge of the biology of the species with which we will be working is perhaps the underlying cause of many of our problems. For instance, site requirements for maximum growth are far from being understood. Information to be gained from the literature states that most species, with the possible exception of cypress, tupelo, and swamp blackgum, grow best on moist, well-drained sites. Although this may be generally true, it is of little use when defining those sites from which orchard candidates will be chosen. If we plan to plant a species in bottomland sites only, dare we go onto the drier sites for a portion of our selections or must we stick to the bottoms to secure orchard material? Can we establish a single orchard for

Piedmont and Coastal Plain or must separate orchards be built? Within the Coastal Plain, what latitudinal or site boundaries must be set for an individual orchard?

Flowering biology itself is incompletely known for many species. Before we can confidently produce seed by any means, we must have concrete information, now lacking for some species, of their reproductive mechanisms including stages and timing of flowering and flowering date variation from site to site and area to area, disease and insect enemies to flowers and seed and how to combat them, methods of determining seed ripeness prior to natural release, and on—and—on.

Methods of orchard propagation are important. It is well substantiated that many of our hardwoods can be propagated vegetatively by rooting; for instance, Brown and McAlpine (1964) have successfully propagated sweetgum from root cuttings, McAlpine (1963) has reported successful rooting of sycamore cuttings, and many publications are available denoting good success in rooting the true poplars. Successful rooting of softwood sweetgum cuttings were made by Farmer (1965). However, what are the seed production possibilities of the rooted material? If the newly rooted plants flower within a few years, as has been observed in sycamore, for instance, all well and good. If the rooted plants revert to a juvenile condition, then it might be 15-20 years before a seed crop would be forthcoming. In such instances, we would best continue with grafting as the propagating technique. On a production basis, Orion Peevy has been successfully grafting and budding both sweetgum and yellow—poplar in the seed orchard program of the Weyerhaeuser Company. I believe satisfactory methods for propagation of outstanding trees of most species is at hand. The proper methods to use will vary, however, by species and objectives.

In establishing seed orchards, it is desirable to maintain as much genetic variability as possible within the selected population making up a given orchard while still maintaining the desirable economic traits on which the orchard is based. Maintenance of this variability in light of the heavy seed yields of our light—seeded species leads to some interesting speculation. For example, suppose one wanted to establish a sweetgum or sycamore seed orchard capable of supplying a million seedlings annually. In sweetgum, the seed required could, perhaps, be obtained from 20 individuals or less and in sycamore somewhat less than half this number. If a minimum of 20 selections is made to maintain genetic variability, and more selections would be desirable, no more than one ramet is needed per selection to achieve the desired quantities. I think it is safe to say that hardwood orchards will not foreseeably obtain the gross size our pine orchards require.

There are many other problems which must be faced in contemplating hardwood seed orchards. Such items as selection criteria, orchard management, collection techniques and genetic testing of selections

offer unique problems which must be resolved. Without going into the specifics of these and other interesting problems, I would like to spend the balance of my time discussing aspects of hardwood seedling production that are somewhat different than our pine nurseries offer.

HARDWOOD SEEDLTNG PRODUCTION

The proof of any tree improvement program, particularly if seed orchards and planting are the means for obtaining genetically improved stands, is dependent upon the production of quality nursery seedlings. Although obtaining this quality material requires the same basic steps as in improving pine, several facets of production are somewhat different. It is true that the basic tasks are still soil preparation, fertilization, seeding, maintaining water schedules, combating insects, diseases and weeds, lifting, packaging, and shipping. However, each step is in some way different than that to which pine nurserymen have become accustomed.

To start off, seed collection, storage, and preplanting treatments differ not only from pines but also between species. Commercial collections for all species can be made behind logging operations if properly timed, and correct timing on many is vital, but collection in seed orchards can present problems. Sweetgum, ash, sycamore, and poplar can be collected by climbing, and expensive though this may be, it offers the only satisfactory method of obtaining seed of the light-seeded species from orchards. The heavier-seeded species, such as the oaks, tupelo, and blackgum, can be most easily picked from the ground. Storage requirements are varied. The oaks and maple are hard to store for even 1-year. Sweetgum, like pine, is successfully stored for several years. Sycamore can be stored dry; tupelo and blackgum in a moist medium, but all three species lose viability after 1 year. Presowing treatments required can generally be summed up as 60-90 days stratification but there are some exceptions. We have found no difference in germination or stand development between stratified and non-stratified sycamore or oak. The Nyssa species, tupelo and swamp blackgum, are essentially in stratification from the time of storage. The hardwood nurseryman, working with several species, thus must keep close rein on storage and stratification schedules if he is to realize the full potential from the seed collected.

Soil preparation and fertilization schedules used are generally those routinely prescribed for a given pine nursery. These have in the main been successful, but I have no doubt that more refined fertilization rates can be prescribed for individual hardwood species within a given nursery. Such refinement has not yet been made since routine rates have been satisfactory and seedling demand has not warranted the formulation of new schedules.

