A COMPARISON OF TREE SHELTERS INSTALLED ON GREEN ASH AND CHERRYBARK OAK SEEDLINGS IN ARKANSAS

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Abstract—Tree shelters can aid hardwood seedling establishment by improving early seedling survival and growth. This study was established in Arkansas to compare three types of tree shelters installed on green ash (*Fraxinus pennsylvanica* Marsh.) and cherrybark oak (*Quercus pagoda* Raf.) seedlings. Seedlings planted in 4 feet tall Blue-X®, Protex® or Tubex® tree shelters were compared to unsheltered controls with respect to survival, browse damage, emergence, groundline diameter, and height. Tubex® shelters cost about twice as much to purchase and establish as the Blue-X® shelters, with the Protex® cost in between. Tree shelters did not affect survival. Diameter growth varied by site and shelter treatment. Height growth and emergence rates were greater for sheltered seedlings than unsheltered seedlings, but shelter type made little difference. Overall growth differed between sites, but sheltered cherrybark oaks grew slightly taller than sheltered green ash seedlings at both sites. Less costly shelters may provide the same growth benefits as more expensive shelters.

INTRODUCTION

The planting of hardwood tree seedlings is becoming more popular in the Southern United States. Cost-share programs such as Conservation Reserve Program and Environmental Quality Incentives Program are used by farmers and nonindustrial forest landowners to convert marginal farmlands and other nonforested lands to trees. Planting hardwood trees offers more opportunities for tree species diversity, adaptability to wetter sites, and more benefits for wildlife. However, hardwood seedlings can be more difficult to establish than pine seedlings. Slower initial growth, weed competition, and herbivory often present challenges for hardwood seedlings during the first several years after planting. Tree shelters have been found to aid hardwood seedling establishment in other regions of the United States (Minter and others 1992, West and others 1999). Faster growth, increased survival, and protection from animal browse are the primary benefits of tree shelters.

Tree shelters were first developed in England during the late 1970s (Potter 1991). Tree shelters usually consist of a translucent plastic tube, about 4 inches in diameter, and from 1 to 6 feet tall. The shelters are installed at planting time, and act like a minigreenhouse with favorable light and humidity conditions (Potter 1991).

This 5-year study was implemented by the Arkansas Forest Resource Center, a Center of Excellence within the University of Arkansas (UA) system. The purpose was to compare the performance of three types of tree shelters on green ash (*Fraxinus pennsylvanica* Marsh.) and cherrybark oak (*Quercus pagoda* Raf.) seedlings grown at two sites in Arkansas. This included comparing shelter costs and establishment times and effects on seedling survival and growth. If the shelters produced similar results, the less expensive shelter might be a more cost-effective investment for landowners than the more expensive shelters.

METHODS

Site Location and Description

Two study sites in Arkansas were used for this study. One site was at the UA Southwest Research and Extension Center near Hope in Hempstead County (Hope study site). This field was previously in hay production, and the soil is a Una silty clay loam. The other site was at the Pine Tree Branch Experiment Station near Forrest City in St. Francis County (Pine Tree site). This field was previously in row crop production, and the soils are Calloway, Loring, and Zachary silt loams. Each site occupied about 2.5 acres.

Study Design and Layout

Seedlings were planted in a randomized complete block design. Four treatments (three shelter types and a control without shelters) were applied to green ash and cherrybark oak seedlings. Each treatment-species plot consisted of 20 seedlings and each plot was replicated 4 times. This resulted in a total of 32 plots containing a total of 640 seedlings at each site.

