

GROWTH AND PERFORMANCE OF LOBLOLLY PINE GENETIC PLANTING STOCK THROUGH EIGHT YEARS

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Abstract—Currently, the need in the pine market is to develop higher sawtimber quality trees. The pine biomass and pulpwood market supports the low end of the product chain. However, we must improve on the quality of the southern pine for construction lumber if the southern region is expected to capture the shortfall of the sawtimber market expected in the future. Various pine genetic types ranging from open-pollinated to varietal seedlings must be closely evaluated for quality characteristics as to determine the best genetic material for regeneration. In 2007, a test of mass control-pollinated (MCP) and 2nd-generation open-pollinated seedlings (OP) was planted on a retired pasture site in north Mississippi. Measurements were taken annually from age one to age six and then again at age eight. The performance and quality of the MCP and OP seedlings will be discussed as to the recommendations for landowners in north Mississippi. In addition, the varietal portion of the study, which is a mix of different varieties, will be compared to both the performance of the MCP and OP seedlings.

INTRODUCTION

The landscape of southern pine markets and especially loblolly pine (*Pinus taeda* L.) has been shifting away from the pulp and paper industry and gradually more towards sawtimber (e.g., McKeand and others 2008). This change began in the mid to late 1990s as offshore pulp and paper mills in Brazil and other countries began production in a significant fashion capitalizing on the ability to use a single species, lower growing costs, and lower mill labor costs. The result of this shift has resulted in closure of a number of mills in southern states. The pulpwood market, mainly along the southern coastal areas, continues to be strong with the more recent increases in the European pellet market. This market takes advantage of the need for early pine thinnings that were typically needed for reducing the number of stems to allow better growth. These first thinnings in pine plantations are designed not only to reduce the number of stems per acre but also remove those stems that exhibited some obvious defect such as forking, disease, and sinuosity.

Non-Industrial Private Forest (NIPF) landowners in the South have willingly embraced pine plantation culture and have come to expect good financial returns from these plantations (e.g., McKeand and others 2003). However, the management of these plantations for the most part lacks the intensity typically practiced by the timber industry. While the NIPF landowners are willing to do site preparation work and some first-

year herbaceous competition control, they generally lack knowledge in what type of seedlings they should be planting. In general, they seem to think that 2nd-generation open-pollinated planting stock is just as good as any of the alternatives that are available. One reason for this is the cheaper cost of the open-pollinated seedlings, which currently ranges from \$60 to \$80 per thousand and the continual practice of planting greater than 600-700 seedlings per acre. Under this strategy, the landowner would expect to pay a total of \$87 to \$110 per acre, with \$42 to \$56 per acre for seedlings and contract planting of somewhere around \$45 to \$53 per acre. McKeand and others 2006 indicated that landowners would definitely benefit from purchasing the best genetic seedlings available even it meant paying higher prices.

There is no doubt that the selected individuals within second-generation populations have demonstrated considerable gain over those of the first-generation. But today there are a number of different genetic seedling stock types, including both control-pollinated (mass control-pollinated or MCP) and varieties (i.e. clones). These genetic types have the specific advantage of exploiting more of the available genetic variation relative to open-pollinated seedlings. There is no doubt that more reliable information on productivity and quality is needed to allow NIPF landowners and consultants to make informed decisions on selection of available genetic planting stock (Burkhardt 2013).

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This particular study was designed with two specific goals; a comparison of a single select 2nd-generation open-pollinated family to that of a selected MCP family, and evaluation of numerous varietal seedlings as provided through ArborGen as a portion of the ArborGen Testing Service (ATS).

METHODS

The test site is located near Holly Springs, Mississippi on the North Mississippi Branch Experiment Station of Mississippi State University. The test site was previously in pasture, which consisted of primarily Bermuda grass (*Cynodon dactylon*). A Loring silt loam with a minor portion made up of a Cahaba-Providence silty-clay loam are the two soil types found on the test site. Prior to planting the site was sub-soiled to a depth of 14 inches on 12 foot centers and then treated with a 2 percent solution of glyphosate applied as a three-foot band directly over the sub-soil area. The test design is a randomized complete block consisting of six blocks, three genetic seedling types (all of which were provided by ArborGen), arranged in 100-tree block plots with the inner 64 trees forming the measurement plot. The test site was planted by hand at a spacing of 12 x 9 feet in April 2007. During the first growing season the test site was treated with the herbicide Select in an attempt to control the Bermuda grass problem and mowed later in the year. In 2008, a broadcast application of Oustar was completed in May and followed up with another application of Select in June.

