



Michigan Technical Note

USDA-Natural Resources Conservation Service

FORESTRY #27

Subject: Direct Seeding Tree and Shrub Establishment

Date: April 2010

Background Direct seeding offers an alternative for establishing new or restocking existing stands of hardwood species in Michigan. Direct seeding of hardwood trees has proven successful in Illinois, Indiana, Missouri, Ohio, and Wisconsin. However, little research-based information is available on direct seeding in Michigan.

Description of Study At the Rose Lake Plant Materials Center (PMC) in East Lansing a selection of hardwood tree and shrub species was planted in plots by direct seeding in 2003 and 2004. In the Eastern Upper Peninsula (UP) side-by-side comparisons of direct-seeded and transplanted northern red oak (*Quercus rubra*) were established in 2004. Plots at both locations were evaluated for survival and plant growth characteristics.

Application Summary Broadcast seeding did not result in acceptable stands. Direct seeding of light-mast species and cherry did not result in acceptable stands. (Overall summary is provided in Table 1). Acceptable stands were obtained with direct seeding (drill or hand) of larger-seeded, heavy-mast species (i.e. hickory, oak, and walnut). Results of fall planting were superior to spring planting. Acceptable stands were also obtained with transplanted northern red oak in the UP.

Direct seeding may be a useful alternative to transplanting tree seedlings. Based on results from these studies, seeding populations should be determined based on a 10 – 20% survival rate for heavy-mast, hardwood species from seeds.

	Direct Seeded		Transplanted
	By Broadcast	By Drill or Hand	
Light mast (ash, birch, maple, sumac, viburnum, winterberry), Spring or Fall Planting	0%, typically 0%	0-3%, typically 0%	Not evaluated
Cherry, Spring or Fall Planting	0-1%, typically 1%	0-1%, typically 0%	Not evaluated
Heavy mast (hickory, oak, walnut), Spring Planting	0-9%, typically 1%	0-43%, typically 5%	Not evaluated
Heavy mast (hickory, oak, walnut), Fall Planting	0-16%, typically 9%	2-80%, typically 24%	Not evaluated
Northern red oak, Spring (Trans)planting in UP	Not evaluated	9-91%, typically 40%	16-100%, typically 86%

Procedure (Plant Materials Center) Seeds of heavy-mast (e.g. hickory and oak) and light-mast (e.g. ash and maple) hardwood tree and shrub species were direct planted in field studies at the PMC. (Species are listed in Tables 2 & 3.) Planting dates were spring 2003, fall 2003, and spring 2004. Soil was Boyer sandy loam or loamy sand. Direct-seeding treatments were:

- 1) broadcast on tilled soil, followed by dragging and cultipacking;
- 2) drill in rows (rows 1.5 ft apart, seeds 8-in spacing within rows) in tilled soil, followed by cultipacking; and
- 3) drill in rows (rows 1.5 ft apart, seeds 8-in spacing within rows) in non-tilled soil, preceded by glyphosate application and followed by cultipacking.

A rodent control product was placed in several locations. No fertilizer or irrigation was applied. Stands were evaluated in 2003, 2004, 2005, and 2008. Plants were counted in rows in the drilled plots and by a transect method in the broadcast plots.

Data analysis was performed using Statistics[®]8 based on three separate experiments planted as a randomized complete block design with three replications.

Table 2. Species planted in direct seeding tree and shrub study in 2003. Rose Lake Plant Materials Center.	
Common Name	Scientific Name
Heavy-Mast Species	
Shagbark Hickory	<i>Carya ovate</i>
Black Walnut	<i>Juglans nigra</i>
Black Cherry	<i>Prunus serotina</i>
White Oak	<i>Quercus alba</i>
Scarlet Oak	<i>Quercus coccinea</i>
Bur Oak	<i>Quercus macrocarpa</i>
Northern Red Oak	<i>Quercus rubra</i>
Light-Mast Species	
Red Maple	<i>Acer rubrum</i>
Silver Maple	<i>Acer saccharinum</i>
White Birch	<i>Betula papyrifera</i>
Green Ash	<i>Fraxinus pennsylvanica</i>
White Ash	<i>Fraxinus Americana</i>
Staghorn Sumac	<i>Rhus typhina</i>
Arrowwood	<i>Viburnum dentatum</i>
Highbush Cranberry	<i>Viburnum opulus</i> var. <i>americanum</i>