Materials

Three types of tree shelters were used for this study—Blue-X®, Protex®, and Tubex®. All shelters were about 48 inches tall. The Blue-X® shelter consists of two pieces—an inner poly film is rolled into a cylinder and slipped into a thin plastic tube. The Protex® shelter is shipped flat and must also be rolled into a cylinder. Nine tabs along one edge must be inserted into nine slots along the other edge to maintain the tubular shape. This shelter has prepunched holes for inserting a stake tie. The Tubex® shelter is shipped fully assembled with a stake tie already inserted. Five shelters of slightly smaller diameters are nested inside each other for shipping. Tubex® shelters have a seam along the length of the tube to allow growing trees to break the tube apart. The Blue-X® and Protex® shelters are blue in color, and the Tubex® shelter is green. Bird netting was installed on the top of each shelter

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to prevent birds from falling into the shelters. The netting was removed as each seedling emerged from the tube to prevent damage to the terminal. Four-foot bamboo stakes were used to support each shelter initially. Later, oak stakes were used which lasted longer in the ground.

Study Establishment

The Hope site was disked twice prior to planting, and the Pine Tree site was ripped twice during the fall before planting. The seedlings were handplanted at a 12- by 12-foot spacing in February 2004. Tree shelters were installed immediately after planting. The assembly times were timed for each shelter type, and the installation times required to place each shelter over the planted seedling were recorded. Each site was mowed between tree rows once or twice per growing season to ease access for data collection and for landowner field days.

Field measurements collected during each growing season were survival, browse damage, and emergence. Emergence occurred as each terminal bud broke the plane of the top of each shelter, or when the terminal reached a height of 47 inches for the control seedlings. At least 1 inch of each shelter was buried in the ground to prevent air drafts through the tube and to keep mice out. Total height and basal diameter were measured at the end of each growing season.

RESULTS

Establishment Times and Costs

Establishment times (assembly plus installation) for each tree shelter type at the two study sites are presented in table 1. Assembly times were highest for the Protex® shelters, and zero for Tubex® because no assembly was necessary. Installation times included the time needed to drive a stake next to each seedling, place a shelter over a seedling, attach the shelter to the stake, and place bird netting on top of the shelter. Total establishment times were also highest for Protex® and lowest for Tubex®. Shelters were installed first at Hope and then at Pine Tree, so experience and practice led to shorter times at Hope.

Establishment costs in 2004 are presented in table 2. Establishment times were converted to labor costs and added to materials costs. Total establishment costs for Tubex® were more than twice that of Blue-X® ($1.26 per shelter).

Survival and Browse

Table 3 presents survival and browse percentages after 5 years. There were no significant differences for survival among the four treatments through year 4. A slight difference showed up for the Protex® shelters and the controls at Pine Tree in year 5. In general, shelters did not affect survival in this study. The lower survival rates for cherrybark oak at Hope may have been a function of soil factors, i.e., heavy clay soils. Other studies have shown increased survival for seedlings grown in shelters. Schweitzer and others (1999) reported that shelters improved survival, but Minter and others (1992) found no improved survival.

Green ash seedlings without shelters were heavily browsed, mainly by deer. Cherrybark oak seedlings seem to be less preferred by deer. Deer browse probably contributed to stunted seedling growth but not to mortality. Some seedlings in shelters were browsed after emergence. Taller shelters would have reduced this. An informal comparison of height growth between browsed and unbrowsed green ash at Hope showed that the mean height growth on browsed seedlings was about 3 feet less than for unbrowsed seedlings. However, the population of unbrowsed seedlings was very small.

Diameter Growth

At Hope, there were no significant differences in diameter growth among the four treatments after 5 years for green ash, but there were slight differences for cherrybark oak (fig. 1). Green ash diameters were smaller than cherrybark oak diameters. Blue-X® seedling diameters at Hope were slightly smaller than for the other treatments. Diameter growth for both species was much less the first 2 years than in subsequent years. Tree shelters caused increased seedling height growth until emergence, then normal diameter growth resumed.

Table 1—Establishment times for tree shelters by site and shelter type

Site	Shelter type	Assembly time	Installation time	Total establishment time per shelter
		minutes		
Pine tree	Blue-X	0.92 a	0.94 a	1.86 a
	Protex	1.15 b	1.33 b	2.48 b
	Tubex	0.0 c	1.08 a	1.08 c
Hope	Blue-X	0.51 a	0.80 a	1.31 a
	Protex	1.03 b	1.19 b	2.22 b
	Tubex	0.0 c	0.95 c	0.95 c

Within each site-time group, values followed by different letters indicate significant differences at $\alpha = 0.05$.