The three different genetic seedling types included a single 2nd-generation open-pollinated family (OP), a mass control-pollinated (MCP) family and several varietals. Both the OP and MCP planting stock were bare-root, while the varietal was containerized planting stock. The difference between the varietal plots and the 2nd-generation open-pollinated and the mass control-pollinated seedling is that the interior 64 trees forming the varietal plot consists of 56 different varietals and eight control seedling types. All of the trees within the measurement plots were measured for height at ages one, two, three, four, six, and eight while DBH was measured at ages three, four, six, and eight. Various types of stem quality degrade, which included excessive stem sinuosity, forking, presence of fusiform rust (*Cronartium quercuum* f. sp. *fusiforme*), ramicorn branching, and crown dieback or breakage were also measured at age eight.

RESULTS

Comparison of mean survival, DBH, height, and volume at ages four, six, and eight between the 2nd-generation open-pollinated family and the mass control-pollinated family showed that in general the MCP family outperformed the OP family. Age-four survival of the OP family was higher at 95.3 percent than the MCP family

at 93.2 percent. However, age-eight survival between the OP and MCP families was quite similar at 93.5 percent and 93.0 percent, respectively. Although, there were significant diameter differences between the OP and MCP families for all ages measured, the 0.03 inch difference shown at age four remained the same at age eight. The greatest difference between the OP and MCP families was exhibited in total height. However, this difference did not show up until age eight. At ages four and six, the height difference between the MCP and OP family was identical with the MCP family being 0.9 feet taller. At age eight this difference had expanded to 1.6 feet, with the MCP family exhibiting a mean height of 33.8 feet. Correspondingly, the volume performance between the MCP and the OP family revealed an increasing difference with the MCP volume increasing faster than the OP family as age increased.

Examination of the frequency of the individuals within the MCP and the OP families showed that both total height and diameter were more variable for the OP family (fig. 1). The OP family exhibited trees in the four, five, and six inch diameter class whereas the MCP family showed no individual trees below the six-inch class. In addition, the MCP had very few individuals in the six-inch diameter class. A greater percentage of individuals for both the MCP family and the OP family fell in the 31-35 foot class but the MCP family had a larger number of individuals in this class as well as in the 36-40 foot height class. The OP family had a greater number of individual trees falling into the lower height classes as compared to the MCP family (fig. 1).

Interesting differences were evident among planting blocks. In blocks one and two the OP family outperformed or was almost identical to the MCP family. However, for blocks three through six the MCP family exhibited a significant greater volume production over the OP family (fig. 2).

The variation among the 56 varietals included in the varietal plots was highly significant for height, diameter, and individual tree volume. The composite mean of all 56 varietals for all traits at all ages was lower than that of both the MCP and OP families. However, the best three varietals exhibited age-eight survival, diameter, total height, and volume greater than both MCP and OP family means (table 1).

Every tree in the test was assessed for what was termed as log degrade. This included characteristics such as stem sinuosity, poor stem form, forking, excessive limb breakage, ramicorn branching and the presence of fusiform rust. Surprisingly, both the MCP and OP families and the top three volume performing varietals all expressed approximately similar amounts of degrade (i.e. approximately 14 percent). There was a single varietal identified as 288, which exhibited a very low

