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COMPARISON OF BARE ROOT AND RPM SEEDLING PRODUCTION TECHNOLOGIES: IMPLICATIONS FOR AGROFORESTRY

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Abstract: 'Root Production Method' (RPM) technology significantly increases the development of root systems in containerized seedlings. As an alternative to bare root seedlings, RPM seedlings have been promoted as a method to increase growth and survivability of hardwood trees. However, few scientific studies have been conducted that would support these claims. Three oak species (*Quercus* spp.) were the focus of this study. Seed was collected from a single mother tree of black oak (*Quercus velutina*, Lam.), white oak (*Quercus alba* Linn.), and swamp white oak (*Quercus bicolor* Willd.). Half of the seed from each mother tree was used to produce RPM, the other half bare root stock, (i.e. half siblings) which were planted in the fall (RPM) of 1996 or spring (bare root) of 1997 at the Horticulture and Agroforestry Research Center, New Franklin, MO. After 14 years in the field, bare root and RPM trees were harvested for each species and total above ground weight was recorded. Statistical analysis of the data was conducted using least-square means and a method of orthogonal contrasts to determine if significant differences existed between the biomass of bare root and RPM trees. Results showed that the RPM trees had up to twice as much above-ground biomass weight as the bare root trees of the same age. Implications of this study suggest that RPM trees could be used in agroforestry practices as a way of increasing carbon sequestration and biomass production. In addition, the significant increase in growth that was observed should serve to enhance interest in adopting agroforestry practices.

Keywords: biomass, carbon sequestration, Root Production Method, oak

INTRODUCTION

"Root Production Method" (RPM™) is a registered trademark for a nursery cultural practice developed by the Forrest Keeling Nursery located in Elsberry, MO (Grossman et al., 2003). This nursery cultural technique air prunes the roots of seedlings that are grown in open-bottomed containers as a way to increase lateral root growth and enhance the production of a dense, fibrous root system. In addition to air pruning, the RPM™ process incorporates a proprietary soil and fertilization regime that promotes extensive fibrous root growth prior to out-planting. Based on 50 years of research in container production and hardwood regeneration, the Forrest Keeling Nursery, through the use of

the RPM™ method, has developed a hardwood seedling in either a 3 or 5-gallon container that has an unusually large caliper, height, and a fibrous root system (Dey et al., 2004).

For agroforestry applications, RPM™ seedlings have the potential to reduce the time it takes for a tree to reach an age where it provides either an economical or environmental benefit. For example, the ability of RPM™ trees to sequester carbon at a faster rate may impact both the economic and environmental benefits. More specifically, RPM™ seedlings can reach greater heights and diameters in a shorter time frame than bare root seedlings. As a result of this faster growth, the environmental impact of windbreaks or riparian buffers can be realized sooner than with conventional planting stock.

More recently, with the focus on biomass for energy, the RPM™ technology is being looked at as a method of increasing biomass production for woody species. The economic demands of biomass production require shorter rotations and higher yields in terms of tons per acre in order to be profitable for landowners. Therefore, the use of RPM™ seedlings for biomass production would seem to be an economically viable management strategy.

METHODS

Three oak species (*Quercus* spp.) were the focus of this study. Seed was collected from a single mother tree of black oak (*Quercus velutina*, Lam.), white oak (*Quercus alba* Linn.), and swamp white oak (*Quercus bicolor* Willd.). Half of the seed from each mother tree was used to produce RPM, the other half bare root stock, (i.e. half siblings) which were planted in the fall (RPM) of 1996 or spring (bare root) of 1997 at the Horticulture and Agroforestry Research Center (HARC), New Franklin, MO.

After 14 years in the field, height and diameter at breast height (dbh) measurements were recorded for both the bare root and RPM trees. The trees for each species were then harvested and total above ground weight was recorded using a load cell. After total weight above ground was recorded, the limbs from each tree were removed and the stem was reweighed using the load cell.

Statistical analysis of the data was conducted using several methods, including least-square means and a method of orthogonal contrasts to determine if significant differences existed between the dbh and height of bare root and RPM trees. Another approach compared the ratio of total weight to dbh using a method that plotted the total above ground tree weight by dbh data and then calculated a trendline using the trendline function in Excel™.

RESULTS

A total of 30 RPM™ and 23 bare root trees were harvested. The number of trees for each species and seedling type are listed in Table 1, along with their average dbh, height, tree weight, and stem weight. Based on the comparison of the means, the mean dbh for swamp white oak RPM and swamp white oak bare root were not significantly different (*P=0.0664).* However, the remaining species did have a significant difference in dbh when RPM™ trees were compared to bare root trees. Average heights, average tree weights, and average stem weights all show highly significant differences between RPM™ and bare root. However, the differences between the swamp white oak RPM™ and bare root were only significant at the α=0.05 level.

