

Supplementary Materials: Sub-Soiling and Genotype Selection Improves *Populus* Productivity Grown on a North Carolina Sandy Soil

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Table S1. Mean relative percent difference and one standard deviation (SD) for duplicate parameter measurements collected. LAI, Leaf Area Index.

Parameter	<i>n</i>	Relative Percent Difference	
		Mean	SD
Height	59	1.7%	5.7%
Basal Diameter	59	5.4%	14%
Diameter at Breast Height	59	2.5%	5.6%
LAI	4	7.1%	6.2%
% Nitrogen	8	7.0%	5.0%
Chlorophyll Content	8	15%	17%

Table S2. Number of planted trees, number of living trees, percent survival, percent mortality, mean height and one standard deviation (SD), mean basal diameter and SD, total volume, and mean volume and SD for trees planted in April 2014. Means are listed by overall performance (combined), and then partitioned by soil tillage treatment.

Parent Species		Total Planted				Height (m)		DBH (cm)		Volume (dm³)		
Genotype	Treatment		Alive	Survival	Mortality	Mean	SD	Mean	SD	Total	Mean	SD
<i>P. deltoides</i>	Combined	384	305	79%	21%	5.9	1.4	5.4	2.2	8533	33	20
	Disked	192	137	71%	29%	5.7	1.3	5.0	2.1	3398	29	17
	Sub-soiled	192	168	88%	13%	6.1	1.4	5.7	2.2	5135	28	21
140	Combined	96	78	81%	19%	6.1	1.3	6.3	2.1	2597	25	18
	Disked	48	39	81%	19%	6.0	1.2	5.7	2.1	1126	31	23
	Sub-soiled	48	39	81%	19%	6.2	1.4	6.8	2.0	1471	38	22
176	Combined	96	77	80%	20%	5.8	1.3	5.5	2.1	2328	30	22
	Disked	48	35	73%	27%	5.7	1.3	5.5	2.4	1040	30	23
	Sub-soiled	48	42	88%	13%	5.9	1.3	5.5	1.8	1288	31	21
356	Combined	96	82	85%	15%	6.5	1.2	5.3	2.0	2295	28	20
	Disked	48	37	77%	23%	6.0	1.3	4.6	1.5	833.9	23	14

373	Sub-soiled	48	45	94%	6%	6.9	1.0	5.9	2.1	1461	32	23
	Combined	96	68	71%	29%	5.2	1.5	4.4	2.1	1313	19	21
	Disked	48	26	54%	46%	4.9	1.1	3.9	1.9	398.5	15	15
<i>P. deltooides</i> × <i>P. maximowiczii</i>	Sub-soiled	48	42	88%	13%	5.3	1.6	4.7	2.3	914.4	22	24
	Combined	96	90	94%	6%	5.5	1.2	4.8	1.6	2109	23	18
	Disked	48	44	92%	8%	5.7	1.3	5.1	1.6	1136	26	14
230	Sub-soiled	48	46	96%	4%	5.4	1.1	4.6	1.5	973.6	21	20
	Combined	96	90	94%	6%	5.5	1.2	4.8	1.6	2109	23	18
	Disked	48	44	92%	8%	5.7	1.3	5.1	1.6	1136	26	14
<i>P. trichocarpa</i> × <i>P. deltooides</i>	Sub-soiled	48	46	96%	4%	5.4	1.1	4.6	1.5	973.6	21	20
	Combined	480	414	86%	14%	5.0	1.2	4.2	1.8	6832	17	15
	Disked	240	204	85%	15%	4.7	1.1	3.9	1.7	2824	14	13
185	Sub-soiled	240	210	88%	13%	5.2	1.3	4.5	1.9	4008	19	17
	Combined	96	85	89%	11%	5.9	1.3	5.4	1.9	2483	30	21
	Disked	48	39	81%	19%	5.7	1.1	5.3	1.9	1035	27	20
187	Sub-soiled	48	46	96%	4%	6.0	1.4	5.5	1.9	1448	33	22
	Combined	96	81	84%	16%	4.2	0.93	3.1	1.2	546.0	6.7	4.9
	Disked	48	42	88%	13%	4.2	0.85	3.0	1.1	273.0	6.5	4.4
188	Sub-soiled	48	39	81%	19%	4.2	1.0	3.2	1.3	273.0	7.0	5.3
	Combined	96	78	81%	19%	4.6	1.3	3.8	1.9	921.3	12	11
	Disked	48	39	81%	19%	4.2	1.0	3.2	1.2	278.6	7.1	5.2
229	Sub-soiled	48	39	81%	19%	5.0	1.4	4.4	2.3	642.6	16	14
	Combined	96	93	97%	3%	5.2	0.86	4.7	1.5	1938	21	12
	Disked	48	48	100%	0%	5.1	0.72	4.5	1.4	918.3	19	9.5
339	Sub-soiled	48	45	94%	6%	5.4	1.0	4.9	1.5	1019	23	14
	Combined	96	79	82%	18%	4.8	1.1	4.1	1.7	943.9	12	11
	Disked	48	36	75%	25%	4.3	1.0	3.5	1.4	319.4	8.9	7.1
Overall	Sub-soiled	48	43	90%	10%	5.2	0.95	4.6	1.7	624.5	15	12
	Combined	960	809	84%	16%	5.4	1.4	7.2	2.6	17,474	22	19
	Disked	480	385	80%	20%	5.2	1.3	7.1	2.6	7359	19	16
	Sub-soiled	480	424	88%	12%	5.6	1.4	7.2	2.5	10,116	24	21