Table 2—Purchase and establishment costs for each tree shelter type in 2004

Cost type	Shelter type		
	Blue-X	Protex	Tubex
	dollars		
Tree shelter cost	0.89	1.74	2.40
Bird netting	0.05	0.05	0.00
Bamboo stake	0.11	0.11	0.11
Cable tie	0.00	0.06	0.00
Total purchase cost	1.05	1.96	2.51
Assembly cost[a]	0.09	0.15	0.00
Installation cost[a]	0.12	0.17	0.13
Total established cost	1.26	2.28	2.64

[a] Costs based on $8.00 per hour labor cost.

Table 3—Survival and browse by site, species, and treatment

Site	Treatment	Survival		Browsed	
		Ash	Oak	Ash	Oak
		percent			
Hope	Blue-X	96 a	74 a	4	1
	Protex	96 a	76 a	1	2
	Tubex	98 a	74 a	2	1
	Control	98 a	83 a	74	15
Pine tree	Blue-X	96 a	90 a	25	5
	Protex	91 ab	96 a	19	7
	Tubex	98 a	95 a	27	0
	Control	85 b	91 a	94	26

Within each site-time group, values followed by different letters indicate significant differences at $\alpha = 0.05$.

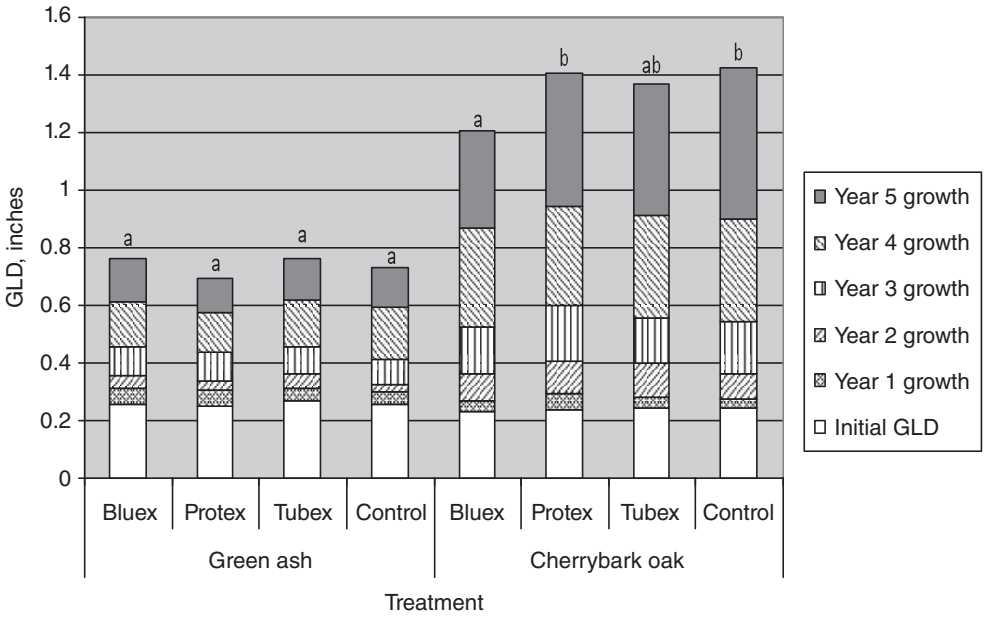

Figure 1—Groundline diameter (GLD) growth at Hope study site. Within each treatment, bars topped by different letters indicate significantly different 5-year growth means at $\alpha = 0.05$.

At Pine Tree, similar trends occurred between the two species, but controls of both species had larger diameters (fig. 2). Perhaps the diameter growth of the sheltered seedlings was still suppressed by the height growth.

