Establishment Methods for Shortleaf Pine

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The Bottom Line

Herbaceous weed control at the beginning of the first growing season improved survival and growth of planted shortleaf pine on both old field and cutover sites after two years. Fertilizer application after the first growing season improved growth on the cutover site but not on the old field locations – unless accompanied by herbaceous weed control. Mechanical scalping was consistently beneficial in terms of survival.

Abstract

A study was installed in 2006 to assess the effects of several competition control and fertilizer treatments on the survival and early growth of planted shortleaf pine. Establishment methods including mechanical scalping, fertilizer (nitrogen plus phosphorus), and herbaceous competition control using herbicides were compared to untreated plots at three locations (one cutover hardwood stand and two converted old fields). Three replications with 10-tree row plots of each treatment were installed at each location and the seedlings were measured one and two growing seasons after planting.

Survival was poor on untreated plots, but removing competing vegetation either by scalping (on old field sites) or applying herbicides was helpful. All the competition control treatments except pre-plant site-prep spray (applied at only one site) improved average tree size and plot-level productivity. Fertilizer alone did not improve growth on old fields. Where herbicides and fertilizer were combined on old fields, the growth was much improved – equal to or better than that on the herbicide-alone plots. Any form of competition control allowed the shortleaf seedlings to grow better, but the value of the herbicide application seemed to depend on the weed complex on the site (i.e., old fields with pre-existing competing plants versus the cutover with competing plants just developing).

Background

In 1915, shortleaf pine's range encompassed 440,000 square miles in 24 states – more than any other pine species. In Virginia, the shortleaf pine forest type has declined from just over 1.9 million acres in 1940 to just 35,221 in 2019 according to forest inventory analysis (FIA) data. Its decline is related to selective harvests from mixed stands or land clearing for agriculture followed by replacement with loblolly pine. Although shortleaf pine can adapt to an array of site and soil

conditions, its growth and yield pattern is not well suited to short rotations. Within the common range of shortleaf and loblolly, old-field plantations of loblolly grow better for 40 to 50 years; beyond 50 years, shortleaf yields approach and perhaps exceed those of loblolly. Loblolly is the preferred species for shorter rotations.

In addition, shortleaf can suffer from littleleaf disease caused by a complex of factors including the fungus *Phytophthora cinnamomi*, low soil nitrogen, and poor internal soil drainage. Often, microscopic roundworms called nematodes and species of the fungal genus Pythium are associated with the disease. Affected trees have reduced growth rates and usually die within six years.

If we are interested in restoring this species in Virginia, one question that arises is how it might respond to the more intensive management options that have been applied to accelerate the growth of loblolly pine. Might it be possible to boost the early development rate of shortleaf to make it more desirable?

Methods

In early 2006, we installed three locations of a study to look at whether different methods of competition control with and without supplemental fertilization have any effects on the early survival and growth of planted shortleaf pine in two old field sites in Albemarle and Louisa counties and one cutover hardwood site (Figure 1) in Louisa County. The treatments compared included:

1. no treatment;
2. scalping using a modified fire plow pulled by a farm tractor to turn over the top 3 to 5 inches of sod along an approximate 2 to 3-foot swath (Figure 2);
3. fertilizer – urea x diammonium phosphate (DAP) – providing approximate rates of 200 lbs./acre nitrogen and 25 lbs./acre phosphorous applied between the first and second growing seasons;
4. weed control using 2 oz. Oust + 4 oz. Arsenal (active ingredients: sulfometuron + imazapyr);
5. weed control using 12 oz. Oustar (active ingredients: sulfometuron + hexazinone);
6. treatments 3 and 4 combined;
7. treatments 3 and 5 combined; and
8. broadcast site preparation weed control using Roundup (glyphosate) applied in the fall prior to planting.

Treatments tested varied by location depending on site conditions and space available. All eight treatments were applied to the Louisa old field; treatments 1 through 6 were tested at the Albemarle old field; and treatments 1 and 3 through 6 were installed at the Louisa cutover. The treatments were replicated three times on each site on plots that were 100 feet long and include 10 planted crop pines (10 ft. x 10 ft. planting spacing, 436 trees per acre). The seedlings were planted in March

2006, and height, groundline diameter (GLD) and survival were measured after the first and second growing seasons at all three locations and again after three years at the Albemarle old field location. The heights and diameters were used to calculate volume index per tree (GLD^2 x height) and per acre (GLD^2 x height x survival x 436 trees per acre).

Figure 1. The Louisa old-field site (left) and cutover site (right).

Figure 2. The scalping, Oust x Arsenal, and Oustar treatments (left to right) on the Louisa old-field site.