Table 3. Species planted in direct seeding tree and shrub study in 2003 and 2004. Rose Lake Plant Materials Center.	
Common Name	Scientific Name
Heavy-Mast Species	
Bitternut Hickory	<i>Carya cordiformis</i>
Pignut Hickory	<i>Carya glabra</i>
Shellbark Hickory	<i>Carya laciniosa</i>
Light-Mast Species	
Sugar Maple	<i>Acer saccharum</i>
Common Winterberry	<i>Ilex verticillata</i>

Procedure (Eastern Upper Peninsula) Site selection in the UP was based on proximity of broken canopy and open sunlight so oak seedling performance could be evaluated in both environments. Acorns and seedlings were supplied by the PMC. Suggested field design was a row of 100 red oak acorns to be planted next to a row of 25 red oak seedlings with three rows of each treatment per test site. Broken canopy and open sunlight sites were to be paired and in close proximity. Acorns were to be planted 1.5-in deep (2 times the diameter of the acorn) approximately 1 ft apart within a row with rows spaced 5 ft apart. Transplants were to be spaced 4 ft apart within a row with rows spaced 5 ft apart.

Planting date was in spring 2004. Data were collected in 2004, 2005, 2006, 2007, and 2008 on survival and plant height. Experimental design was not amenable to analysis of variance.

Results and Discussion

Plant Materials Center

Heavy-Mast Species Significant stand differences were observed among the heavy-mast species and in their response to tillage and timing and method of seeding in 2005 (Table 4) and again in 2008 (Table 5). Stands of fall-drilled seedlings generally exceeded the grand mean in 2005 and 2008. Stands of spring-drilled and spring-broadcast seedlings were generally less than the grand mean in 2005 and 2008.

Table 4. Stand of heavy-mast species. Rose Lake PMC. July 2005.							
	Northern Red Oak	White Oak	Scarlet Oak	Bur Oak	Black Walnut	Black Cherry	Shagbark Hickory
	----- Survival (%) -----						
Spring '03 Till, Drill	10	1	6	20	2	0	0
Spring '03 No-till, Drill	6	4	5	20	0	0	1
Fall '03 Till, Drill	37	11	12	22	62	1	57
Fall '03 No-till, Drill	35	6	19	16	47	0	43
Spring '03 Broadcast	9	1	0	9	0	0	0
Fall '03 Broadcast	9	1	0	12	9	1	16
Grand Mean = 12%							
LSD _{0.05} = 3% (between or among any entries in table)							

Black cherry survival was $\leq 1\%$ in 2005 in all treatments and no remaining black cherry was observed in 2008. No remaining broadcast-established seedlings were observed in 2008. Therefore, broadcast-established treatment combinations were excluded from the analysis of 2008 data. Height differences were observed (Table 6).

	Northern Red Oak	White Oak	Scarlet Oak	Bur Oak	Black Walnut	Black Cherry	Shagbark Hickory
----- Survival (%) -----							
Spring '03 Till, Drill	7	0	4	17	1	0	0
Spring '03 No-till, Drill	11	1	8	23	0	0	1
Fall '03 Till, Drill	29	3	5	12	66	0	40
Fall '03 No-till, Drill	17	2	5	11	50	0	37
Grand Mean = 13%							
LSD _{0.05} = 12% (between or among any entries in table)							

	Northern Red Oak	White Oak	Scarlet Oak	Bur Oak	Black Walnut	Black Cherry	Shagbark Hickory
----- Height (inches) -----							
Spring '03 Till, Drill	10		11	14	10		
Spring '03 No-till, Drill	14	5	13	15			2
Fall '03 Till, Drill	9	6	5	8	19		5
Fall '03 No-till, Drill	10	5	4	9	23		5
No plants observed							
Grand Mean = 7 inches							
LSD _{0.05} = 8 inches (between or among any entries in table)							

Light-Mast Species - Light-mast survival averaged 0.2% in 2005 (Table 7). Only 3 of the 7 planted species were observed in the stand count and no broadcast-planted trees were observed. No remaining trees were observed in 2008.

Results shown in Table 8 corroborated above findings: fall drilling of larger, heavy-mast species resulted in better stands than spring plantings of the same species. Light-mast species did not survive through the course of the experiment. Height differences were observed with fall-seeded treatments being taller than spring-seeded (Table 9).

Droughty soil and growing season conditions (summer of 2003) may have reduced the germination of seedlings which were planted at a shallow, but appropriate depth. Fall planting dates gave seeds natural stratification and the advantage of the earliest possible start to the growing season and an opportunity to extend roots deeper into the soil before summer heat and drought began.