Table 1: Average measurements from the RPM and bare root oaks harvested from the Horticulture and Agroforestry Research Center, New Franklin, MO

	Averages				
	n	dbh (in)	ht (ft)	tree wt (lbs)	stem wt (lbs)
Black Oak RPM	15	8.40	38.2	621.9	404.6
Black Oak Bare root	7	6.23	34.4	356.9	229.4
White Oak RPM	5	7.76	31.7	498.9	326.0
White Oak Bare root	6	5.85	25.2	231.0	160.8
Swamp White Oak RPM	10	7.66	34.0	462.1	299.0
Swamp White Oak Bare root	10	6.73	31.3	324.5	215.9
All RPM	30	8.05	35.7	548.1	356.3
All Bare root	23	6.35	30.7	310.0	205.6

The average dbh, height and weight data indicated that the RPM™ trees were larger than the bare root trees of the same age. The next step in this study was to compare the total above ground tree weight with dbh to determine if there was a difference in tree density. More specifically, this comparison looks at the probability that RPM™ and bare root trees of the same dbh have different weights.

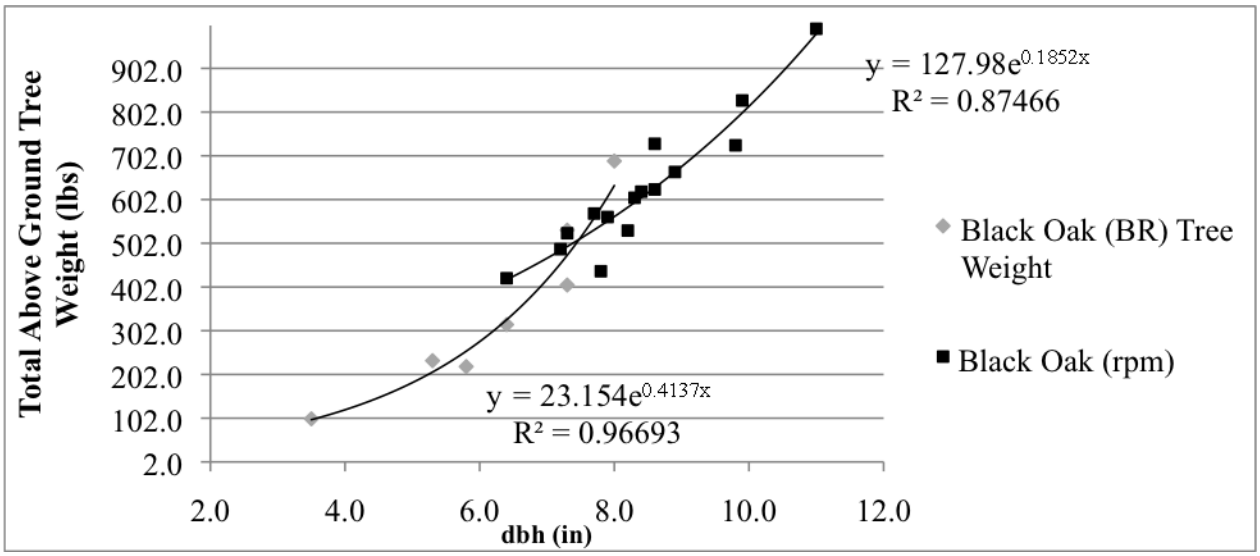

Figure 1: Comparison of dbh to total above ground tree weight with trendline for black oak (Quercus velutina, Lam.) RPM™ and bare root grown at the Horticulture and Agroforestry Research Center, New Franklin, MO.

Figure 1 shows the comparison of dbh and total above ground tree weight for black oak grown at the HARC farm. Based on this figure and the data reported in Table 1, the RPM™ trees have a larger dbh and total weight at age 14, but the relationship of dbh to total above ground weight isn't impacted by the type of seedling (RPM™ or bare root) initially planted. In other words, a tree with an 8-inch dbh will have about the same total above ground weight regardless if it is an RPM™ or a bare root. This trend is the same with the swamp white oak (Figure 2). There is little difference in the comparison of dbh to total above ground tree weight between RPM™ and bare root.

The results for white oak indicate that there may be a slight difference between the biomass potential based on the dbh to total above ground tree weight comparison. Figure 3 shows a trendline that predicts total above ground tree weight to be nearly 50 lbs less for bare root at each dbh level.