Nursery seeding has been largely a hand operation to this time. Again, I believe this to be primarily a matter of hardwood seedling production being of insufficient magnitude to justify development of more efficient seeders. I should think adaptation of present seeders could be made which would allow them to be used for sowing hardwoods as well as pine. Walter Chapman has been successfully sowing small-seeded hardwoods for several years in the Kimberly-Clark nursery by reducing the size of opening on his fertilizer spreader and making several passes over the bed until the calculated amount of seed has been dispensed. It is particularly important that mechanized methods be developed since, as we shall see later, control of density appears to be all important in growing quality hardwoods.

I have been asked several times why hardwood seedlings costs are so much greater than pine. To you this is apparent, but to the landowner accustomed only to purchasing seedlings, it is not; furthermore, it directly affects his pocketbook. Several basic nursery practices necessary for obtaining quality seedlings are more expensive for the hardwoods by the very nature of their requirements for growth and development.

Weed control perhaps is responsible for a large part of the increased production costs. Other than preplanting treatments, chemical weeding cannot be resorted to for hardwood beds and expensive hand weeding must be used to free the beds of unwanted vegetation. This technique increases production costs rapidly.

Lower bed densities require that a larger proportion of the nursery be allotted for production of hardwoods than for a like number of pine seedlings. In the early days of nursery production in the South, pine was grown at densities of 50-60 seedlings per square foot. With such high densities, a large percentage of seedlings were culled at the packing shed or performed unsatisfactorily in the field. Reduction of density to 25-30 seedlings decreased the cull percentage and resulted in production of higher quality seedlings for outplanting. Even lower densities are indicated for hardwoods. Tests of sycamore and sweetgum indicate that the larger seedlings in terms of root collar diameter perform much better when planted in the field, and densities of 15-20 seedlings per square foot appear to be the most satisfactory. Such densities thus increase seedling production costs by increasing pre- and post-emergent weeding, fertilizer, and watering costs.

Packaging, storage, and shipping contribute to the increased prices that must be charged for hardwood seedlings. Their larger size and increased weight dictate fewer seedlings per bundle, more storage facilities, and the very nature of the larger root systems compound packaging difficulties and efforts to keep the roots moist prior to out planting.

There are other problems that will be encountered in large-scale production of hardwoods, both in the seed orchard and nursery. I have mentioned insects and disease problems to be faced, primarily because we have little evidence of what these will be and how to combat them.

It would be premature to predict their nature, but rest assured that we will have them. As special problems develop, be they soils, insects, disease, or others, you nurserymen will be the ones most directly affected and must guide the researchers in seeking methods to combat them. Their solution hopefully will contribute to production of quality stock at lower costs, but the biological requirements of hardwoods will require that production costs remain higher than for pine

SUMMARY

Although it is difficult to predict what the demand for hardwood seedling production will ultimately be, it now seems apparent that some portion of our hardwood lands will be artificially regenerated. Prudent husbandry suggests we would be remiss not to obtain the advantages of genetically improved seed for stocking these sites. Establishment of hardwood seed orchards will, in the long run, be the means of obtaining this improved stock, but establishment of hardwood orchards presents problems unique to hardwoods and differing by species and species groups.

Connoted by the very act of establishing hardwood seed orchards is the production of hardwood seedlings for that portion of artificially regenerated stands not established by direct seeding. Just as individual species present different problems in seed orchard management, so do they individually and collectively present operational diversities in the nursery. These diverse problems all increase production costs for hardwood seedlings as compared with pine. Future efforts, quite rightly, will be aimed at reducing these costs, but I do not believe they will allow hardwood seedling costs to be comparable with pine.

LITERATURE CITED

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Discussion

Q. (Jones) On what will the future demand for hardwood be based?

A. (McElwee) I believe the biggest demand for the increased use of hardwood timber will be in the pulp industry. There will probably be an increase in use of veneer stock, hardwood sawtimber, and other products; but percentage wise, I don't believe they will reach the demand that pulp will. There are several mills in the South which have cut back their use of hardwoods in the past several years-- not because they don't want it but because it just isn't available to them in efficient freight rate zones.

Q. (Vande Linde) When do you sow these hardwood seed, in the spring or fall?

COMMENTS (Vande Linde). We have found that if you are going to direct-seed acorns, you must chill them for 60 - 90 days but if you plant them in the nursery it doesn't make a whole lot of difference -- it just takes longer for them to germinate. If you chill them for 60 - 90 days, they will germinate in 10 days otherwise, they will take about 40 days.

Q. What do you mean by chill?

A. (Vande Linde) The chilling is accomplished by placing the seed in a cooler at 38°F. It appears to be as good as stratification. White oaks are kept until March and then planted.

COMMENTS (Darby). We fall plant and get good spring germination with acorns on low bed densities. We are also trying some in rows like row crops.