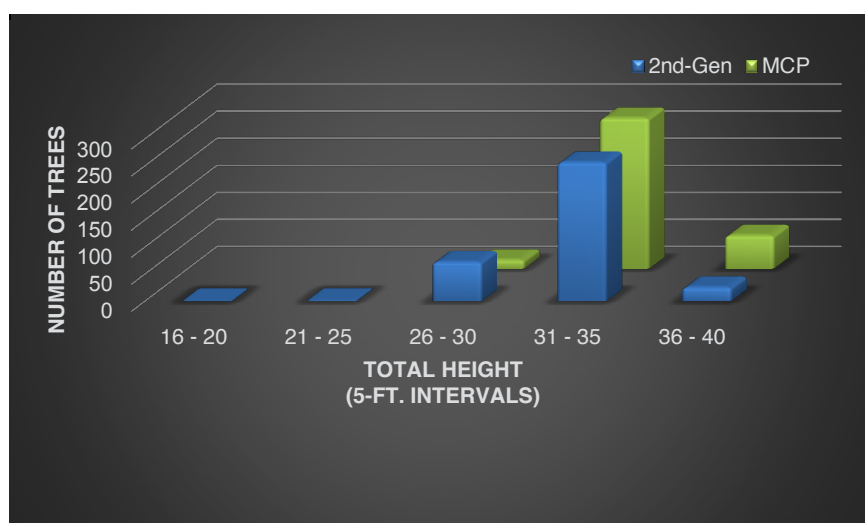
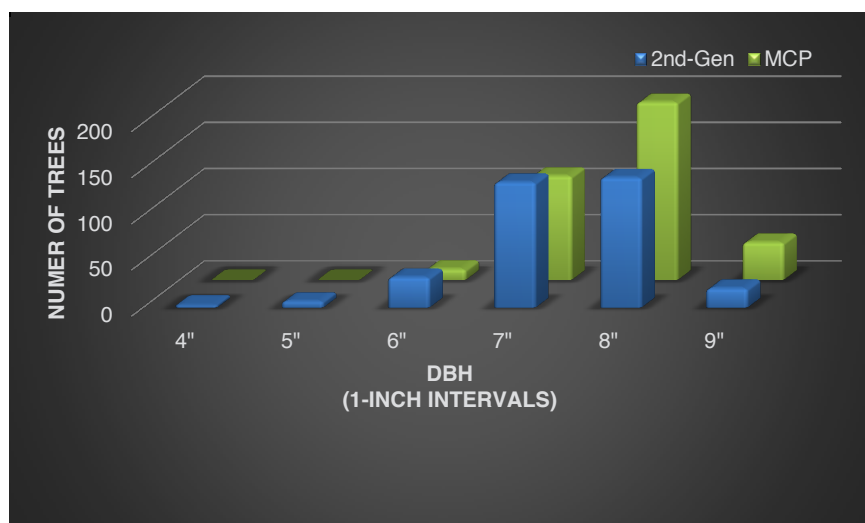


Figure 1—Distribution of trees by height and diameter class at eight years for both the MCP and OP families included in Genetic Comparison Test located near Holly Springs, MS.

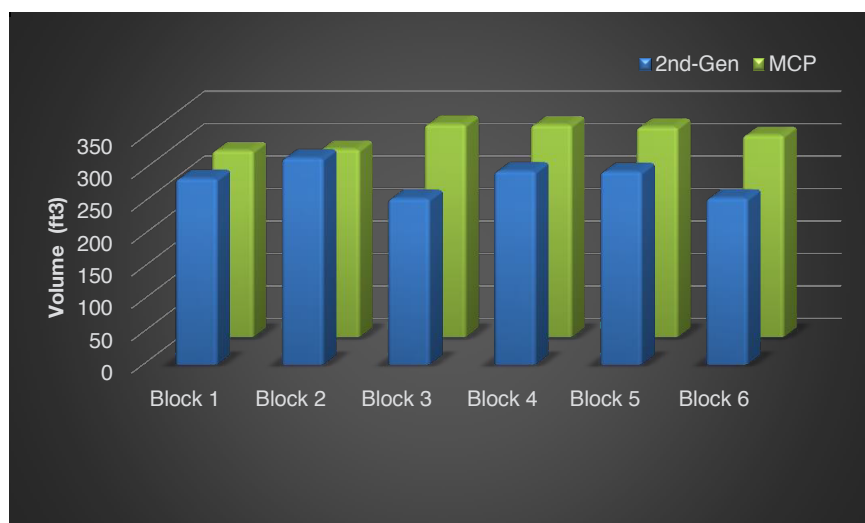


Figure 2—Age-eight total cubic foot volume differences by block for both the MCP (green) and OP (blue) in the Genetic Comparison Test located near Holly Springs, MS.

