Effects of Hardwood Control Timing on Loblolly Pine Growth – Age Five Results

Research Report 144 **August 2021**

Jerre Creighton, Virginia Department of Forestry Research Program Manager

The Bottom Line

To maximize loblolly pine growth, earlier hardwood control is more advantageous than later control. In the absence of volunteer pine competition, the growth difference between pre-plant site preparation and year-one release may not be large enough to warrant letting a site lay out for a year before planting to increase chances for an effective pre-plant treatment. Projected markets and rotation length combined with species and intensity of hardwood completion should influence the layout vs. year-one release decision.

Abstract

A study of the effects on loblolly pine growth of five hardwood competition control strategies (pre-plant site prep, year-one release, year-two release, one-year layout followed by pre-plant site prep, and no control) was installed at the Cumberland State Forest between October 2015 and September 2017. Five years after study establishment, all treatments have effectively controlled hardwood competition as measured by pine free-to-grow (FTG) rating and differences in pine growth are directly related to timing of hardwood control. The dbh of individual trees average 4.0, 3.4, 3.2 and 2.3 inches on plots with pre-plant, year-one, year-two and no hardwood control, respectively. Where pre-plant control and planting were delayed a year, dbh averages 2.8 inches. Survival differences due to unknown factors in years one through three plus beaver damage in year five may have influenced relative differences in per-acre basal area and volume growth between some treatments but the same trend of declining productivity with later hardwood control is evident.

Background

Decades of research have documented that hardwood competition is a key limiting factor in the productivity of loblolly pine plantations. In many instances, herbicide applications prior to planting have been the preferred control method because they allow more flexibility in rates and products and hence can result in better and longer-lasting control of a broader range of hardwood species, volunteer pines and herbaceous competition. For herbicides to be most effective, the target plants – particularly volunteer pines – must have healthy and well-developed foliage. As a result, when the previous stand is harvested in the spring or later, it may be necessary to delay planting a year to allow time for competing plants to recover to the point where they become susceptible to herbicides. This delay of planting comes at a cost, which raises questions about the relative benefits of pre-plant control compared to other control times and strategies.

Methods

The study was installed at the Cumberland State Forest. The previous stand was 40-year-old loblolly pine where a final harvest was completed in late September 2015. A site-prep burn was conducted on October 21, 2015. Study plots in a randomized complete block experimental design with three replications per treatment were installed in January 2016, and the site was planted (except for the one-year layout plots described below) with VDOF Elite seedlings in February 2016.

In each replication, five hardwood control scenarios were compared:

1. Pre-plant site preparation (SP) was simulated by removing all competing hardwoods and herbaceous plants using directed backpack applications of a 2% glyphosate solution beginning shortly after planting (applied on March 14, May 11, and May 31 of 2016) to maintain control through the first growing season.

2. Year-one release (REL1) was simulated using a broadcast backpack spray of imazapyr (Arsenal AC at 16 oz./acre) plus metsulfuron methyl (Escort XP at 1 oz./acre) applied on September 21, 2016.

3. Year-two release (REL2) was simulated using a broadcast backpack spray of imazapyr (Arsenal AC at 16 oz./acre) plus metsulfuron methyl (Escort XP at 1 oz./acre) applied on September 13, 2017.

4. One-year layout (Layout) to facilitate pre-plant site preparation was simulated by removing all competing hardwoods and herbaceous plants with a broadcast backpack spray of imazapyr (Arsenal AC at 16 oz./acre) plus metsulfuron methyl (Escort XP at 1 oz./acre) applied on August 18, 2016. To simulate site preparation results, those plots received follow-up backpack applications of a 2% glyphosate solution (on May 16 and June 6 of 2016) to maintain control through the first growing season. The layout plots were planted with VDOF Elite seedlings on March 2, 2017.

5. No hardwood control (Check).

Pine survival and height were measured annually for five years and diameter at breast height (dbh) was measured beginning three years after study establishment. Hardwood competition was evaluated each year using a modified free-to-grow (FTG) scale (0-4) where zero indicates no hardwood competition at all and four indicates complete overtopping likely leading to mortality. This system is based on the one developed by Dr. Tom Dierauf and first published in 1989 in Occasional Report 78 (https://dof.virginia.gov/wp-content/uploads/report-0078.pdf). Pine basal area and a volume index (diameter squared x height x survival x 484 planted trees per acre) were calculated based on the observed average stem diameters, heights, and plot survival.

