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TOP-CLIPPING OF LONGLEAF PINE MORE IMPORTANT THAN ADEQUATE RGP?

by
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INTRODUCTION

Needle-clipping of bare-root longleaf pine is practiced to increase the probability of survival after outplanting (South 1998). Some studies have shown that clipping needles before outplanting can increase survival by 13 percentage points. South (1989) speculated that the increase in survival might be due to a reduction in transpiration.

Although there have been numerous clipping studies with bare-root stock, there have been few studies with clipping of container-grown stock. We are aware of only four such studies (one by Dr. Barnett and three at Auburn University). Barnett (2004) reported that clipping needles back to a length of 2 inches (5 cm) reduced both root growth and diameter growth in the nursery. Not allowing needles to grow longer than 3 inches in the nursery is an extreme treatment and is not operationally practiced. Barnett and McGilvery (1997; 2000) suggest that needles not be clipped shorter than 6 inches.

Barnett reported that a single clipping to 4 inches (10 cm) reduced shoot mass by 20% to 37%. When seedlings were outplanted in July, this treatment increased early survival (2 months after planting; controls = 15%; clipped = 37%). Clipping did not improve survival when seedlings were outplanted in months when soil moisture was likely higher. Barnett's study and one by Paul Jackson (in preparation) are the only clipping studies to report the effect of clipping on survival of container-grown longleaf pine. The objective of this study was to determine if needle clipping affects transpiration, root-growth potential (RGP) and "greenhouse" survival of container-grown longleaf pine.

METHODOLOGY

Longleaf pine seedlings were grown in containers at the International Forest Company nursery in Moultrie, Georgia. The root plug was 12.1 cm long with a top diameter of 3.9 cm and a cavity volume of 121.9 cm3. Seedlings were cultured using standard nursery practices. Seedlings were transported to the greenhouse at Auburn University where they were removed from the shipping box and placed into Ray-Leach tubes. The study involved three clipping treatments: 0-Clip = no clipping; 6-Clip = clipped to 6 inches; 2-Clip = clipped to 2 inches. An experimental unit included 10 seedlings and there were 10 replications of each treatment (i.e. 100 total seedlings per treatment) for the transpiration study.

Clipping was conducted on January 25, 2010. Ten seedlings per treatment were placed in an aluminum tray and each tray was submerged in water for 3 minutes. Seedlings were not watered for 28 days. During the first 17 days, trays were weighed daily at 1:30 PM. On February 22, seedlings were re-watered and survival of seedlings (still in the containers) was recorded on March 11.

A root-growth potential (RGP) study was conducted simultaneously using 8 aquarium tanks (each representing one replicate). Each aquarium was aerated and contained 30 seedlings (i.e. 10 seedlings from each treatment). After 44 days, the numbers of new white root tips (> 0.5 cm) were recorded.

RESULTS

The 6-Clip treatment removed about 30% of the shoot while the 2-Clip treatment removed about 63% (Table 1). As expected, the unclipped seedlings lost water more rapidly than did clipped seedlings (Figure 1). These 6-Clip and 2-Clip treatments reduced water loss (by day 5) by 28% and 43%, respectively (Table 2). The 6-Clip treatment reduced RGP by 46% and the more extreme 2-Clip treatment reduced RGP by 94%. Withholding water for 28 days killed many of the non-clipped seedlings. The 6-Clip treatment increased survival by 11 percentage points and the extreme 2-Clip treatment increased survival by 34 percentage points (Table 2).

Average daily temperature in the greenhouse was approximately 19.5 °C (67 °F). Water loss appeared to be more related to the maximum daily temperature (Figure 2).

DISCUSSION

These results support a preliminary clipping study reported in a Forest Nursery Cooperative Newsletter (Jackson and South 2009). In the preliminary study, container longleaf pine needles were clipped to 8 inches and placed either in a greenhouse or in a cool laboratory (with less light). After 3 days, control seedlings in the laboratory lost 250 g (per tray) while seedlings with clipped needles lost 140 g. As expected, water loss was greater if seedlings were kept in the greenhouse (520 g for controls vs. 410 g for clipped seedlings). These studies demonstrate that needle clipping can reduce transpiration of longleaf pine seedlings. We no longer have to presume that needle clipping reduces transpiration.