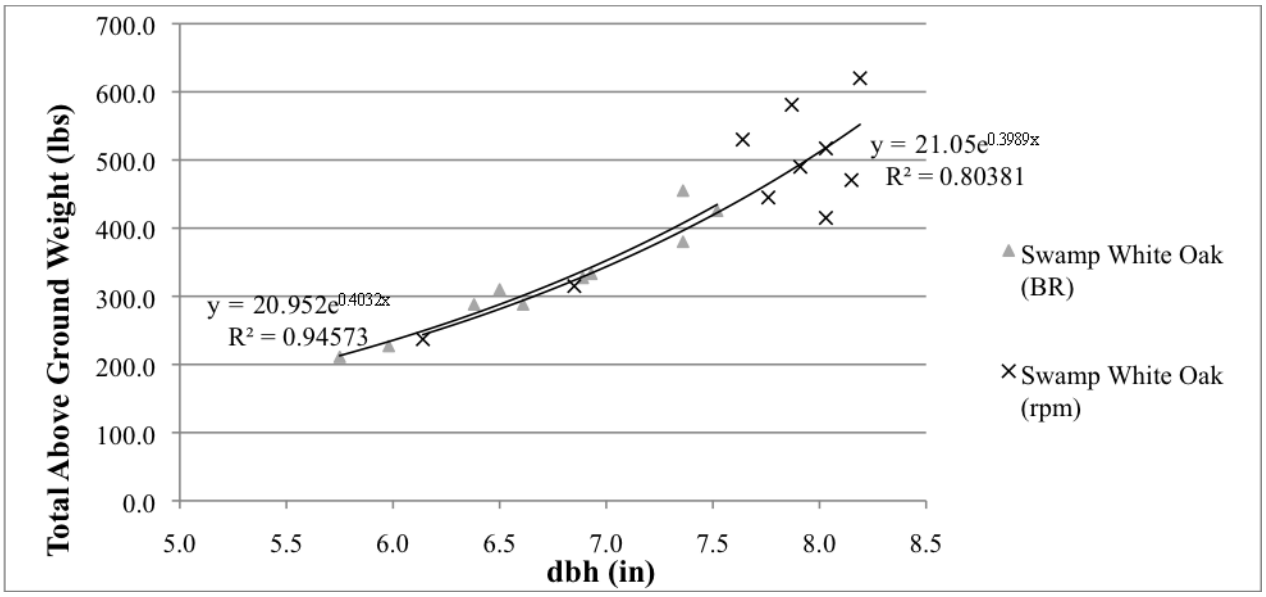

Figure 2: Comparison of dbh to total above ground tree weight with trendline for swamp white oak (Quercus bicolor Willd.) RPM™ and bare root grown at the Horticulture and Agroforestry Research Center, New Franklin, MO.

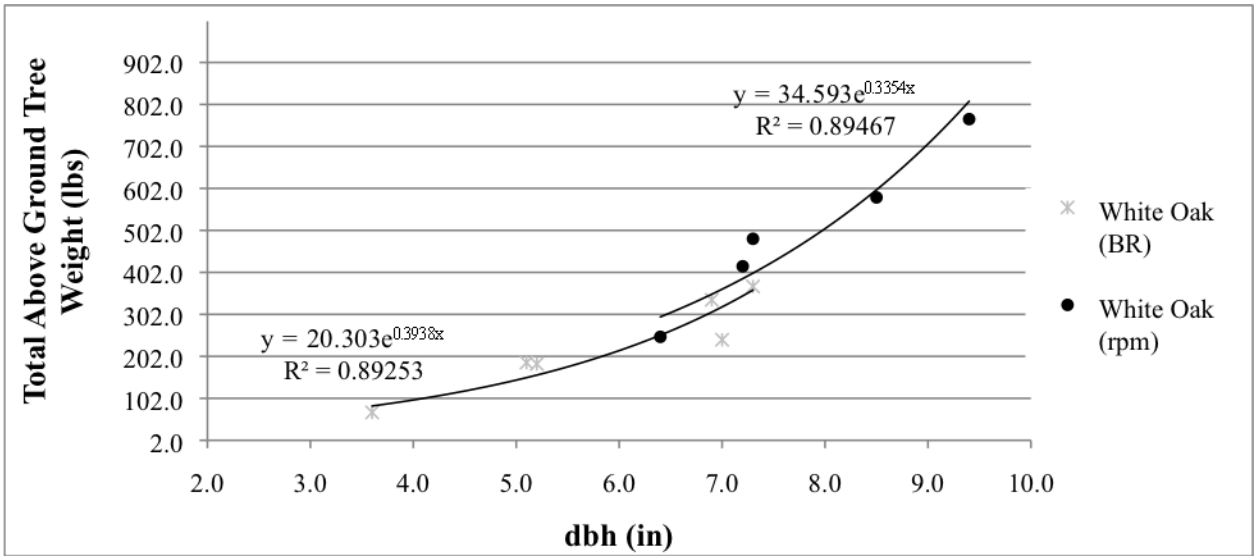

Figure 3: Comparison of dbh to total above ground tree weight with trendline for white oak (Quercus alba Linn) RPM™ and bare root grown at the Horticulture and Agroforestry Research Center, New Franklin, MO.

CONCLUSIONS

Although this study is a preliminary in nature, the results of the mean dbh, height, and weight comparisons indicate that the RPM™ trees are significantly larger than bare root trees of the same age. This supports the idea that RPM™ trees can decrease the time required for agroforestry plantings to reach economic maturity or achieve the desired environmental effect. Moreover, our findings clearly illustrate the advantage of using RPM™ trees, rather than conventionally grown trees, to maximize carbon sequestration on a per acre basis.

LITERATURE CITED

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