Effect of family and seed size on growth in red oak

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Abstract

The objectives of this experiment are to study the effects of seed size and family on seedling development and to quantify any interaction between the two variables. The height, diameter, and root volume of the seedlings will be measured at the end of the first growing season.


Figure-1, seed size-sorting machine


Figure-2, perforated sizing screens

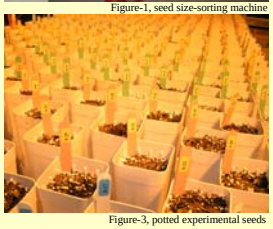
Figure-3, potted experimental seeds

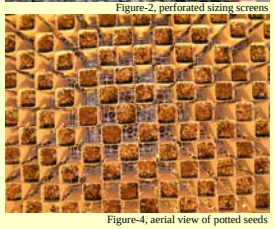
Figure-4, aerial view of potted seeds

Problem

The central hardwoods region has experienced a production shortage on the order of 25 to 50 million hardwood tree seedlings annually. In addition, seedling production has suffered quality deficiency due to the unimproved nature of seedlings and the unknown fitness and genetic diversity of the seedlings produced (Woeste and Michler 2003). It is a prime objective of the HTIRC to improve genetic traits in planting stock of northern red oak (Michler et al. 2005).

Solution

To address the seedling shortage, it is necessary to allocate nursery space more efficiently by growing more seeds meeting a minimum size and quality requirement. There is large variation among genetic families for height, root collar diameter, and number of first-order laterals (Schlarbaum 1997). Root volume is a reliable, fast, and nondestructive method of estimating survival two years after outplanting (Jacobs et al. 2004). Complimentarily, it has been shown that there is positive correlation between seed size and root volume [Fig. 6]. Indeed, height, diameter, and fresh weight also increase as seed size increased (Karrfalt 2004).

Grading bulk red oak seed for size would be a valuable technique for nursery managers to increase uniformity and productivity. However there may be genetic implications of such seed handling. It has been observed that seeds differ in size among families of red oak (Rogers 2006) [Fig. 7]. So, by grading seeds and disposing of the small acorns, entire genetically valuable small-seeded families may be lost, thereby decreasing genetic diversity of the seedling crop (Karrfalt 2004, Schmidt 2000). This study seeks to relieve ambiguity from the seed size x family issue.

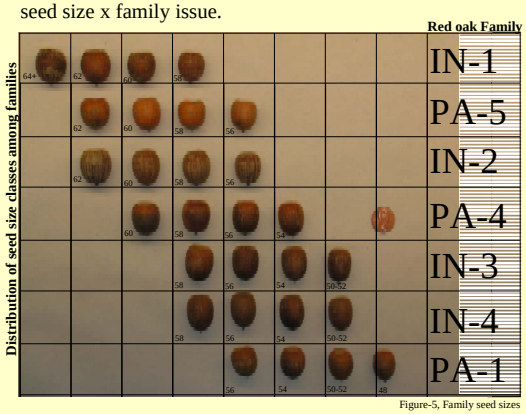

Figure-5, Family seed sizes

Kormanik et al. (1998) investigated the effects of relative seed size on families of red oak. Karrfalt (2004) graded bulk seeds absolutely. Both recognized correlations between variables but no interaction was sensed due to the relative sizing. No studies have been initiated thus far that have sought to identify the full effect and interaction of family and seed size.

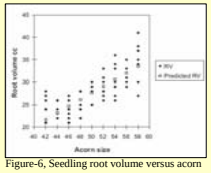
Figure-6, Seedling root volume versus acorn size at Vallonia State Nursery (Karrfalt 2004)

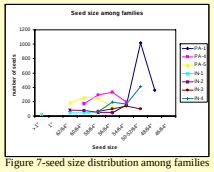
Figure 7-seed size distribution among families

Characteristic by root-vol. category	Northern red oak Range Min	Range Max	Mean (SE)
Root volume (cm³)			
RvC1	15	16	15 (0.2)d
RvC2	23	25	24 (0.1)c
RvC3	33	35	34 (0.2)b
RvC4	54	66	59 (1.3)a
Fresh mass (g)			
RvC1	20	23	21 (0.3)d
RvC2	32	50	33 (0.4)c
RvC3	45	50	48 (0.5)b
RvC4	79	93	85 (1.5)a
Diameter (mm)			
RvC1	4	5	5 (0.1)c
RvC2	5	6	5 (0.1)c
RvC3	5	6	6 (0.1)b
RvC4	7	8	8 (0.1)a
Height (cm)			
RvC1	25	41	34 (1.3)d
RvC2	32	54	39 (1.1)c
RvC3	43	51	47 (0.9)b
RvC4	57	66	62 (1.0)a
FOLR			
RvC1	4	6	4 (0.2)d
RvC2	5	8	7 (0.3)c
RvC3	7	11	8 (0.4)b
RvC4	9	15	12 (0.7)a

Figure-8, range of growth character in response to root volume categories (Jacobs 2005)

We propose to address the problem by conducting a study where family and seed size can be connected directly to 1-0 containerized seedling performance. It has been suggested that size be measured absolutely rather than relatively (Kormanik et al. 1998). We will determine seed size with a perforated hole sorter ([Figs. 1 & 2] and quantify mass with a metric balance. Identity (family, round-hole screen size, and mass) are recorded and maintained for each seed. These values may then be directly correlated to growth traits of subsequent seedlings. Covariates may be removed for enhanced significance.

Approach

Seeds were collected by family from seven red oak mother trees, and each family graded into six size classes with a perforated round-hole seed sorter. Twenty-eight sufficient family x size groups were identified and, after the mass of each seed was measured, the seeds were planted in sixteen randomized blocks in the greenhouse at the John S. Wright Center. Each of the 448 seeds will be cultivated, monitored, and measured for date of germination (Seiwa 2000), height, diameter at root collar, and root volume (Harrington 1994) at the end of the growing season.



Future

Upon completion of the experiment, the seedlings will be planted along with other families into a test designed to determine the effects of seed size and family on precocity, a trait valued by landowners in Indiana.

Acknowledgements

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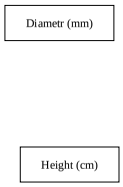
Diametr (mm)
Height (cm)

	Acorn size										
Family		>1"	1"	62/64	60/64	58/64	56/64	54/64	50-52/64	48/64	46/64
	PA-1						44	157	1019	360	
	PA-4				171	294	331	194			
	PA-5			183	261	249	125				
	IN-1	23		45	45	62					
	IN-2			83	78	52	48				
	IN-3					67	99	139	101		
	IN-4					60	196	168	409		