We selected an arbitrary stress level of 30 g of water per container (see Figure 1), and then calculated a “time delay” for each clipping treatment. For example, the non-clipped seedlings reached the 30 g level on day 7.3. Likewise, the 6-Clip and 2-Clip treatments reached this level on days 9.6 and 13.1, respectively. Therefore, in this greenhouse trial, one might conclude that the 6-Clip treatment reduced the onset of stress by an estimated 2.3 days. This supports the idea that top-clipping longleaf pine seedlings may be beneficial to outplanting performance (South 1998; Dumroese et al. 2009)

Jackson and South (2009) established an experiment to determine if clipping needles affects RGP of longleaf pine. RGP was 29, 19, 6 and 0 for seedling that received (1) no clipping, (2) clip to 8 inches; (3) clip to 4 inches and (4) all needles removed, respectively. RGP decreased as more needle mass was removed with no RGP occurring when all needles were removed. Clipping seedlings to 8 inches reduced RGP by 34% (Jackson study) and clipping to 6 inches resulted in a 46% reduction in RGP (this study). These findings support the statement that RGP of pines depends primarily on current photosynthesis.

Many bare-root clipping studies are evaluated by outplanting seedlings into soil in the field. As a result, stress may be minimal if rainfall keeps soil from drying out. Therefore, efforts by researchers to detect a difference in survival can be thwarted by a wet spring which minimizes stress. For this reason, some researchers plant treatments in soil boxes where rainfall is eliminated by a roof or plastic tent. In our study, we imposed a quick stress treatment by (1) not planting the plugs into soil and (2) keeping both irrigation and rainfall from rewetting the plug. This treatment was able to kill some non-clipped seedlings after just 4 weeks of stress.

Barnett (1984) outplanted clipped seedlings in May, July and September. Clipping of small longleaf pine seedlings (average RCD 2.9 to 3.5 mm at planting) had little effect on survival in May (96% survival) or September (66% survival) when the seedlings were not under much stress. However, when outplanted in the hot month of July, survival (2-month) was 15% for non-clipped seedlings and 37% for seedlings clipped once (to 4 inches at week 13). This is a 22 percentage point increase in initial survival of small container-grown seedlings. To increase the probability of survival, Dumroese and others (2009) now recommend planting longleaf pine seedlings with a RCD $\geq$4.75 mm. Top-pruning of loblolly pine and slash pine (at week 10) increased early survival (2-month) by 14 percentage points (Barnett 1984).

Although the 2-Clip treatment resulted in the greatest survival, this treatment is not recommended as an operational practice. First, results from this study are not directly applicable to the field, since (1) seedlings were not planted in soil and (2) growth after planting was not measured. Clipping needles short (to a 2 inch length and maintaining them at 2 inches) can reduce diameter growth in both the nursery and in the field (Barnett 1984). Since longleaf pine is very sensitive to competition from weeds, it is important to not delay the time required to emerge from the grass stage.

An interesting aspect of this study involves the inverse relationship between RGP and survival. Seedlings with the most foliage had the highest RGP and the lowest greenhouse survival (Table 2). This suggests that under environments with limited and declining moisture availability, new root growth is not able to offset the loss of moisture through transpiration. In other words, new roots cannot extract moisture from the plug when transpiration has removed all the moisture. In contrast, new roots will likely be beneficial when soil contains moisture. For example, when a treatment reduces RGP, survival of bare-root longleaf pine seedlings may be reduced (South and Loewenstein 1994).

MANAGEMENT IMPLICATIONS

Clipping needles of longleaf pine can reduce transpiration and can extend the period of time before seedlings die due to moisture stress. Clipping longleaf pine needles to 8 to 10 inches in the nursery can increase the potential for seedling survival in the field. Clipping of needles to 2 inches is not recommended (Dumroese et al. 2009). Since meteorologists have a difficult time predicting rainfall two months in advance, managers need to culture seedlings so they have a better chance of surviving an early spring drought.

LITERATURE CITED

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Table 1. The effect of clipping on needle length and needle mass.

Treatment	**0-Clip**	**6-Clip**	**2-Clip**
Needle length (cm)	28	15	5
Needle mass removed (g)	0	819 mg	1746 mg
Top dry weight (g)	2.76	*1.9*	*1.0*
Top mass removed (%)	0	30%	63%
Root + media (g)	11.4	--	--

Values in *italics* are estimates.

Table 2. The effect of clipping on water loss (per seedling), RGP and survival.