Height Growth

At Hope, height growth was higher for all sheltered seedlings compared to control seedlings (fig. 3). Oak seedlings grew taller than the ash seedlings. At Pine Tree (fig. 4), height growth for sheltered seedlings was very fast until emergence, then height growth slowed down. Sheltered ash seedlings grew taller than the controls, but the opposite was true for the oaks. Shelters did not improve height growth over the controls at Pine Tree. Tree shelters generally increased height growth at both sites, but this may be more pronounced only during the early years of growth (Ponder 2003). One advantage of early increased height growth may be to quickly outgrow weed competition.

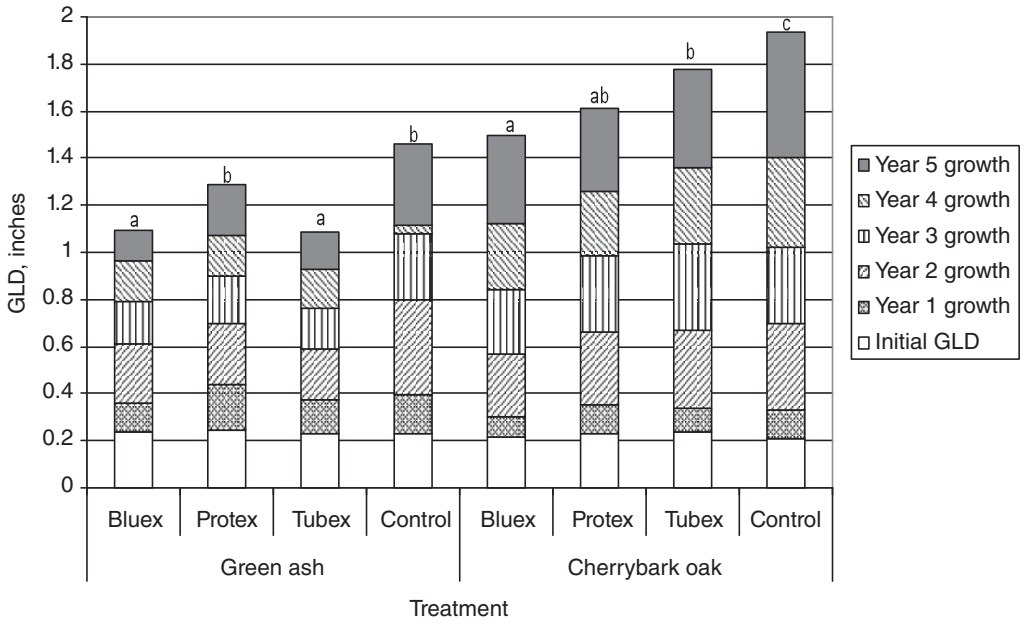

Figure 2—Groundline diameter (GLD) growth at Pine Tree study site. Within each treatment, bars topped by different letters indicate significantly different 5-year growth means at $\alpha = 0.05$.

