RESPONSE OF PLANTED ROYAL PAULOWNIA TO WEED CONTROL TREATMENTS AFTER COPPICE

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Abstract—Today there is an increased interest in growing royal paulownia (*Paulownia tomentosa*) in the southeastern United States, but difficulties have been encountered in the Piedmont due to heavy clays and intense competition for moisture. Two royal paulownia plantations were established on the Virginia Piedmont to evaluate the effects that weed-mats have on tree survival and growth. The trees with weed-mats on the first plantation, an upland site, had 28 percent greater survival, were 2.8 feet taller, and had .9 inch greater diameter at breast height (dbh) at 4 years after coppice than the trees with no weed-mats. The trees with weed-mats on the second plantation, a bottomland site, had 10 percent greater survival, were 1.6 feet taller, and had .2 inch greater dbh at 4 years after coppice than the trees with no weed-mats.

INTRODUCTION

Today, there is growing interest in growing and managing paulownia plantations in the southeastern United States (Kays and others 1998). Royal paulownia (*Paulownia tomentosa*)is a pioneer species that was introduced into the United States approximately 160 years ago (Hu 1959). Royal paulownia is also known as the kiri tree, empress tree, and the princess tree. Paulownia wood is light in color, has a low density, and dries quickly without warping or cracking. Royal paulownia is easy to recognize by its large heart shaped leaves, its purple flowers, and large number of seed-pods present in mature trees. This tree is known for its rapid growth and ability to grow on a variety of sites. However, difficulties have been encountered in the Piedmont due to heavy clay soils and intense competition for moisture. Site preparation treatments can be used to break up the heavy clay soils, while herbicide and/or weed-mats can be used to control competition. The purpose of this study is to quantify the effects that weed-mats have on royal paulownia growth and survival in the Virginia Piedmont.

METHODS

In the spring of 1994, two royal paulownia plantations were installed near Virginia Tech's Reynolds Homestead Forest Resources Research Center located in the Piedmont physiographic province in Patrick County, VA. One plantation was on an upland (ridge-top) site, while the other was located on a bottomland site (floodplain). Each site was bedded before planting. Soil samples were collected from each plantation for characterization purposes. Ten push tube samples of the top 10 inches were collected and composited for each plantation. The soils were air dried and ground to pass a 2 mm sieve. The soils were then analyzed for total nitrogen and total carbon. Particle size analysis and pH were also determined. Containerized seedlings were planted in the spring of 1994. A 3ft by 3ft weed-mat was put around half of the trees at each site, while the other half were untreated. Herbicide applications of a 1.5 percent solution of glyphosate were applied around all trees each year. The trees were coppiced in the spring of 1997 after 3 growing seasons. Tree survival, tree heights, and diameters were recorded each November for five years (1996-2000). Weed-mat treatment effects on ground line diameter (GLD), height, diameter at breast height (DBH), and volume were analyzed by t-tests at the .10 level.

RESULTS AND DISCUSSION

Soil Characterization

Soil chemical and physical properties for both sites are presented in table 1. The upland site had a much higher coarse fragment content and a higher clay percentage than the bottomland site. The bottomland site has much higher levels of nitrogen and organic matter than the upland site. Sites with clay contents greater than 30 percent should be

Table 1—Soil chemical and physical properties for the upland and bottomland sites in Patrick County, VA

Site properties	Upland	Bottomland
Coarse fragment(%)	41	3
Sand(%)	39	38
Silt(%)	27	48
Clay(%)	34	14
Textural class	clay loam	loam
pH	5.31	5.67
Total N(ppm)	783	1338
Estimated N(lbs/ac)	1355	3222
Organic matter(%)	1.90	2.89

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Table 2--Royal paulownia seedling performance for the upland site in Patrick County, VA

Variable	Treatment	Year[a] 1996	1997	1998	1999	2000
Survival(percent)	Weed-mat	51	51	50	50	50
	No weed-mat	23	23	23	23	22
GLD (in)	Weed-mat	2.4a	1.9a	8.5a	4.4a	5.3a
	No weed-mat	1.9b	1.6b	6.6b	3.4a	4.4a
DBH (in)	Weed-mat				3.1a	3.8a
	No weed-mat				2.6b	2.9b
Height (ft)	Weed-mat		7.5a	14.2a	19.6a	23.6a
	No weed-ma		6.2b	11.8a	16.7a	20.8a
Volume (ft^3)	Weed-mat		0.24a	1.4a	1.5a	2.7a
	No weed-mat		0.19a	0.9a	1.0a	2.0a

[a] Means within a column followed by the same letter are not significantly different at the 0.10 level.