Results

The results (Table 1) demonstrate the importance of hardwood competition control timing as a factor affecting loblolly pine growth. Five years after study establishment, all treatments have effectively controlled hardwood competition as measured by pine free-to-grow rating, and differences in pine growth are directly related to timing of hardwood control.

Few volunteer pines developed on this study site. Although they can be a key consideration when deciding whether to delay planting to improve the odds of controlling them with a site-prep spray, that factor could not be assessed on these plots. As a result, these data are limited to comparing the relative growth of plots where hardwoods were controlled at different times relative to pine planting.

The dbh of individual trees averages 4.0, 3.4, 3.2 and 2.3 inches on plots receiving SP, REL1, REL2 and Check treatments, respectively. The dbh averages 2.8 inches on the Layout plots – exactly the same as the pines on the SP plots at the same age (Figure 1). The average FTG rating of pines on those plots are 0.83, 0.67, 0.24, 1.76 and 0.15, respectively. All the treatments have significantly reduced FTG rating (i.e., controlled hardwoods) relative to the Check plots. The differences in FTG between the other treatments are probably a reflection of hardwood re-colonization as time passes after treatment; the treatments applied earlier (e.g., SP) have had more time to recover post-treatment than the more recent treatments (e.g., REL2 or Layout).

Table 1. Summary of pine size, productivity, and hardwood control five years after study establishment (trees are five years old in the Check, SP, REL1, and REL2 treatments and four years old in the Layout plots).

Hardwood Control	Height (ft.)	DBH (in.)	BA ($ft.^2$/acre)	Volume ($ft.^3$/acre)	Survival (%)	FTG Rating
Check	13.4	2.3	9.7	191	61%	1.76
SP	18.6	4.0	36.2	885	84%	0.83
REL1	17.2	3.4	23.7	533	73%	0.67
REL2	16.4	3.2	24.7	534	87%	0.24
Layout	14.6	2.8	17.7	336	84%	0.15

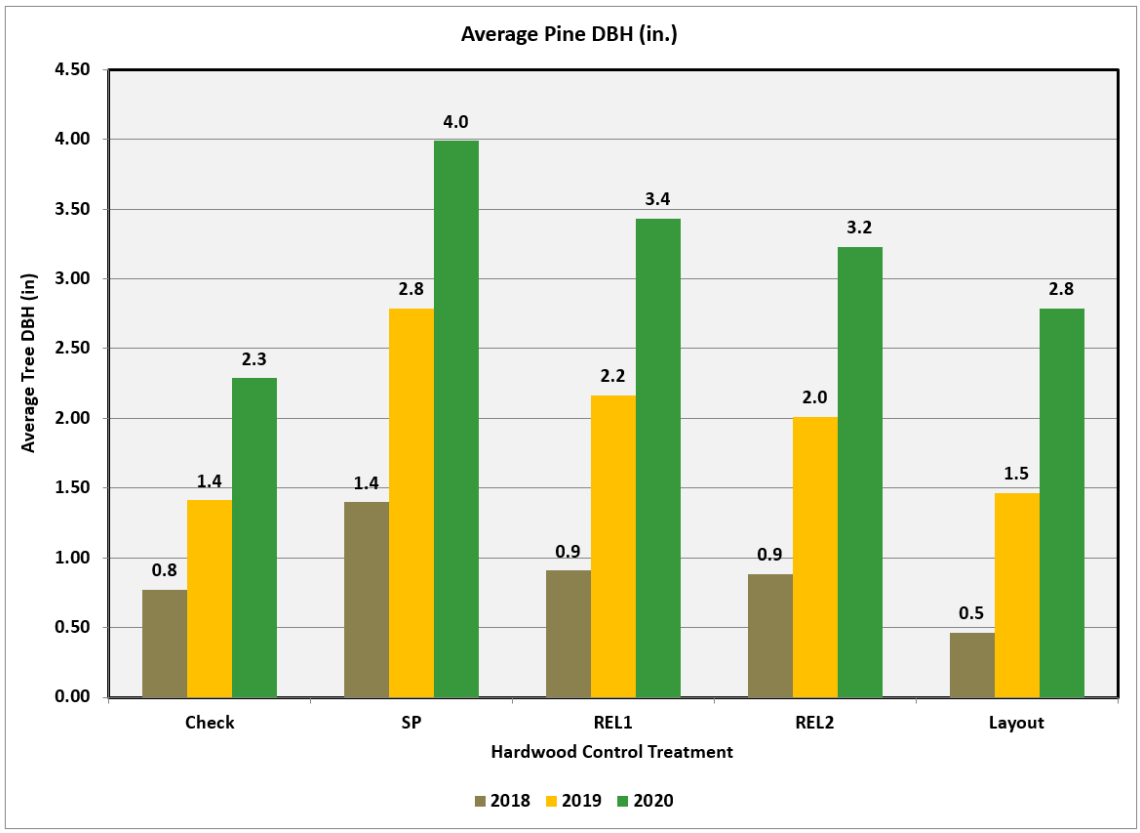

Figure 1. Average pine diameter in 2018-2020.

