



# Establishment Methods for Longleaf Pine

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## The Bottom Line

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When establishing containerized longleaf pine on old fields, scalp before planting to turn over the top 3 to 5 inches of sod and plant the seedling so the container plug is exposed by ½ to 1 inch. Adding a weed control treatment with Oustar at 8 to 12 oz./acre is also likely to be helpful. Avoid seedlings from Georgia coastal sources for Virginia plantings.

## Abstract

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A study designed to test the effects of competition control methods, seedling source (NC orchard mix, GA mountain and GA coastal), and planting depth on the establishment and early growth of longleaf pine on an old field site was installed in 2005. Competition control options included mechanical sod clearing (scalping) or herbicide treatments using Oustar at 8, 12, or 16 oz./acre or Arsenal + Oust at 4 + 2 oz./acre). Planting depth was either deep (plug surface even with ground line) or shallow (plug exposed by ½ to 1 inch).

After five years, results showed that the most important factor in old field establishment success was scalping. Shallow planting and Oustar at 8 to 12 oz./acre were also helpful. Planting deep, the higher Oustar rate (16 oz./acre) and the Arsenal x Oust tank mix were detrimental to seedling growth and caused moderate to high seedling mortality. Scalping and shallow planting with NC or GA mountain sources led to results as good as any in the study (75% and 83% survival with 69% and 86% of seedlings 4.5 ft. or taller in height, respectively).

## Background

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When Virginia was first being settled 400 years ago, the lands south of the James River were dominated by longleaf pine forests at the northern limit of their range. These forests were extremely high in biological diversity and provided some of the most important resources needed by the early colonists: naval stores (tar and pitch) for use in ship building and lubricating wagon axles; grazing range for livestock, and high-quality timber. However, human land use practices caused the longleaf forests of Virginia to decline and virtually disappear by the mid-1800s.

The species remains in viable numbers in the sand hills of North Carolina and southward, but only 150 to 200 mature native longleaf trees remain in Virginia today. A few also exist in the northern counties of neighboring North Carolina, which together with the Virginia trees, form a remnant but potentially significant northern range seed source that is the basis of a program to produce and deploy significant quantities of longleaf seedlings to be made available to Virginians.

## Methods

In early 2005, we planted a study designed to test the effects of competition control methods, seedling source (NC vs. GA), and planting depth on the establishment and early growth of longleaf pine on an old-field site at the New Kent property. The study tests the effects of mechanical sod clearing (scalping – Figure 1), planting depth (plug surface even with ground line or plug exposed by ½ to 1 inch – Figure 2), and herbicide treatment (Oustar at 8, 12, or 16 oz./acre and Arsenal + Oust at 4 + 2 oz./acre) on containerized longleaf seedling survival and early growth. The herbicide treatments were sprayed in bands over the newly-planted seedlings on April 13, 2005. In addition, seedlings from North Carolina are compared to two Georgia sources (mountain and coastal). The complete list of nine treatments detailing the combinations of these factors is provided in Table 1.

**Table 1. Treatments compared in the 2005 longleaf pine establishment methods study.**

Treatment #	Scalping	Planting Depth	Source	Herbicide
1	None	Shallow	NC	None
2	Scalp	Deep	NC	None
3	Scalp	Shallow	NC	None
4	Scalp	Shallow	NC	Oustar 8 oz.
5	Scalp	Shallow	NC	Oustar 12 oz.
6	Scalp	Shallow	NC	Oustar 16 oz.
7	Scalp	Shallow	NC	Arsenal + Oust
8	Scalp	Shallow	GA Mountain	None
9	Scalp	Shallow	GA Coastal	None



**Figure 1. The scalping treatment.**

The treatments were replicated four times in 15-tree row plots planted at a close in-row spacing (4 ft.) because the study was only intended to compare early effects on longleaf survival, height, grass stage emergence (defined as a terminal bud tip height of 4 in. or greater), and (when available) diameter at breast height – which were assessed after one, two, three, and five years.



