

MORPHOLOGICAL DIFFERENCES OF THE ROOT SYSTEM OF BAREROOT AND CONTAINER LONGLEAF PINE AFTER OUTPLANTING

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Abstract

For container longleaf pine (*Pinus palustris*), this study seeks to confirm the presence or absence of a true taproot or sinker root (from laterals), and to record differences in sinker root length and diameter. Bareroot and container longleaf seedlings were dug up on a dry site and a wet site. The trees were 4 and 6 years old respectively. Measurements of sinker root length, diameter at groundline, diameter 8 inches (20 cm) below groundline, diameter 16 inches (41 cm) below groundline, and number of first order lateral roots were taken. The deepest sinker root was measured whether it was a true taproot or a lateral that developed to replace the primary taproot. On the dry site, no significant differences in sinker root (or taproot) length, diameter at groundline, diameter at 8 inches below groundline, and diameter at 16 inches below groundline were found. On the wet site, no significant difference in sinker root length, groundline diameter, or diameter at 16 inches was recorded, but container seedlings were significantly smaller in diameter at 8 inches. Multiple sinker roots were observed on the both sites, but appeared more common on the wet site. Root origin, as the true taproot or a primary lateral expressing dominance, could not be positively identified. Sinker roots were significantly longer on dry sites with less variance, while sinker root length on the wet site was variable and limited by a high water table and soil hard pan. No correlation between root size and tree height was indicated. In all cases a single or multiple sinker root was present.

Key Words

Root conformation, outplanting survival

INTRODUCTION

Container longleaf pine seedlings typically have a shorter, smaller diameter taproot than bareroot longleaf seedlings. This is due to the container size used to grow longleaf seedlings (6 inch³ [98 cm³] volume is common) that restricts root growth. The taproot of a container longleaf seedling air prunes as it grows out the drain hole of the container cell. It has been suggested that a taproot of a container seedling does not develop after outplanting and that the absence of a taproot necessary to anchor the tree makes them susceptible to windthrow. Our objective was to measure the number and size of taproots and sinker roots of longleaf pine grown as bareroot or container seedlings.

METHODS

The study was located in Bladen Lakes State Forest on 2 sites planted with both container and bareroot longleaf seedlings in 1994 and 1996. One site was a wet sandy soil with the high water table about 4 feet (1.2 m) below the surface. The other was a dry deep sand. The trees were destructively sampled by digging them out of the ground using a backhoe. A trench was dug about 1 foot (0.3 m) away from the stem to a depth of 6 feet (1.8 m) and the soil was carefully removed from around the sinker root. Tree height, sinker root length, stem diameter at groundline, sinker root diameter at 8 inches (20 cm) below groundline, sinker root diameter at 16 inches (41 cm) below groundline, and the number of primary laterals in the upper portion of the root were measured.

Tree height and sinker root length were measured to the nearest inch using a tape measure. Root diameter was measured to the nearest 0.01 inch (0.25 mm) using digital calipers. The deepest and most prominent sinker root was selected for measurement when multiple sinker roots were found. The sinker roots on the dry site grew deeper than the capabilities of the backhoe, so the diameter at the end of the sinker root, where it broke, was taken. Photos were taken of all the trees measured. Duncan's Multiple Range Test was used to determine statistical significance of recorded measurements.

RESULTS

Dry Site

Sinker root length was not significantly different between the container and bareroot trees on the dry site (table 1). Sinker root length could not be measured beyond 6 feet due to the limited capability of the backhoe; therefore true length was not determined. At a depth of 5 to 6 feet, the sinker root diameters measured between 0.11 and 0.25 inch (2.79 and 6.35 mm) and roots continued downward to an undetermined depth. Sinker root length was essentially the same for bareroot and container seedlings on this site. Sinker roots were more obvious and better defined on the dry site and had fewer multiple sinker roots. It should be noted that in all the trees extracted, at least one sinker root was present.

No statistical difference in sinker root diameter or taper was measured on the dry site. Average sinker root diameter at 8 inches was 0.89 inch (22.6 mm) for the container and 0.69 inch (17.5 mm) for the bareroot. At 16 inches, average sinker root diameter was 0.51 inch (13.0 mm) for the container and 0.48

inch (12.2 mm) for the bareroot (tables 2 and 3). Sinker root diameter for container trees was larger on the dry site, while on the wet site the sinker root diameter of the bareroot seedlings was larger.

Wet Site

Sinker root length between the bareroot and container trees was not significantly different on the wet site. The bareroot trees had a higher average length than the container trees (29.4 inches [74.7 cm] compared to 25.2 inches [64.0 cm]), but because of the wide range of values in the sample, the difference was not statistically significant (table 1). A hard pan located about 20 inches (51 cm) and a high water table near 4 feet influenced sinker root development for both treatments. Damage to the root from planting, as well stem damage, was also observed and likely contributed to both length and diameter differences. Pigtail and ball ends were observed on both bareroot and container seedlings. Sinker roots were less obvious or well defined on the wet site, particularly for the container trees. Multiple sinker roots were observed more often on the container trees than the bareroot trees suggesting that in the absence of a true sinker root, one or more laterals express dominance to replace the damaged sinker root.

On the wet site, the sinker root diameter differed between the bareroot and container trees. Generally the bareroot roots were larger with a more carrot-like form and taper. The container trees, while having no difference in groundline diameter, tapered quickly. This was evidenced by the significantly smaller diameter at 8 inches below groundline: 0.62 inch (15.8 mm) compared to 0.86 inch (21.8 mm) (table 2). The diameter at 16 inches below groundline, although not statistically significant, was smaller for the container trees: 0.29 inch (7.4 mm) compared to 0.39 inch (9.9 mm) (tables 2 and 3).