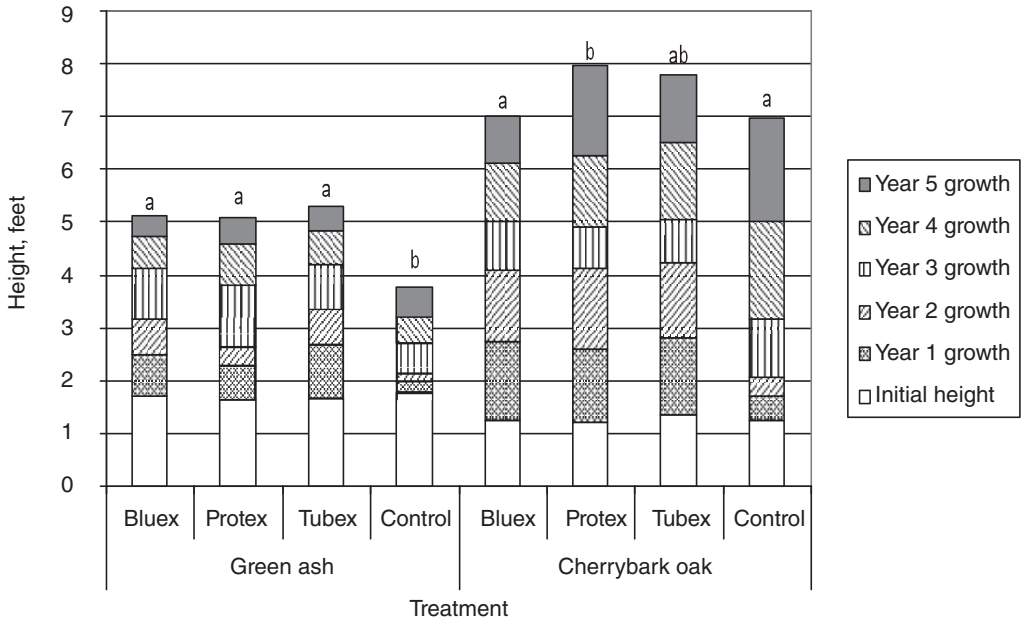

Figure 3—Height growth at Hope study site. Within each treatment, bars topped by different letters indicate significantly different 5-year growth means at $\alpha = 0.05$.

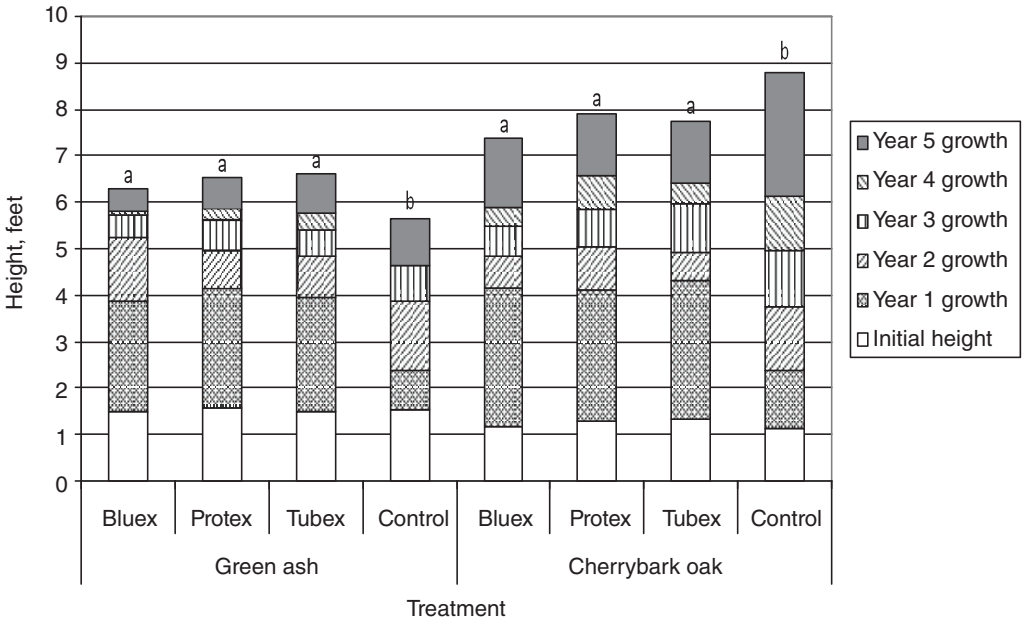

Figure 4—Height growth at Pine Tree study site. Within each treatment, bars topped by different letters indicate significantly different 5-year growth means at $\alpha = 0.05$.