Results

After the first growing season (Table 1), fertilizer treatments had not yet been applied so only the seedlings on treatments 1, 2, 4, 5 and 8 were measured. The early growth was slow and survival was not outstanding, but there were differences among the treatments. On the old field sites, all

the treatments except pre-plant site preparation spraying resulted in improved survival and tree growth (Figure 3). At the cutover site, meanwhile, responses to treatment were not yet apparent, perhaps because competing vegetation was not already established there as it was on the old fields. The combined effect is best demonstrated by the volume index (Figure 4). The effects of the treatments on volume per acre were statistically significant on the old field sites.

Table 1. First-year results from the shortleaf pine establishment study.

Albemarle Old Field	Height (ft.)	GLD (in.)	Survival (%)	Volume Index ($in.^3$/tree)	Volume Index ($in.^3$/acre)
Check	1.0	0.15	43%	0.29	56
Scalp	1.2	0.19	93%	0.56	228
Oust + Arsenal	0.9	0.16	78%	0.31	107
Oustar	1.1	0.17	63%	0.39	108
Louisa Old Field	**Height (ft.)**	**GLD (in.)**	**Survival (%)**	**Volume Index ($in.^3$/tree)**	**Volume Index ($in.^3$/acre)**
Check	0.6	0.13	52%	0.13	30
Scalp	0.8	0.15	70%	0.27	83
Oust + Arsenal	0.7	0.16	77%	0.26	88
Oustar	0.7	0.14	70%	0.20	62
Site Prep	0.7	0.12	23%	0.17	17
Louisa Cutover	**Height (ft.)**	**GLD (in.)**	**Survival (%)**	**Volume Index ($in.^3$/tree)**	**Volume Index ($in.^3$/acre)**
Check	1	0.25	77%	0.88	297
Oust + Arsenal	1.1	0.27	61%	1.05	282
Oustar	1.1	0.25	71%	1.24	388

Figure 3. One-year-old shortleaf pine in a scalped row at the Albemarle old field site.

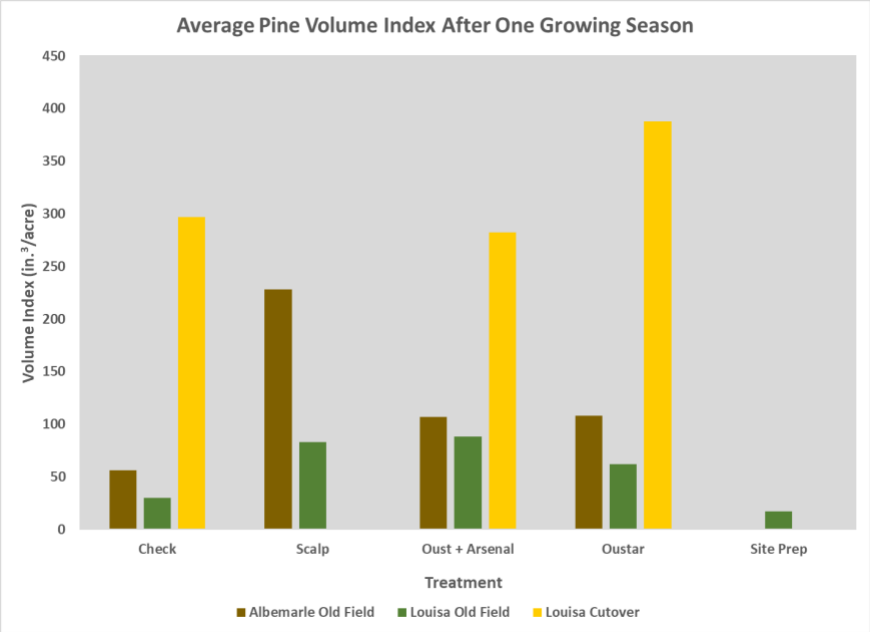

Figure 4. Volume index (cubic inches per acre, calculated as [average tree volume x survival x 436 planted trees per acre]) after one growing season.

The results after two years (including the fertilizer treatments applied after the first growing season) are listed in Table 2, and Figure 5 shows the productivity in volume index per acre for each location after the second year. All the competition control treatments except the pre-plant site-prep spray (applied at only one site) improved average tree size and plot-level productivity. Heights and groundline diameters averaged 1.2 feet and 0.3 inches on the untreated plots contrasted with up to 1.8 feet and 0.5 inches on the best treated plots. Trends in differences among sites and the effects of the fertilizer were apparent. In general, survival was not acceptable (ranging from 30% to 87%) although treatments to remove competing vegetation either by scalping or applying herbicides were helpful. Analysis of variance indicated that the differences among treatments in growth, volume index, and survival were significant on both of the old field sites but not on the cutover site.

In terms of tree size and growth, fertilizer alone did not work on old fields – probably because the fertilizer benefited the competing vegetation more than the pine seedlings. Where herbicides and fertilizer were combined on old fields, the growth was much improved – equal to or better than that on the herbicide-alone plots. Any form of competition control allowed the shortleaf seedlings to grow better, but the value of the herbicide application seemed to depend on the weed complex on the site. Scalping was consistently beneficial (Figure 6), particularly in terms of survival.