Table S3. Mean foliar nitrogen and one standard deviation (SD), phosphorous $\pm$ SD, potassium $\pm$ SD, magnesium $\pm$ SD, calcium $\pm$ SD, and sulfur $\pm$ SD for trees. Means are listed by overall performance (combined), and then partitioned by soil tillage treatment.

Genotype Clone	Treatment	n	% Nitrogen		% Phosphorous		% Potassium		% Magnesium		% Calcium		% Sulfur	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
<i>P. deltooides</i>	Combined	32	2.79	0.33	0.25	0.07	1.49	0.35	0.34	0.07	1.66	0.44	0.54	0.08
	Disked	16	2.75	0.34	0.28	0.08	1.54	0.28	0.34	0.06	1.57	0.37	0.56	0.06
	Sub-soiled	16	2.84	0.32	0.23	0.05	1.43	0.41	0.35	0.07	1.75	0.10	0.51	0.10
	140 Combined	8	2.87	0.34	0.25	0.07	1.43	0.28	0.33	0.08	1.79	0.40	0.53	0.03
	140 Disked	4	2.62	0.17	0.25	0.08	1.26	0.18	0.37	0.07	1.98	0.37	0.54	0.03
	140 Sub-soiled	4	3.12	0.29	0.24	0.06	1.60	0.28	0.29	0.08	1.60	0.28	0.52	0.03
	176 Combined	8	2.81	0.42	0.24	0.05	1.29	0.27	0.37	0.07	1.89	0.36	0.56	0.06
	176 Disked	4	3.05	0.47	0.27	0.06	1.52	0.09	0.30	0.02	1.58	0.17	0.58	0.08
	176 Sub-soiled	4	2.58	0.18	0.21	0.01	1.05	0.09	0.43	0.03	2.19	0.15	0.53	0.03
	356 Combined	8	2.68	0.23	0.28	0.09	1.84	0.35	0.33	0.06	1.44	0.40	0.56	0.09
	356 Disked	4	2.54	0.06	0.30	0.13	1.80	0.35	0.30	0.13	1.27	0.32	0.55	0.04
	356 Sub-soiled	4	2.82	0.27	0.25	0.05	1.88	0.39	0.36	0.06	1.61	0.43	0.58	0.13
	373 Combined	8	2.82	0.33	0.25	0.06	1.39	0.26	0.35	0.05	1.53	0.52	0.50	0.12
	373 Disked	4	2.80	0.37	0.29	0.02	1.58	0.19	0.38	0.06	1.45	0.20	0.59	0.07
	373 Sub-soiled	4	2.82	0.27	0.25	0.05	1.88	0.39	0.36	0.06	1.61	0.43	0.58	0.13
<i>P. trichocarpa</i> $\times$ <i>P. deltooides</i>	Combined	40	2.92	0.32	0.25	0.06	1.53	0.24	0.26	0.07	1.03	0.23	0.33	0.06
	Disked	20	2.88	0.38	0.27	0.07	1.55	0.30	0.25	0.04	0.97	0.24	0.32	0.04
	Sub-soiled	20	2.95	0.25	0.24	0.05	1.52	0.17	0.27	0.97	1.09	0.22	0.34	0.07
	185 Combined	8	2.81	0.18	0.28	0.06	1.35	0.23	0.25	0.03	1.27	0.16	0.29	0.02
	185 Disked	4	2.71	0.19	0.29	0.07	1.38	0.30	0.26	0.02	1.28	0.24	0.29	0.02
	185 Sub-soiled	4	2.92	0.18	0.28	0.06	1.32	0.16	0.25	0.04	1.26	0.06	0.29	0.03
	187 Combined	8	3.22	0.16	0.27	0.05	1.52	0.24	0.23	0.05	0.94	0.14	0.32	0.02
	187 Disked	4	3.16	0.20	0.28	0.06	1.47	0.36	0.26	0.06	0.93	0.19	0.32	0.02
	187 Sub-soiled	4	3.29	0.18	0.26	0.05	1.57	0.04	0.20	0.02	0.95	0.08	0.32	0.03
188	Combined	8	3.12	0.44	0.26	0.06	1.55	0.32	0.30	0.12	1.13	0.25	0.38	0.09
	Disked	4	3.23	0.60	0.29	0.08	1.63	0.45	0.24	0.02	0.95	0.21	0.34	0.05
	Sub-soiled	4	3.00	0.25	0.24	0.02	1.48	0.16	0.36	0.14	1.31	0.13	0.42	0.11
229	Combined	8	2.64	0.11	0.21	0.05	1.66	0.16	0.21	0.05	0.80	0.11	0.30	0.02