Emergence

The percentages of seedlings that emerged after 5 years are presented in table 4. At Hope, emergence for sheltered ash seedlings was about twice that of controls. There were no large differences for the oaks. At Pine Tree, almost all of the sheltered ash seedlings emerged. Figures 5 and 6 show the cumulative percent emerged by study site for each treatment combination. At Hope, several sheltered seedlings emerged each year, usually during the first few months of each growing season. The controls lagged behind for the green ash, but the unsheltered oaks caught up with the sheltered seedlings during the fifth year. At Pine Tree, most of the sheltered seedlings emerged during the first 2 years. The controls emerged more slowly at first, but their height growth and emergence increased during the last 2 years. The quick emergence at Pine Tree for the sheltered seedlings again shows how the tree shelters force height growth, which is desirable for outgrowing weed competition and herbivory.

Table 4 also presents the emergence rate, or height growth rate, in feet per month, for seedlings inside their shelters. Growth rates at Hope were moderate, and slightly higher for cherrybark oaks. At Pine Tree, sheltered seedlings grew an average of almost 6 inches per month until emergence, which is very fast. At both sites, growth rates of sheltered seedlings were significantly higher than for controls.

Table 4—Percentage of seedlings emerged and mean emergence growth rate by site, treatment, and species

		Emerged		Emerge rate	
Site	Treatment	Ash	Oak	Ash	Oak
		----*percent* ----		*foot per month*	
Hope	Blue-X	89	73	0.17 a	0.26 a
	Protex	86	81	0.13 b	0.25 a
	Tubex	89	75	0.19 a	0.26 a
	Control	48	79	0.08 c	0.11 b
Pine tree	Blue-X	100	98	0.48 a	0.48 a
	Protex	99	98	0.46 a	0.42 b
	Tubex	100	98	0.48 a	0.53 c
	Control	75	90	0.19 b	0.19 d

Within each site-species group, emergence rate means followed by different letters are significantly different at $\alpha = 0.05$.

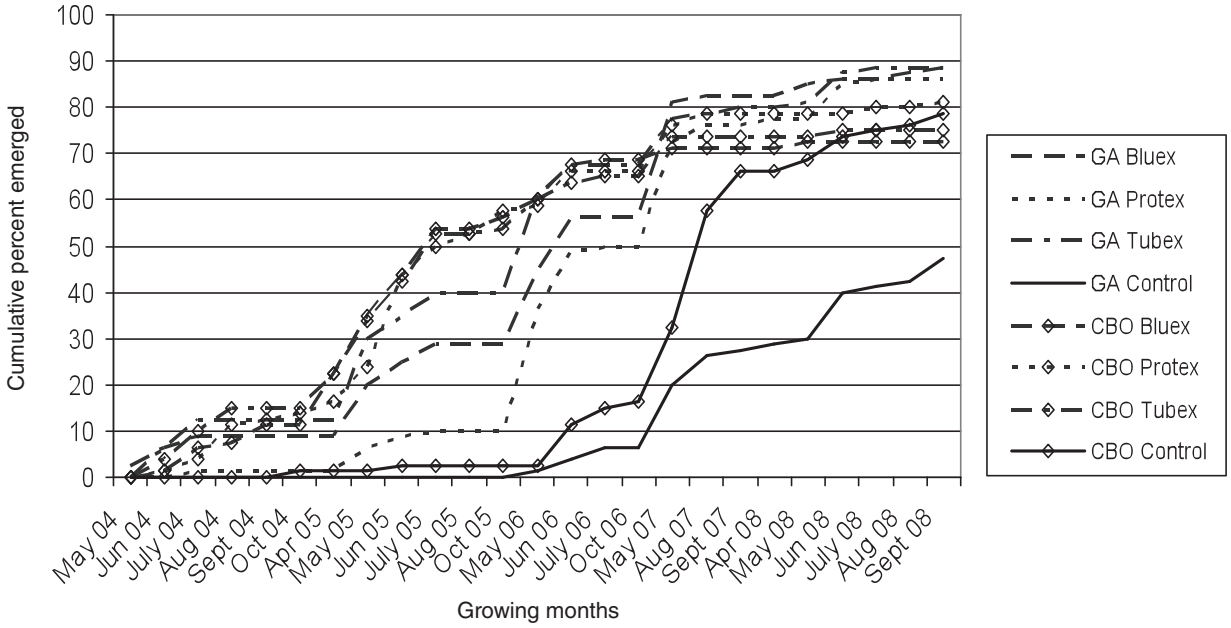

Figure 5—Cumulative percentage of seedlings emerged at Hope study site over 5 years.