Treatment	**0-Clip**	**6-Clip**	**2-Clip**	**Linear Contrast**	**LSD (α=0.05)**
Water loss by day 5 (g)	37.0	26.6	21.2	0.0001	2.7
Water loss by day 17 (g)	64.3	60.4	53.7	0.0001	4.1
Water remaining day 17 (g)	75	77	83	0.0001	2.8
RGP #	10.9	5.9	0.7	0.0001	2.3
Seedlings with no RGP %	6.25	12.5	62.5	0.0200	8.2
Greenhouse survival (%)	8	19	42	0.0001	12.6

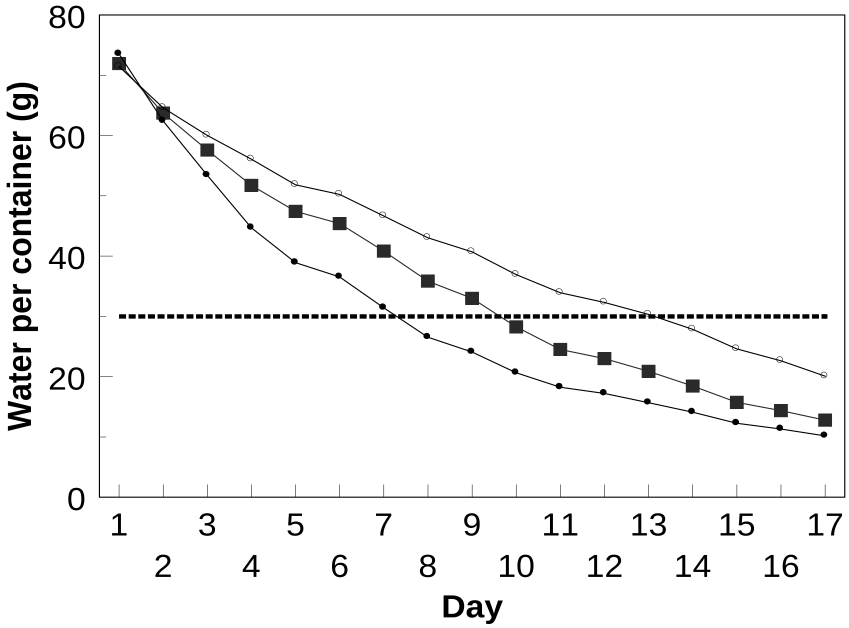

Figure 1. Effect of clipping treatment on water remaining in the container-seedling. Control = bottom line, solid circle; 6-Clip = solid square; 2-Clip = top line, open circle.

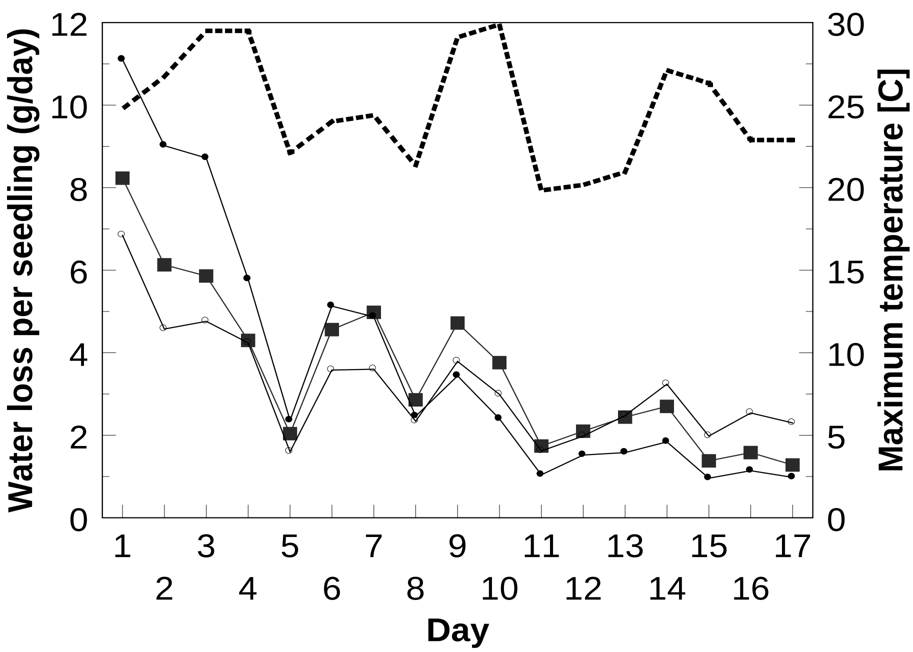

Figure 2. Water loss per seedling by day and clipping treatment. Control = solid circle; 6-Clip = solid square; 2-Clip = open circle. Maximum daily temperature (dashed line) was highest on day 10.