Table 3--Royal paulownia seedling performance for the bottomland site in Patrick County, VA

Variable	Treatment	Year[a] 1996	1997	1998	1999	2000
Survival(percent)	Weed-mat	55	55	46	40	37
	No weed-mat	40	40	36	32	27
GLD (in)	Weed-mat	2.2a	1.4a	2.2a	2.8a	3.5a
	No weed-mat	2.1a	1.3a	1.9b	2.4b	3.0b
DBH (in)	Weed-mat				2.0a	2.4a
	No weed-mat				1.8b	2.2a
Height (ft)	Weed-mat		5.6a	10.7a	13.8a	15.4a
	No weed-mat		5.2a	14.2a	12.8a	13.8a
Volume (ft^3)	Weed-mat		0.15a	0.56a	0.56a	0.89a
	No weed-mat		0.12a	0.44a	0.44a	0.69a

[a] Means within a column followed by the same letter are not significantly different at the 0.10 level.

avoided for paulownia plantations (Kays and others 1998), but site preparation treatments such as bedding or trenching can be used to ameliorate the effects of heavy clays by providing an improved rooting medium. The upland site is more typical of abandoned agricultural land in the Piedmont that would be planted to paulownia.

Seedling Performance

Seedling survival and growth were measured for five growing seasons, 1996 to 2000. Variables measured include percent survival, ground-line diameter (GLD), diameter at breast height (DBH), total height, and seedling volume expressed as diameter squared times height. In 1996, only GLD and survival data was collected. The 1999 growing season was the first year that DBH data was collected.

Upland Site—The means for the upland site are presented in table 2. The trees with weed-mats had 50 percent survival in the year before coppice, while the trees without weed-mats had only 23 percent survival (table 2). Survival did not vary substantially after the third growing season. Royal paulownia is highly dependent on adequate soil moisture for rapid growth (Beckjord 1991). Factors that influenced survival at this site were drought, late frosts, and disease. The weed-mats reduced competing vegetation,

and thereby conserved water. High competition for moisture gave the trees with weed-mats an advantage which may have lessened the damage done by late frosts and disease.

Significant differences in GLD's were found for 1996, 1997, 1998, but not for 1999 and 2000. However, significant differences for DBH's were found for 1999 and 2000 suggesting that early GLD response leads to increased DBH growth in later years. In the fourth year after coppice (2000), the mean DBH was 0.9 inches larger for trees with weed-mats (table 2). A significant difference in height was found for only the first year after coppice, but 4 years after coppice the mean height was 2.8 feet taller for trees with weed-mats(table 2). No significant differences were found for volumes. Four years after coppice, the trees with weed-mats had 35 percent greater volume than trees without weed-mats.

Bottomland Site—The means for the bottomland site are presented in table 3. Tree survival slowly declined from 1997 to 2000. This site initially had higher survival than the upland site, but was more prone to multiple late spring frosts and deer damage. Late frosts killed back initial flushes at least once each year. Deer damage at this site included girdling the trees, as well as breaking the stem in some cases. The trees with weed-mats had 37 percent survival while trees without weed-mats had only 27 percent survival at four years after coppice (table 3). This site is a good example of how important site selection is when considering planting royal paulownia. The soils at this site would indicate royal paulownia should grow very well, but due to its topographic position and susceptibility to frost damage, this was a poor site selection.

Significant differences in GLD's were found for 1998,1999, and 2000. In addition, DBH's were found to be significantly different for 1999, but not for 2000. In the fourth year after coppice (2000), the mean DBH was .2 inches larger for trees with weed-mats (table 3). No significant differences were found for tree heights or volumes. However, trees with weed-mats were 1.6 feet taller and had 29 percent more volume than trees without weed-mats.

CONCLUSION

The establishment of a royal paulownia plantation on the Virginia Piedmont can best be described as difficult. On these sites, late frosts, drought, disease, and deer damage reduced overall survival and growth. This study does however suggest that weed-mats are beneficial and improve tree survival and growth. The trees with weed-mats on the upland site had DBH's that were 31 percent larger, heights 13 percent greater, and a survival rate that was more than twice that for trees having no weed-mats. The trees with weed-mats on the bottomland site had DBH's that were 9 percent larger, heights 12 percent greater, and survival that was 10 percent greater than the trees without weed-mats. Weed-mats can be a useful tool for the establishment of a productive royal paulownia plantation.

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