

Influence of Competition Control on the Survival of Planted Oak Seedlings

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Introduction

Historically, the bottomland areas of the South were covered by large expanses of hardwoods. Scattered pine were found in these areas, but oaks were a dominant species group in most of these stands prior to European settlement. Fire is believed to have been a factor in the development and continuation of these stands, but not nearly to the extent of influence that it exerted in the upland areas of the South. While exact species composition of these bottomland hardwood stands varied then as they do now, oaks are considered to have been a consistent overstory species, attaining large diameters, and occupying sites for prolonged periods in the absence of catastrophic, stand-replacement fires or wind events. This situation persisted for thousands of years.

With European settlement came the clearing of land for agriculture. Bottomland areas were among the first cleared because they were the most desirable for crop production. This clearing began in the 1700's, was intensified during the 1800's, and then restarted in the mid-1900's. Thus, millions of acres of hardwoods in the South were simply cleared, piled, and burned.

The current trend is to "retire" these agricultural production areas and replant hardwoods on them. As the economics of producing agricultural crops on these acres has become less attractive and cost-share programs have made tree planting more attractive, each year marks the return of more land back to trees. Current projections estimate that by 2040, approximately 34 million acres of agricultural land will be "retired" from crop production and planted with trees (Wear and Greis, 2002). Some of these areas will be planted with pine species, but many will be planted with hardwoods. Of all the hardwood planted, oaks are the species planted most often (King and Keeland 1999, Schoenholtz et al 2001, James 2002). To date, more than 500,000 acres have been planted with hardwoods. Thousands of acres are being planted each year in the South. Unfortunately, survival of planted oak seedlings on many of these acres is very low, and would be considered unacceptable for most management purposes (Stanturf et al 1998, Ezell 1999a, 1999b, Groninger et al 2000, James 2002, Stanturf et al 2004). The problems were noted as early as the 1980's, and concern over seedling mortality has increased as planting efforts have increased.

Seedling Mortality Factors

The survival and early growth of oak seedlings is heavily dependent on three factors – seedling quality, planting quality, and competition control. A complete exploration of seedling quality is beyond the scope of this paper, but repeated research efforts have demonstrated that seedlings which are either too small or too large are at a disadvantage in regard to survival in operational, large scale plantings. Those that are too small typically lack the root system needed and those too large will either receive excessive pruning, be planted improperly, or simply

be discarded. Associated with seedling size is the desirable root system. Again, too little or too much are both detrimental conditions. Our observations over the years indicate that an oak seedling with a height of 18 inches to 24 inches and an absolute minimum of six first-order lateral roots (10 – 12 is preferable) represents the optimal size for desirable planting and subsequent survival. If only a very few trees are to be planted, bigger could be better if you are willing to excavate an appropriate planting hole and properly transfer the large seedling with its associated root mass. However, when dealing with millions of seedlings on many thousands of acres, having seedlings of an optimal planting size is a critical “first step”.

Planting quality is just as important for oak seedlings as it is for pines – perhaps even more important. A planting crew can take very good seedlings and greatly diminish the survival by mishandling the trees prior to planting or by doing a poor job of getting the seedling in the ground properly. In most situations, securing the services of a contractor with a proven record of high-quality planting work and field supervision of the crew are essential to ensure optimal results.

Site fluctuations due to natural occurrences are overriding factors in seedling survival. Droughts and floods are events that can impact any regeneration effort and are usually beyond the control of landowners. There are cases where flooding is reasonably predictable, and planting efforts can be modified to accommodate these situations. While droughts are not usually predictable, the impact may be decreased by having good seedlings, good planting, and competition control.

Competition is the last item to be considered in seedling survival. Generally, the importance of controlling competing vegetation in oak plantings has been greatly underrated. For many years, we have recognized the importance and benefits of herbaceous weed control for pine seedlings. However, there seems to have been a generally accepted sense that oak seedlings were hardier and could withstand the competition with little or no harmful effects. In reality, pine seedlings have survived better in our comparison plantings when subjected to comparable levels of competition (Ezell, unpublished data).

Most of the oak seedlings currently planted are being placed in abandoned ag fields. These areas have generally been “out of production” for 1-5 years and are heavily infested with both grasses and broadleaf weeds. In these situations, the critical competition is for water. Ample sunlight is available, even in most areas where the competition is not controlled. However, the root system of a recently planted oak seedling is no match for the established root masses of grasses and forbs when it comes to competing for limited quantities of available soil moisture. Even if the oak seedling survives, its growth and development are severely retarded.

Materials and Methods

Seedlings – The research has been conducted on a variety of oak species. However, most of the individual projects have focused on one or more of the following species: cherrybark (*Quercus pagoda* Raf.), Nuttall (*Q. nuttallii* Palmer), water (*Q. nigra* L.), willow (*Q. phellos* L.), Shumard (*Q. shumardii* Buckl.), and white (*Q. alba* L.) oaks. Lesser amounts of other species have been included in one or more individual projects, but these six species are well represented in a variety of research efforts. A small amount of 2-0, bareroot seedlings and some containerized and potted seedlings have been utilized in the process of the research, but the vast majority of the research has been conducted using 1-0, bareroot seedlings.

This is because 1-0, bareroot seedlings are the principal nursery stock used in operational plantings. While we have utilized a variety of seedling sizes with associated root systems, we have concentrated our efforts on what we have identified as the optimal size and root system (previously described).