Figure 2. Containerized longleaf pine seedlings planted shallow (left) and deep (right).

## Results

After two growing seasons, survival varied from 27% to 87% (Table 2, Figure 3). In particular, results were poor when Arsenal x Oust was applied (27%) and when no scalping occurred (32%). Seedlings planted shallow (leaving ½ to 1 inch of the plug exposed) in scalped rows ranged in survival from 78% to 87% regardless of source (NC, GA mountain or GA coastal), either without further herbicide treatment of Oustar at 8 to 12 oz./acre (Figure 4). Those planted deep or treated with 16 oz./acre of Oustar exhibited intermediate in survival.

Table 2. Survival after one and two growing seasons ranked from best to worst.

Scalped (Yes/No)	Planting Depth	Source	Herbicide	Age 1 Survival (%)	Age 2 Survival (%)
Yes	Shallow	GA Mountain	None	92%	87%
Yes	Shallow	NC	None	87%	82%
Yes	Shallow	GA Coastal	None	85%	82%
Yes	Shallow	NC	Oustar 12 oz.	80%	80%
Yes	Shallow	NC	Oustar 8 oz.	92%	78%
Yes	Deep	NC	None	87%	73%
Yes	Shallow	NC	Oustar 16 oz.	68%	67%
No	Shallow	NC	None	43%	32%
Yes	Shallow	NC	Arsenal + Oust	27%	27%



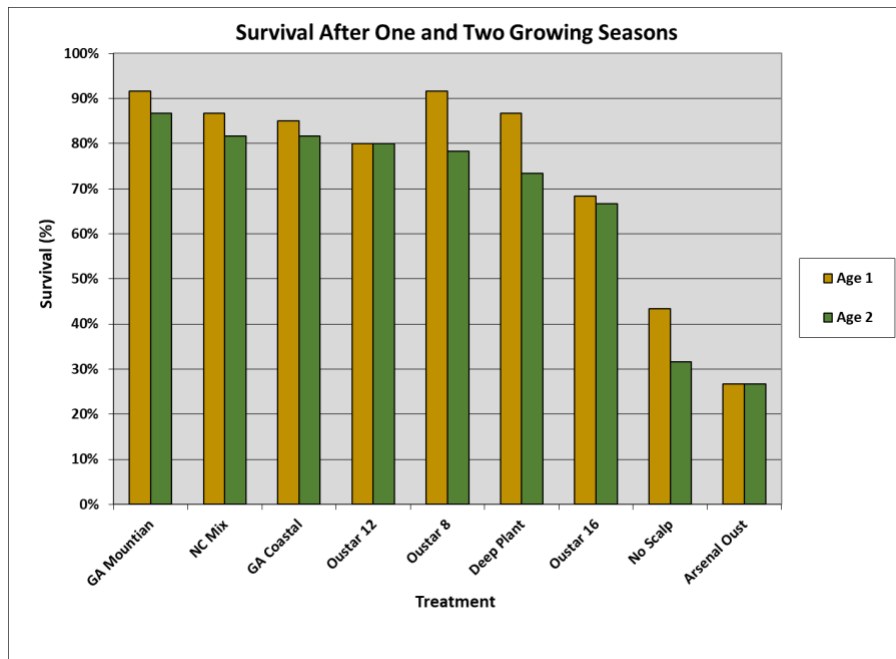


Figure 3. Survival after one and two growing seasons.