Table 2. Second-year results from the shortleaf pine establishment study.

Albemarle Old Field	Height (ft.)	GLD (in.)	Survival (%)	Volume Index (in.³/tree)	Volume Index (in.³/acre)
Check	1.6	0.34	30%	2.8	361
Scalp	2.1	0.50	87%	7.6	2,860
Fertilize	1.7	0.33	50%	2.5	553
Oust + Arsenal	1.9	0.43	77%	4.5	1,534
Oustar	1.9	0.44	63%	6.2	1,828
O + A + Fertilize	1.8	0.40	70%	4.1	1,239
Louisa Old Field	**Height (ft.)**	**GLD (in.)**	**Survival (%)**	**Volume Index (in.³/tree)**	**Volume Index (in.³/acre)**
Check	0.7	0.18	37%	0.4	70
Scalp	1.3	0.34	70%	2.9	892
Fertilize	0.9	0.21	43%	0.6	103
Oust + Arsenal	1.4	0.29	67%	2.3	670
Oustar	1.1	0.24	63%	1.4	382
O + A + Fertilize	1.5	0.34	67%	3.4	991
Oustar + Fertilize	1.5	0.36	57%	3.2	790
Site Prep	1.2	0.20	17%	0.8	56
Louisa Cutover	**Height (ft.)**	**GLD (in.)**	**Survival (%)**	**Volume Index (in.³/tree)**	**Volume Index (in.³/acre)**
Check	1.4	0.46	61%	4.4	1,151
Fertilize	1.8	0.65	67%	11.8	3,421
Oust + Arsenal	1.6	0.60	58%	8.1	2,024
Oustar	1.5	0.58	67%	10.2	2,958
O + A + Fertilize	1.8	0.59	55%	9.2	2,181

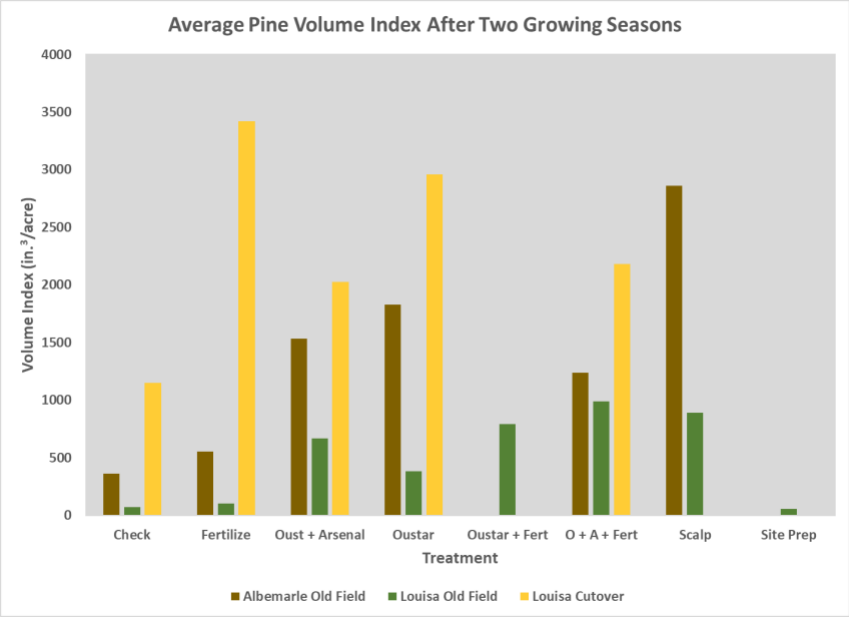

Figure 5. Volume index (cubic inches per acre, calculated as [average tree volume x survival x 436 planted trees per acre]) after two growing seasons.

Figure 6. Shortleaf pine at age two following no treatment (left) compared to scalping (right) at the Albemarle old field study site.

One site – the Albemarle old field – was measured after the third growing season (Table 3) and the earlier trends continued. Competition control enhanced survival and growth, fertilizer alone was counter productive, and scalping tended to be as beneficial as herbicide options to control weeds.

Table 3. Third-year results from the shortleaf pine establishment study at the Albemarle old field location.

Albemarle Old Field	Height (ft.)	GLD (in.)	Survival (%)	Volume Index ($in.^3$/tree)	Volume Index ($in.^3$/acre)
Check	2.5	0.63	30%	16.0	2,087
Scalp	3.4	0.90	87%	37.8	14,298
Fertilize	2.3	0.59	50%	10.9	2,380
Oust Arsenal	3.1	0.84	77%	29.9	9,983
Oustar	3.1	0.84	63%	34.4	9,495
O + A + Fertilize	2.8	0.75	70%	21.4	6,523