Herbicides – More than forty different herbicide products have been utilized in the research projects over the past sixteen years. Most of these are not available for an approved application over oak seedlings due to label restrictions. While a small percentage of the products tested did result in phytotoxic effects on the oaks, the vast majority were effective to variable degrees depending on the weed complex in the study and did not result in any damage to the oak seedlings.

Study Sites – More than 90% of all the research has been conducted in old field settings. However, our work in cutover areas has produced results which concur with the findings from old fields as relates to control of herbaceous competition. Old fields have been preferred study sites since they represent where almost all oak seedlings are being planted under cost share programs.

Application Methods – All herbicides were applied over-the-top of the oak seedlings. Our research was especially interested in crop tolerance as well as treatment efficacy. We have completed numerous preemergent studies (application prior to budbreak of the oaks), postemergent studies (middle of the growing season), and some studies which involved both timings. Many of the individual projects have utilized a banded application wherein the herbicide was applied as a four-to six-foot-wide swath using the planted row as the center of the swath. Other projects have used broadcast application in which the entire area was sprayed. Total spray volume for individual projects ranged from 10 gpa to 20 gpa (gallons per acre), with 10-15 gpa being used most.

Evaluations – Treatment areas are typically evaluated at 30-day intervals, following the application throughout the first growing season. At each evaluation, treatment efficacy and crop tolerance are rated. In addition, pretreatment measurements of total height and groundline diameter (GLD) are completed and used for comparison to post growing season measurement of the same parameters. Survival is evaluated at the end of the first growing season for all projects, and repeated annual survival checks are completed on some projects for prolonged periods.

Analysis – Data are subjected to appropriate statistical analyses which seeks to identify significant differences among treatments. ANOVA and means separation tests are utilized for these purposes.

Results

Crop Tolerance – No preemergent application of any product has ever damaged an oak seedling. No postemergent application which has label approval has ever damaged an oak seedling. Overall, if labeled products are used according to label directions, no damage will occur in the oak plantings.

Competition Control – Treatment efficacy will vary widely depending on the weed complex and the herbicide being used. While some products have a very wide spectrum of control, no herbicide will control all species.

Generally, preemergent applications are more effective than postemergent for broadleaf control. Best results are obtained by using both, but if only one application is to be used, the preemergent timing is preferred. However, if a graminicide is to be used for grass control, the application must be completed when the grass is actively growing which is usually after the tree has broken dormancy. These

are approved applications, work well, and do not damage oak seedlings, but no broadleaf control is to be expected – only grasses.

With many herbicides, competition control extended through the majority of the growing season (September or later). The critical time for control is early in the growing season when the seedling is trying to reestablish a root system. Therefore, if competition control will last for the first half of the growing season, the seedling is much better prepared to withstand any late growing season soil moisture shortages.

Survival – Over the sixteen years of research, we have identified three categories of survival patterns. These categories are the expected survival in (1) average rainfall years, (2) droughty rainfall years, and (3) extremely droughty rainfall years. Results for all the species, applications, and effective products are consistent for survival of “good” seedlings that are planted well.

“Average” Years – In average rainfall years, first-year survival of oak seedlings will be 60-70% in areas that receive no competition control. Again, this involves good seedlings that were properly planted. Overall, one of every three seedlings will die. In areas receiving competition control, survival is expected to be 90% or greater. Thus, controlling herbaceous competition consistently results in a 20% (or greater) increase in Survival.

“Droughty” Years – In growing seasons deemed “droughty”, wherein precipitation is four to eight inches below the expected average, more than half the oak seedlings typically die in areas receiving no competition control. Survival may range from 25% to 40% in these areas depending on the oak species and the drought, but in most cases, the potential for future management is questionable. By comparison, survival in treated areas is typically 75% to 85%. In essence, it becomes the difference in having a manageable stand or not.

“Extremely Droughty” Years – These years are characterized by precipitation amounts which are more than eight inches less than the average amount expected for the evaluation period. In such years, survival of oak seedlings is typically less than 10% - often no trees survive, and those that survive usually die in the second growing season.

By comparison, survival of oak seedlings in treated areas is typically 65-75% which still leaves the land manager with a manageable stocking.

Survival After the First Year – The majority of seedling mortality is expected during the first growing season. In areas receiving competition control, that is reality. Mortality after the first year is almost negligible, regardless of what the weather conditions were in the first year. However, in areas not receiving competition control, seedlings continue to die for several years. This is especially notable when a planting may have “above average” rainfall during the first growing season and survival in “untreated” areas may be comparable to “treated” areas. However, during the second and later years, many of the trees in the “untreated” areas will die, because even though they survived the first year, the competition prevented them from establishing a strong root system.

Summary

While no absolute figures exist for the survival of oak seedlings planted on thousands of acres across the South, all indications are that survival has been poor in plantings which did not receive control of herbaceous competition. Controlling herbaceous competition consistently improves survival by 20% in average rainfall

years. This competition control appears to be the difference in having a manageable stand or not in droughty or extremely droughty years.

Competition control is only one of three important management factors. It will be of little or no benefit if high quality seedlings and high quality planting are not utilized. But, if the landowner is allocating capital to good seedlings and proper planting, it follows that these seedlings would benefit greatly from competition control.

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