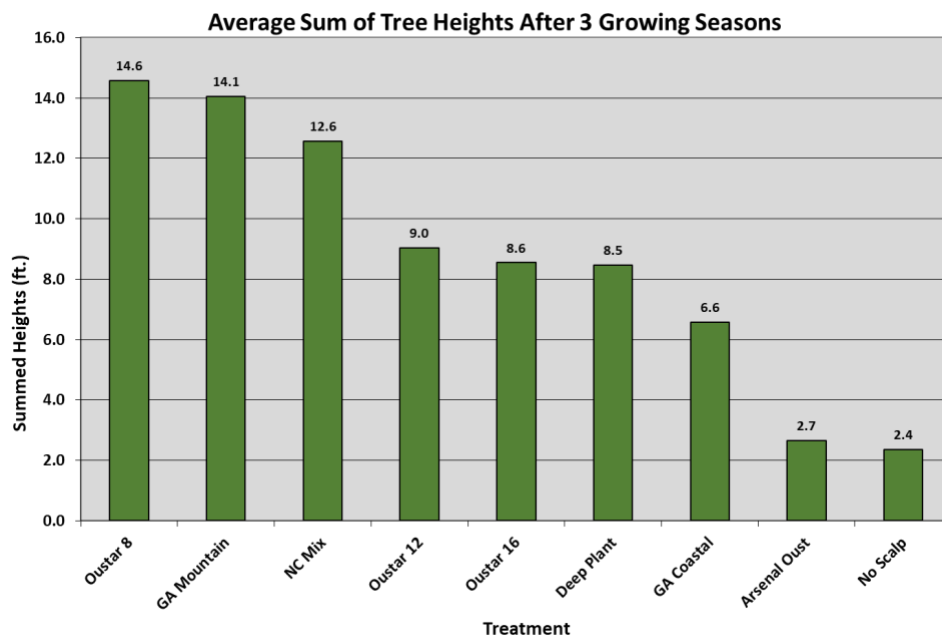
Figure 4. A one-year-old scalped row (left) and an individual seedling (right) of two-year-old longleaf pine planted in a scalped row treated with Oustar at 12 oz./acre).

The data after three years (Table 3) confirm these findings and reveal that the single most important factor in old field establishment success was scalping. We also found that higher Oustar rates (16 oz./acre) and the Arsenal x Oust tank mix (at 4 and 2 oz./acre respectively) were detrimental to seedling growth and increased mortality substantially. It should be noted that other researchers have found that the Arsenal x Oust treatment works quite well when applied in May or later, but our treatment was applied on April 13. Scalping and shallow planting led to results as good as any in the study (75%+ survival and roughly 2/3 of seedlings out of the grass stage).

Figure 5 shows the summed heights of trees (averaged across plots), a metric which integrates the impacts of survival and height growth. The scalped, shallow-planted plots with or without 8 oz./acre of Oustar (treatments 3, 4 and 8) were superior. Higher rates of Oustar (12 or 16 oz./acre), or deep planting produced moderate height growth and survival, and seedlings from a Georgia coastal source were also intermediate in survival and height growth. Arsenal x Oust application in mid-April or lack of scalping were failed alternatives.

**Table 3. Survival, height, and grass stage emergence after three growing seasons.**

Scalped (Yes/No)	Planting Depth	Source	Herbicide	Survival (%)	Out of Grass Stage (%)	Mean Height (ft.)	Sum of Heights (ft.)
Yes	Shallow	NC	Oustar 8 oz.	78%	68%	1.3	14.6
Yes	Shallow	GA Mountain	None	83%	78%	1.2	14.1
Yes	Shallow	NC	None	77%	61%	1.3	12.6
Yes	Shallow	NC	Oustar 12 oz.	80%	62%	0.9	9.0
Yes	Shallow	NC	Oustar 16 oz.	67%	55%	0.9	8.6
Yes	Deep	NC	None	72%	36%	1.2	8.5
Yes	Shallow	GA Coastal	None	75%	56%	0.8	6.6
Yes	Shallow	NC	Arsenal + Oust	27%	23%	0.7	2.7
No	Shallow	NC	None	32%	22%	0.6	2.4



**Figure 5. Average sum of tree heights of longleaf pines on 15-tree plots after three growing seasons.**

The final measurement of this study occurred after the 2009 growing season (age 5) and those data (Table 4) confirm the earlier findings. Analysis of variance showed that the treatment effects on survival, height, height growth (as indicated by calculating the percentage of trees on the plot that were measurable for dbh and therefore had a height greater than 4.5 feet), and diameter were all statistically significant. The most important factor in old field establishment success was scalping. Shallow planting and Oustar at 8 to 12 oz./acre were also helpful (Figure 6). The higher Oustar rate (16 oz./acre) and the Arsenal x Oust tank mix were detrimental to seedling growth and increased mortality. Scalping and shallow planting with NC or GA mountain sources led to results as good as any in the study (75% and 83% survival with 69% and 86% of seedlings 4.5 ft. or taller in height, respectively). Figure 7 shows the combined effect of survival (assuming 450 trees per acre originally planted) and growth differences integrated as a volume index for each treatment; the scalped, shallow-planted plots with or without 8 to 12 oz./acre of Oustar were superior.

