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Morphological Differences of Longleaf Pine Root Systems after Outplanting

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Abstract: -- Container grown longleaf pine (*Pinus palustris*) seedlings typically have a shorter, smaller diameter taproot than field grown bareroot longleaf seedlings. This is due to the container used to grow longleaf seedlings that confines root growth. The taproot of the longleaf seedling air prunes as it grows out the drain hole of the container cell and forms a callus at its tip. It has been suggested that a taproot of a container-grown seedling does not develop after out planting and that the absence of a taproot necessary to anchor the tree makes them susceptible to windthrow. This study seeks to confirm the presence or absence of a taproot or surrogate sinker root (from laterals), and to record differences in root length and diameter. Bareroot and container grown 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 ground line, diameter 8 inches below ground line, diameter 16 inches below ground line, 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 length, diameter at ground line, diameter at 8 inches below ground line, and diameter at 16 inches below ground line was found. On the wet site, no significant difference in sinker root length, ground line 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. A single or multiple taproot or sinker root was present on all the trees .

Methods

The study is located in Bladen Lakes State Forest on two sites planted with container grown and field grown bareroot longleaf (*Pinus palustris*) seedlings side by side in 1994 and 1996. One site was a wet sandy soil with the high water table about four feet below the surface. The other was a dry deep sand. The trees were destructively sampled by digging a trench about one foot away from the stem to a depth of 6 feet and the soil was carefully removed from around the sinker root. Tree height, sinker root length, stem diameter at ground line, sinker root diameter at 8 inches below ground line, sinker root diameter at 16 inches below ground line, and the number of primary lateral in the upper portion of the root were measured.

Tree height and sinker root length was measured to the nearest inch using a tape measure. And root diameter

measured to the nearest one hundreds inch 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 was taken (where it broke). 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 grown and bareroot trees on the dry site (table 1.). Sinker root length could not be measured beyond 6 feet because the capability of the backhoe and so true length was not determined. At a depth of 5 to 6 feet the sinker roots' diameter measured between 0.11 and 0.25 inches and they continued downward to an undetermined depth. Sinker root length is essentially the same for bareroot and container grown seedling on this site. Sinker roots are more obvious and better defined on the dry site and have 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 inches for the container and 0.69 inches for the bareroot , and at 16 inches average sinker root diameter was 0.51 for the container and 0.48 for the bareroot (table 1.). Sinker root diameter for container grown trees was larger on the dry site while on the wet site the sinker root diameter of the bareroot seedlings was larger.

Table 1. Root measurement summary (inches) from a dry site in eastern NC

	Taproot Length	DGL	Dia.@ 8"	Dia@ 16"	# Lat-erals
Con-tainer	54a	1.7a	0.9a	0.5a	10a
Bare-root	59a	1.6a	0.7a	0.5a	10a