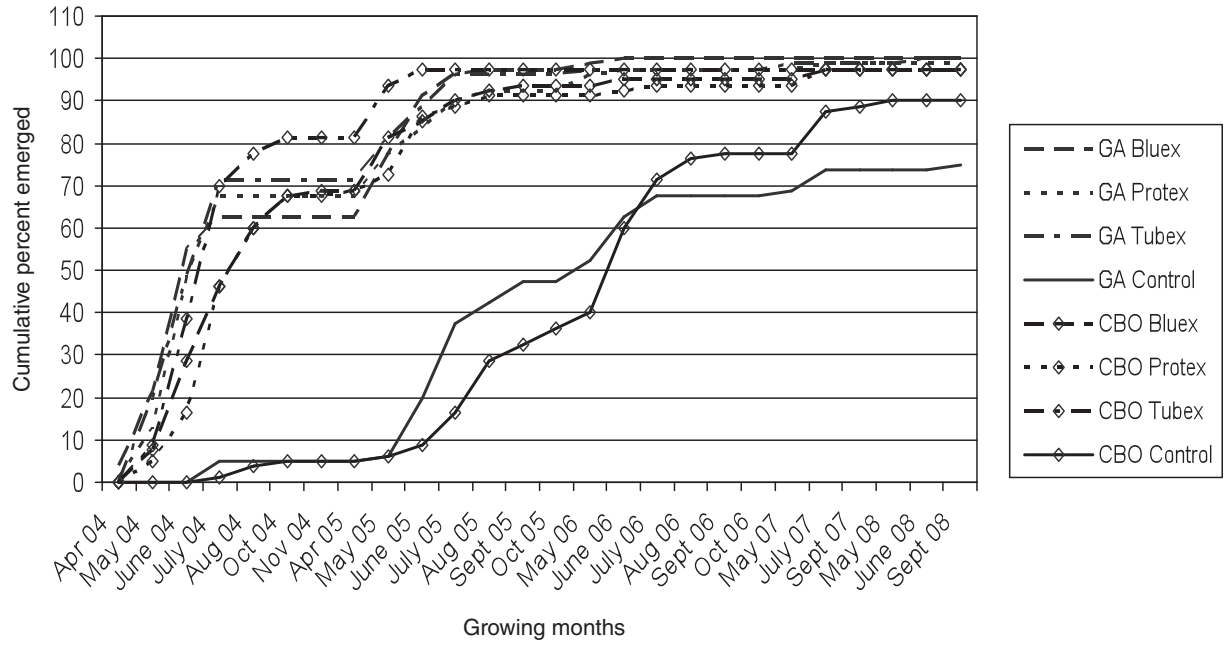

Figure 6—Cumulative percentage of seedlings emerged at Pine Tree study site over 5 years.

CONCLUSIONS

Results of this 5-year study show that Tubex® shelters are the quickest to install but also the most expensive to purchase. Site, not tree shelters, affected survival. Also, the cherrybark oaks at Hope had 15 to 20 percent lower survival than the green ash, probably due to the oaks being less adapted to the heavier soils. Not ripping the Hope site may have also made a difference. Unsheltered green ash seedlings suffered from heavy deer browse. Tree shelters significantly increased height growth for every treatment combination except the oaks at Pine Tree. There were slight growth differences among the shelter types. Even so, Blue-X®, which is quite a bit less expensive than the Tubex®, can produce similar growth advantages. Blue-X® tree shelters might be a cost-effective compromise for landowners. In this study, cherrybark oak seedlings did not benefit significantly from tree shelters, but the green ash did. The advantages provided by tree shelters appear to be somewhat species and site specific.

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