**Table 4. Age five survival, height, dbh and volume index summary.**

Scalped (Yes/No)	Planting Depth	Source	Herbicide	Survival (%)	Height (ft.)	% > 4.5 ft.	DBH (in.)	Volume Index (ft. <sup>3</sup> /acre)
Yes	Shallow	NC	Oustar 8 oz.	77%	6.7	83%	1.4	605
Yes	Shallow	GA Mountain	None	83%	6.5	86%	1.4	570
Yes	Shallow	NC	None	75%	6.0	69%	1.4	481
Yes	Shallow	NC	Oustar 12 oz.	78%	5.9	72%	1.2	431
Yes	Shallow	NC	Oustar 16 oz.	65%	6.0	72%	1.2	353
Yes	Deep	NC	None	72%	5.1	49%	1.3	352
Yes	Shallow	GA Coast	None	72%	4.6	49%	1.2	218
No	Shallow	NC	None	32%	3.47	32%	1.13	50
Yes	Shallow	NC	Arsenal + Oust	27%	4.35	42%	0.94	44



**Figure 6. Five-year-old longleaf pine established after scalping, shallow planting and application of Oustar at 12 oz./acre (left) compared to scalping and shallow planting with no additional herbicide treatment (right).**

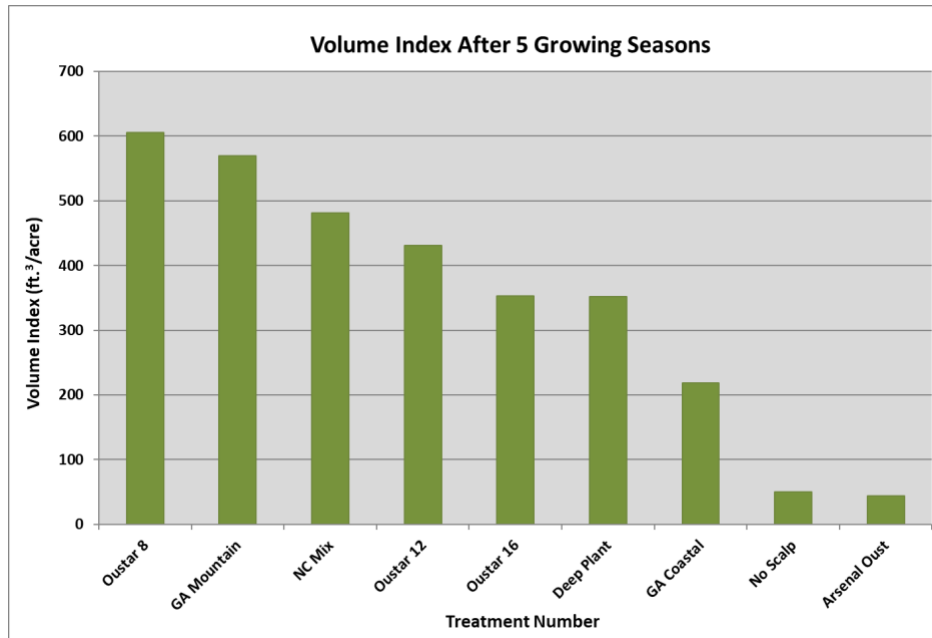


Figure 7. Volume index (calculated as diameter squared x height x survival x 450 planted trees per acre) as a measure of performance of treatments in the longleaf pine establishment study through five growing seasons.