Figure 2. Typical container-grown root from the dry site

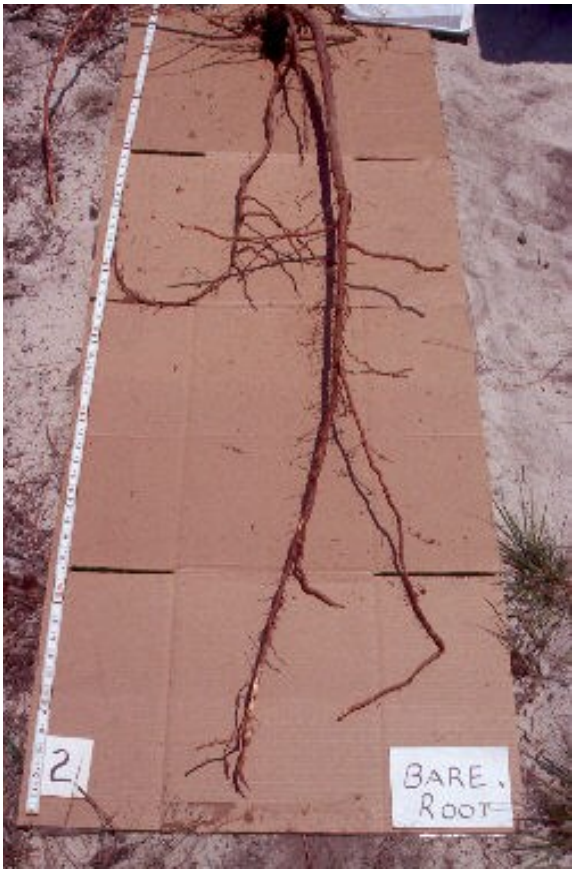

Figure 3. Typical bareroot root system from the dry site

Wet Site

Sinker root length was not significantly different between the bareroot and container trees on the wet site. Numerically the bareroot taproots were longer (29.4 inches compared to 25.2 inches), but because of the wide range of values in the sample the difference was not statistically significant (table 2.). A hard pan at about 20 inches 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 root was less obvious or well defined on the wet site particularly for the container grown trees. Multiple sinker roots were observed more often on the container trees than the bareroot 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 were larger with a more carrot-like form and taper. The container while having no difference in ground line diameter tapered quickly as seen by the significantly smaller diameter at 8 inches below ground line, 0.62 inches compared to 0.86 inches (table 2.). The diameter at 16 inches below ground line, although not statistically significant, was smaller for the container trees, 0.29 inches compared to 0.39 inches (table 2.).

Table 2. Root measurement summary from a wet site in eastern NC

	Tap-root Length	DGL	Dia.@ 8”	Dia@ 16”	# Lat-erals
Con-tainer	25a	1.9a	0.6a	0.3a	10a
Bare-root	29a	1.9a	0.9b	0.4a	10a

Laterals

The average number of primary laterals was the same for both container and bareroot trees at both sites. It appeared that lateral roots of container seedlings on wet sites were concentrated in the top 6 inches of the root system while the bareroot were better distributed along the top 10 to 12 inches. Twisting of the laterals was observed on both the container and bareroot seedling. This damage may have affected sinker root development

Figure 3. Typical bareroot root system from the wet site

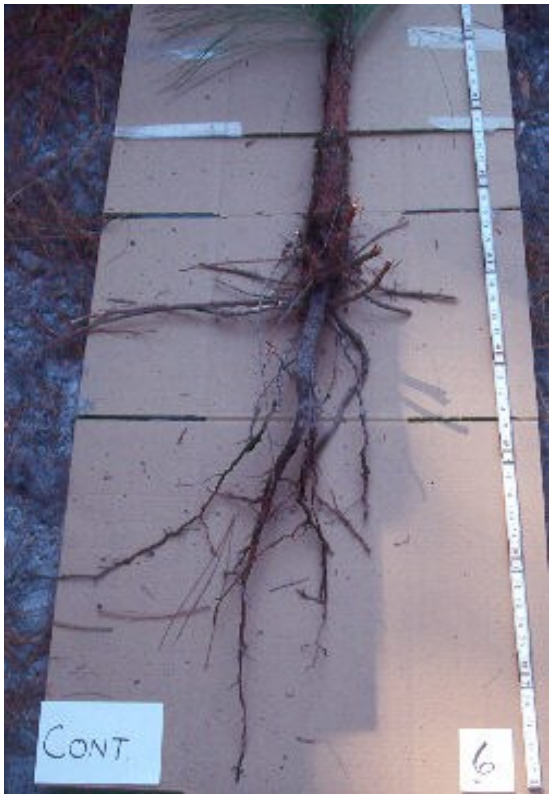

Figure 2. Typical container-grown root from the wet site

Conclusions

The study results do not support the hypothesis that lack of a sinker root or differences in sinker root development makes container grown longleaf seedlings more susceptible to windthrow. A sinker root was present on all the 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 grown seedlings. Longleaf branching habit may make it more susceptible to windthrow at an early age. The site characteristics, the type of storm, storm intensity, and storm frequency are strong influences that must be factored into the susceptibility to windthrow.

Table 3 . Root measurement data (inches) for container-grown longleaf on a dry site in eastern NC.