Table 1. Root measurement summary (inches) for a dry and wet site in eastern North Carolina.

	Length	Taproot		Number of laterals	
		Ground line	Diameter		
			8"	16"	
DRY					
Container	54a	1.7a	0.9a	0.5a	10a
Bareroot	59a	1.6a	0.7a	0.5a	10a
WET					
Container	25a	1.9a	0.6a	0.3a	10a
Bareroot	29a	1.9a	0.9b	0.4a	10a

Sites analyzed separately.

Table 2. Root measurement data for container longleaf seedlings (inches) for a dry and wet site in eastern North Carolina.

	Height (inches)	Sinker root (inches)	Taproot Diameter			Number of laterals
			Ground line	8"	16"	
DRY	6	56	1.3	0.58	0.47	9
	16	56	1.5	0.79	0.45	12
	15	52	1.0	0.53	0.30	12
	80	56	2.6	1.10	0.61	9
	66	50	2.4	1.60	0.74	13
	70	20	1.6	0.92	0.30	16
	50	66	2.1	1.30	0.91	9
	42	58	1.9	0.81	0.48	9
	45	64	1.4	0.68	0.49	4
	14	62	1.2	0.55	0.37	9
Ave	40	54	1.7	0.90	0.50	10
WET	46	26	1.81	0.68	0.20	11
	37	23	1.87	0.42	0.35	6
	64	25	1.87	0.61	0.31	12
	68	29	2.12	0.64	0.40	9
	41	18	1.82	0.14	0.05	9
	53	31	1.95	0.86	0.50	16
	57	33	1.67	0.60	0.25	10
	26	11	1.70	0.18	—	6
	30	18	2.00	0.67	0.09	9
	59	22	1.50	0.67	0.12	6
	58	40	2.14	0.56	0.26	18
	49	21	2.15	0.66	0.20	6
	31	11	1.50	0.15	—	13
	45	19	1.77	0.49	0.13	8
	48	31	2.09	0.96	0.30	13
	34	42	1.77	0.82	0.38	12
	78	28	2.54	1.49	0.80	7
Ave	48	25	1.90	0.60	0.30	10

Table 3. Root measurement data for bareroot longleaf seedlings (inches) for a dry and wet site in eastern North Carolina.

	Height (inches)	Sinker root (inches)	Taproot Diameter			Number of laterals	
			Ground line	8"	16"		
DRY	28	69	1.9	0.63	0.48	9	
	66	68	1.9	0.92	0.77	17	
	38	56	1.5	0.68	0.40	10	
	46	64	1.9	0.94	0.51	16	
	24	59	1.7	0.72	0.53	6	
	26	60	1.7	0.70	0.57	5	
	14	50	1.3	0.59	0.37	8	
	40	60	1.5	0.58	0.41	10	
	23	52	1.4	0.59	0.42	10	
	17	55	1.3	0.59	0.34	10	
	Ave	32	59	1.6	0.70	0.50	10
	WET	109	19	2.15	0.44	0.14	12
106		23	2.33	1.32	0.61	11	
69		17	1.79	1.04	0.34	10	
48		32	1.85	1.20	0.74	11	
65		32	1.90	1.29	0.54	8	
35		14	1.63	0.24	—	14	
58		51	1.81	0.13	0.47	9	
65		25	1.52	0.65	0.22	9	
57		24	1.89	1.33	0.35	12	
47		27	1.77	0.47	0.14	9	
100		29	2.40	1.56	0.69	10	
28		32	1.58	0.61	0.34	8	
55		18	2.18	1.26	0.63	12	
84		48	2.33	0.88	0.22	12	
59		38	1.90	0.65	0.22	11	
84		58	1.84	0.80	0.19	8	
40		13	1.62	0.73	—	7	
Ave	48	29	1.90	0.90	0.40	10	

Laterals

The average number of primary laterals was the same for both container and bareroot trees on both sites. It appeared that lateral roots of container seedlings on wet sites were concentrated in the top 6 inches (15 cm) of the root system, while the lateral roots of bareroot seedlings were better distributed along the top 10 to 12 inches (30 cm). Twisting of the laterals was observed on both the container and bareroot seedlings, which was likely a result of planting technique used. This damage may have effected sinker root development in some instances.

CONCLUSIONS

The study results do not support the hypothesis that lack of a sinker root or differences in sinker root development makes container longleaf seedlings more susceptible to windthrow. A sinker root was present on all trees sampled. On both sites, no significant difference in sinker root length was recorded. Many of the most notable differences in

sinker root length could be attributed to planting damage or environmental hindrances within the soil, such as a frag-pan or high water table. The smaller average sinker root diameter for container trees on wet sites may be due to multiple sinker roots observed or that the high quality site provided more nutrients and water, and therefore an extensive root system was not needed. Perhaps several small sinker roots serve the same function as one larger sinker root. We could not determine if the true sinker root developed on the container seedlings, but the presence of multiple sinker roots indicate that laterals do develop to replace the primary taproot to anchor and supply resources to the newly planted seedling.

Based on this study, it seems the risk of windthrow in longleaf pine is just as likely for trees from bareroot seedlings as for those from container seedlings. Longleaf is susceptible to windthrow at an early age. The site characteristics, the type of storm, storm intensity, and storm frequency factor into the susceptibility.