Table 7. Stand of light-mast species. Rose Lake PMC. July 2005.							
	<i>Viburnum spp.</i>	Staghorn Sumac	Green Ash	White Ash	Red Maple	Silver Maple	White Birch
	----- Survival (%) -----						
Spring '03 Drill, Till	0	0	0	0	0	0	0
Spring '03 Drill, No-till	0.7	0	0.7	0	0	0	0
Fall '03 Drill, Till	0.7	0	0	0	0	3.0	0
Fall '03 Drill, No-till	0.7	0	0	0	0	1.5	0
Spring '03 Broadcast	0	0	0	0	0	0	0
Fall '03 Broadcast	0	0	0	0	0	0	0
Grand Mean = 0.2%							
LSD _{0.05} = 0.3% (between or among any entries in table)							

Table 8. Stand as evaluated. Rose Lake PMC. May 2008.					
	----- Survival (%) -----				
	Pignut	Shellbark	Bitternut	Winterberry	Sugar Maple
Fall '03 Till, Drill	21	46	25	0	0
Spring '04 Till, Drill	5	25	9	0	0
Fall '03 No-till, Drill	31	80	23	0	0
Spring '04 No-till, Drill	4	43	13	0	0
Grand Mean = 16%					
LSD _{0.05} = 13% (between or among any entries in table)					

Table 9. Tree height. Rose Lake PMC. May 2008.					
	----- Height (inches) -----				
	Pignut	Shellbark	Bitternut	Winterberry	Sugar Maple
Fall '03 Till, Drill	6	7	11		
Spring '04 Till, Drill	2	6	4		
Fall '03 No-till, Drill	6	7	12		
Spring '04 No-till, Drill	3	6	4		
No plants observed					
Grand Mean = 4 inches					
LSD _{0.05} = 3 inches (between or among any entries in table)					

Drilled seeding of heavy-mast species has the advantage of relatively accurate and consistent seed depth. Broadcast seeding produces a more natural distribution of seeding depths; some will be deeper than ideal and some will be on the soil surface and subject to drying and consumption by seed-eating mammals and birds.

Eastern Upper Peninsula

Survival and height data are presented in Table 10. Survival rates were typically 40-50% higher with transplants compared to seeds. Moreover, transplants were taller; it took four years for direct seeded northern red oak acorns to attain the height of bare root seedlings at the time of transplanting. Differences in response to broken canopy vs. open sunlight were inconsistent.

Credits Grateful appreciation is expressed to forester cooperators including Bob Poehl of Linden, Michigan who made this study possible.

Location	Site Description	Treatment	Survival (%)					Height (inches)				
			2004	2005	2006	2007	2008	2004	2005	2006	2007	2008
Luce County (site 1)	Broken canopy opening, northern hardwood stand	Direct Seed	91	91	77	62	77	4	4	5	7	8
		Transplant	100	100	92	100	100	8.6	9.3	10.3	14	17
Luce County (site 2)	Edge open meadow, east side	Direct Seed	40	40	36	37	24	4	4	5	7	9
		Transplant	90	86	76	76	90	7.2	8	7	10	10
Luce County (site 3)	Edge open meadow, west side	Direct Seed	20	25	21	21	18	3	3	5.5	10	13.5
Luce County (site 4)	Edge open meadow, lower elevation	Direct Seed	67	60	55	63	52	4	4	6	9	9
		Transplant	100	95	95	89	95	7.6	8.5	11.8	18	18
Luce County (site 5)	Broken canopy opening, aspen clear cut	Direct Seed	71	82	32	46	57	3	3	3	3	16
		Transplant	67	67	22	56	67	6.5	7.5	5.5	7	8
Luce County (site 6)	Open meadow	Direct Seed	60	40	23	19	23	4	4	4.3	5	4.7
		Transplant	83	83	77	70	77	7.2	8.2	6.6	8.5	8.5
Luce County (site 7)	Broken canopy opening, aspen	Direct Seed	37	38	42	14	20	4	4	4	6	6
Mackinac County (Northern Timberland Ventures Inc., site) (site 8)	Old pasture reverting back to forest, sandy loam	Direct Seed	71	31	9	No data in 2007	No data in 2008	3.7	4	3	No data in 2007	No data in 2008
		Transplant	95	77	16	No data in 2007	No data in 2008	8.6	9	9.3	No data in 2007	No data in 2008