Type	Height (inches)	Sinker root (in)	DGL(inches)	Dia@ 8"	Dia@ 16"	# of Lats
cont	6	56	1.25	0.58	0.47	9
cont	16	56	1.5	0.79	0.45	12
cont	15	52	1	0.53	0.3	12
cont	80	56	2.6	1.1	0.61	9
cont	66	50	2.4	1.6	0.74	13
cont	70	20	1.6	0.92	0.3	16
cont	50	66	2.1	1.3	0.91	9
cont	42	58	1.9	0.81	0.48	9
cont	45	64	1.4	0.68	0.49	4
cont	14	62	1.2	0.55	0.37	9
Average	40.4	54	1.7	0.9	0.5	10.2

Table 4. . Root measurement data (inches) for bareroot-longleaf on a dry site in eastern NC.

Type	Height (in)	Sinker root (in)	DGL(in)	Dia@ 8"	Dia@ 16"	# of Lats
bare root	28	69	1.9	0.63	0.48	9
bare root	66	68	1.9	0.92	0.77	17
bare root	38	56	1.5	0.68	0.4	10
bare root	46	64	1.9	0.94	0.51	16
bare root	24	59	1.7	0.72	0.53	6
bare root	26	60	1.7	0.7	0.57	5
bare root	14	50	1.3	0.59	0.37	8
bare root	40	60	1.5	0.58	0.41	10
bare root	23	52	1.4	0.59	0.42	10
bare root	17	55	1.3	0.59	0.34	10
Average	32.2	59.3	1.6	0.7	0.5	10.1

Table 5. Root measurement data (inches) for container-grown longleaf trees from a wet site in eastern NC

Type	Height (in)	Sinker root (in)	DGL(in)	Dia@ 8"	Dia@ 16"	# of Lats
cont	46	26	1.81	0.68	0.2	11
cont	37	23	1.87	0.42	0.35	6
cont	64	25	1.87	0.61	0.31	12
cont	68	29	2.12	0.64	0.4	9
cont	41	18	1.82	0.14	0.05	9
cont	53	31	1.95	0.86	0.5	16
cont	57	33	1.67	0.6	0.25	10
cont	26	11	1.7	0.18	-	6
cont	30	18	2	0.67	0.09	9
cont	59	22	1.5	0.67	0.12	6
cont	58	40	2.14	0.56	0.26	18
cont	49	21	2.15	0.66	0.2	6
cont	31	11	1.5	0.15	-	13
cont	45	19	1.77	0.49	0.13	8
cont	48	31	2.09	0.96	0.3	13
cont	34	42	1.77	0.82	0.38	12
cont	78	28	2.54	1.49	0.8	7
AVG	48.47	25.2	1.9	0.6	0.3	10.1

Table 6. Sinker root data (inches) from bareroot grown longleaf trees on a wet site in eastern NC

Type	Height (in)	Sinker root (in)	DGL(in)	Dia@ 8"	Dia@ 16"	# of Lats
bare root	109	19	2.15	0.44	0.14	12
bare root	106	23	2.33	1.32	0.61	11
bare root	69	17	1.79	1.04	0.34	10
bare root	48	32	1.85	1.2	0.74	11
bare root	65	32	1.9	1.29	0.54	8
bare root	35	14	1.63	0.24	-	14
bare root	58	51	1.81	0.13	0.47	9
bare root	65	25	1.52	0.65	0.22	9
bare root	57	24	1.89	1.33	0.35	12
bare root	47	27	1.77	0.47	0.14	9
bare root	100	29	2.4	1.56	0.69	10
bare root	28	32	1.58	0.61	0.34	8
bare root	55	18	2.18	1.26	0.63	12
bare root	84	48	2.33	0.88	0.22	12
bare root	59	38	1.9	0.65	0.22	11
bare root	84	58	1.84	0.8	0.19	8
bare root	40	13	1.62	0.73	-	7
Avg.	65.24	29.4	1.9	0.9	0.4	10.2