Table 1—Comparison of the three top performing varieties to the MCP and OP family means at eight years for the Genetic Comparison Test located near Holly Springs, MS

Genetic Stock Type	Survival (%)	DBH (in)	Height (ft)	Volume (ft ³)
Varietal 567	100	8.0	33.9	5.71
Varietal 586	100	8.1	33.3	5.66
Varietal 484	100	7.9	34.1	5.58
2 nd -Gen OP	93.5	7.5	32.2	4.78
MCP	93.0	7.8	33.8	5.31

percent degrade combined with good age-eight growth characteristics for diameter, height, and volume at 7.5 in., 33.6 ft. and 4.94 ft³, respectively.

DISCUSSION

Interest has continued to grow among NIPF landowners to determine if higher quality genetic seedlings will actually lead to increased revenue. While this test is limited due to the inclusion of only a single family of both mass control-pollinated and open-pollinated 2nd-generation family, there is no doubt that the MCP family performed better than the OP family. The MCP family exhibit greater uniformity than the OP family as shown in the diameter and height frequency distribution, where all of the MCP trees were grouped into the larger classes. This is to be expected, since full-sibs (MCP) possess a greater amount of additive genetic variation over open-pollinated (OP) individuals. While some non-additive genetic variance is also expected this has been suggested to be very low (Jansson and Li 2004). The rationale for this was that the selection of both parents was based on high general combining ability (GCA). Other studies have also noted that gains in productivity, fusiform resistance, and stem straightness have been remarkable when both male and female parents have been carefully selected (e.g., McKeand and others 2008). What was extremely interesting was the response that was observed between the MCP and OP families across the six blocks. Blocks one and two were extremely heavy to Bermuda grass and the soil more compacted from traffic. Subsequently the performance of all of the trees suffered, no matter the genetic type. In these two blocks the growth performance between the MCP and OP families was much more similar than in the other four blocks. This seems to indicate that the MCP family has the capability of expressing its inherit growth potential better than the OP family as site index increases (e.g., McKeand and others 2006).

The performance of the varietal plot is understandable as this is was really designed to be a portion of a much

larger varietal trial by ArborGen to determine possible selections for commercial release. When examined at this test site alone, selections can be made but stand performance is unknown since only six individuals per varietal were evaluated. In this test, three varieties demonstrated excellent survival and growth when compared to the mean of the OP family. However, the age-eight performance of these three varieties was very similar to that of the MCP family. The mean diameter of these three varieties was the biggest difference which also affected volume.

From this specific data, the question remains as to whether varieties are worth the extra cost compared to either OP or MCP seedlings. But, before that can be truly answered, there is a need to include quality characteristics that will provide added value to the landowner. As mentioned earlier both the MCP and OP families graded out very similar in relationship to quality. However, one specific varietal (i.e. 288) demonstrated excellent quality characteristics. This specific genotype was superior to the OP family in terms of growth and quality while also exhibiting quality characteristics superior to the MCP family. While overall volume performance is lower than the MCP family the quality of this varietal will override this aspect when the focus is more on producing quality (e.g., Cumbie and others 2013). The next step to examine is the performance of this varietal when it competes with itself when evaluated in stand conditions.

CONCLUSION

After eight years, the MCP family has outperformed the OP 2nd-generation family in diameter, height, and volume. The MCP family was also shown to be more uniform than the OP family, with the majority of the MCP trees being found in the taller height classes as well as the greater diameter classes. In addition, the MCP family expressed greater growth potential in those blocks where herbaceous competition was controlled to a greater extent. Unfortunately, both families showed

very similar percentage of quality characteristics that would provide even greater value for the MCP family. Careful selection of an MCP family that expresses both excellent growth and quality characteristics would yield greater revenue over the OP family and most of the varieties evaluated within this test.

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