During the third and fourth years of stand development, some trees on the plots suffered damage that we have not been able to explain. Foliage on otherwise normal looking trees turned entirely brown and the trees died (Figure 2). In addition, during the winter of 2020-2021, trees on several of the plots were impacted by beavers that cut trees and dragged them to a backwater of the Willis River about 150 yards away (Figure 3). The plots have suffered varying levels of mortality on REL1, REL2 or Check plots which has impacted both per-acre estimates of productivity and ongoing growth of the residual trees at different stand densities. Most of the damage occurred on Check, REL1 or REL2 plots. Even so, the same statistically-significant trend of decreasing pine productivity with increasing time between planting and hardwood control is apparent (Figure 4). Volume index on the SP plots (Figure 5) was 885 $ft.^3$/acre compared to 533-534 on the REL1 and REL2 plots (probably impacted by the mortality factors described above), and 191 $ft.^3$/acre on the Check (Figure 6). The Layout plots have 336 $ft.^3$/acre – more than the Check plots containing trees one year older.

Figure 2. Example of unexplained pine mortality.

Figure 3. Beaver damage (left) to study pines and their destination (right).

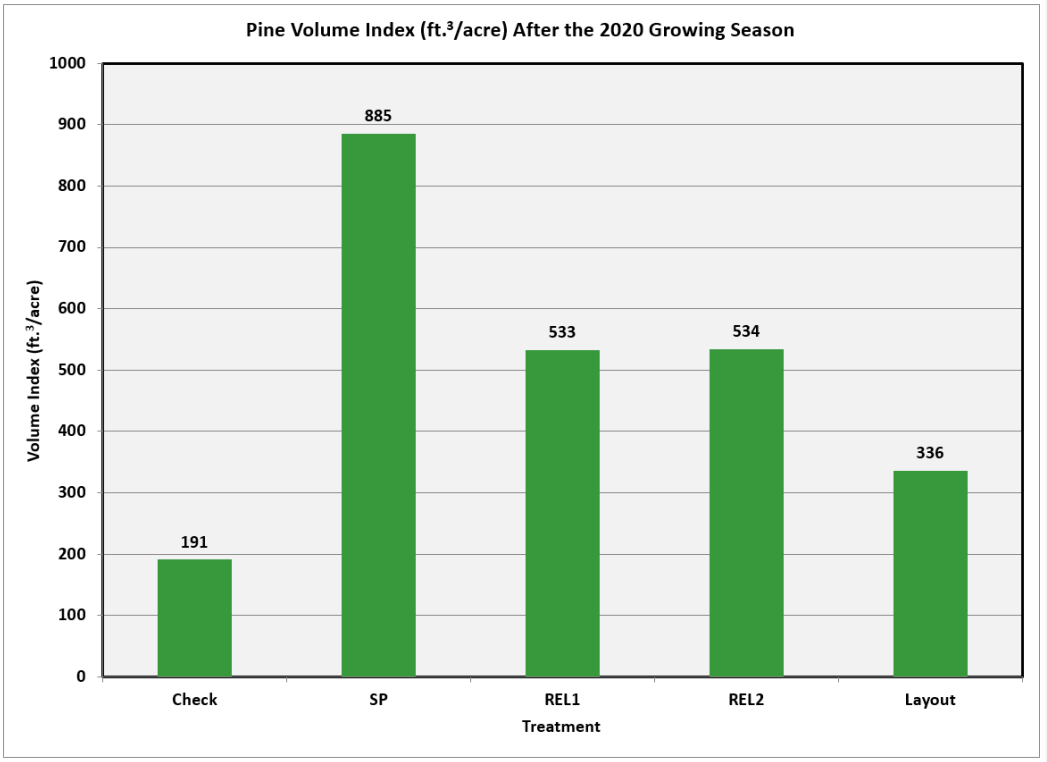

Figure 4. Average pine volume index (ft.^{3}/acre) on plots after the 2020 growing season.

Figure 5. Stand condition during the winter of 2020-2021 on a plot where hardwoods were controlled from the time of planting (SP).

Figure 6. Stand condition during the winter of 2020-2021 on a plot where hardwoods have not been controlled (Check).