<i>P. deltooides</i> × <i>P. maximowiczii</i>	Disked	4	2.56	0.10	0.23	0.06	1.62	0.19	0.23	0.03	0.78	0.14	0.31	0.03
	Sub-soiled	4	2.71	0.06	0.20	0.02	1.70	0.14	0.22	0.04	0.81	0.09	0.30	0.01
	Combined	8	2.80	0.18	0.23	0.04	1.59	0.14	0.31	0.07	1.03	0.18	0.36	0.04
	Disked	4	2.76	0.14	0.24	0.05	1.66	0.16	0.28	0.04	0.94	0.17	0.35	0.05
	Sub-soiled	4	2.83	0.23	0.22	0.04	1.53	0.08	0.35	0.07	1.12	0.17	0.38	0.04
	Combined	8	2.76	0.33	0.22	0.03	1.57	0.12	0.30	0.05	1.08	0.27	0.37	0.02
	Disked	4	2.68	0.37	0.23	0.03	1.56	0.07	0.29	0.02	1.07	0.28	0.37	0.03
	Sub-soiled	4	2.85	0.31	0.21	0.03	1.58	0.17	0.31	0.08	1.09	0.29	0.37	0.03
	Combined	8	2.76	0.33	0.22	0.03	1.57	0.12	0.30	0.05	1.08	0.27	0.37	0.02
	Disked	4	2.68	0.37	0.23	0.03	1.56	0.07	0.29	0.02	1.07	0.28	0.37	0.03
	Sub-soiled	4	2.85	0.31	0.21	0.03	1.58	0.17	0.31	0.08	1.09	0.29	0.37	0.03
	Combined	8	2.76	0.33	0.22	0.03	1.57	0.12	0.30	0.05	1.08	0.27	0.37	0.02
Overall	Combined	80	2.85	0.33	0.25	0.06	1.52	0.28	0.29	0.08	1.29	0.45	0.42	0.12
	Disked	40	2.81	0.37	0.27	0.07	1.55	0.27	0.29	0.06	1.22	0.41	0.42	0.13
	Sub-soiled	40	2.89	0.28	0.23	0.05	1.49	0.29	0.31	0.09	1.35	0.48	0.41	0.11

Table S4. Mean Leaf Area Index (LAI) and one standard deviation (SD) collected in October 2014.

Genotype Clone	Treatment	n	LAI	
			Mean	SD
<i>P. deltooides</i>	Combined	16	2.09	0.68
	Disked	8	1.82	0.69
	Sub-soiled	8	2.33	0.60
	Combined	4	2.30	0.34
	Disked	2	2.08	0.17
	Sub-soiled	2	2.52	0.35
	Combined	4	2.47	0.85
	Disked	2	2.25	1.30
	Sub-soiled	2	2.69	0.51
	Combined	3	2.03	0.48
	Disked	2	1.47	0.02
	Sub-soiled	2	2.31	0.02
	Combined	4	1.55	0.71
	Disked	2	1.39	0.03
	Sub-soiled	2	1.81	1.12
<i>P. trichocarpa</i> × <i>P. deltooides</i>	Combined	20	1.36	0.48
	Disked	10	1.52	0.51
	Sub-soiled	10	1.21	0.43
	Combined	4	2.04	0.32
	Disked	2	1.81	0.27
	Sub-soiled	2	2.27	0.15
	Combined	4	1.02	0.35
	Disked	2	0.94	0.57
	Sub-soiled	2	1.11	0.07
	Combined	4	1.12	0.21
	Disked	2	1.11	0.29
	Sub-soiled	2	1.13	0.22
	Combined	4	1.56	0.37
	Disked	2	1.28	0.17
	Sub-soiled	2	1.84	0.28
339	Combined	4	1.09	0.26
	Disked	2	0.93	0.23
	Sub-soiled	2	1.25	0.22
<i>P. deltooides</i> × <i>P. maximowiczii</i>	Combined	4	1.50	0.31
	Disked	2	1.60	0.10
	Sub-soiled	2	1.45	0.42
230	Combined	4	1.50	0.31
	Disked	2	1.60	0.10
	Sub-soiled	2	1.45	0.42
Overall	Combined	39	1.65	0.65
	Disked	18	1.47	0.60
	Sub-soiled	21	1.80	0.66

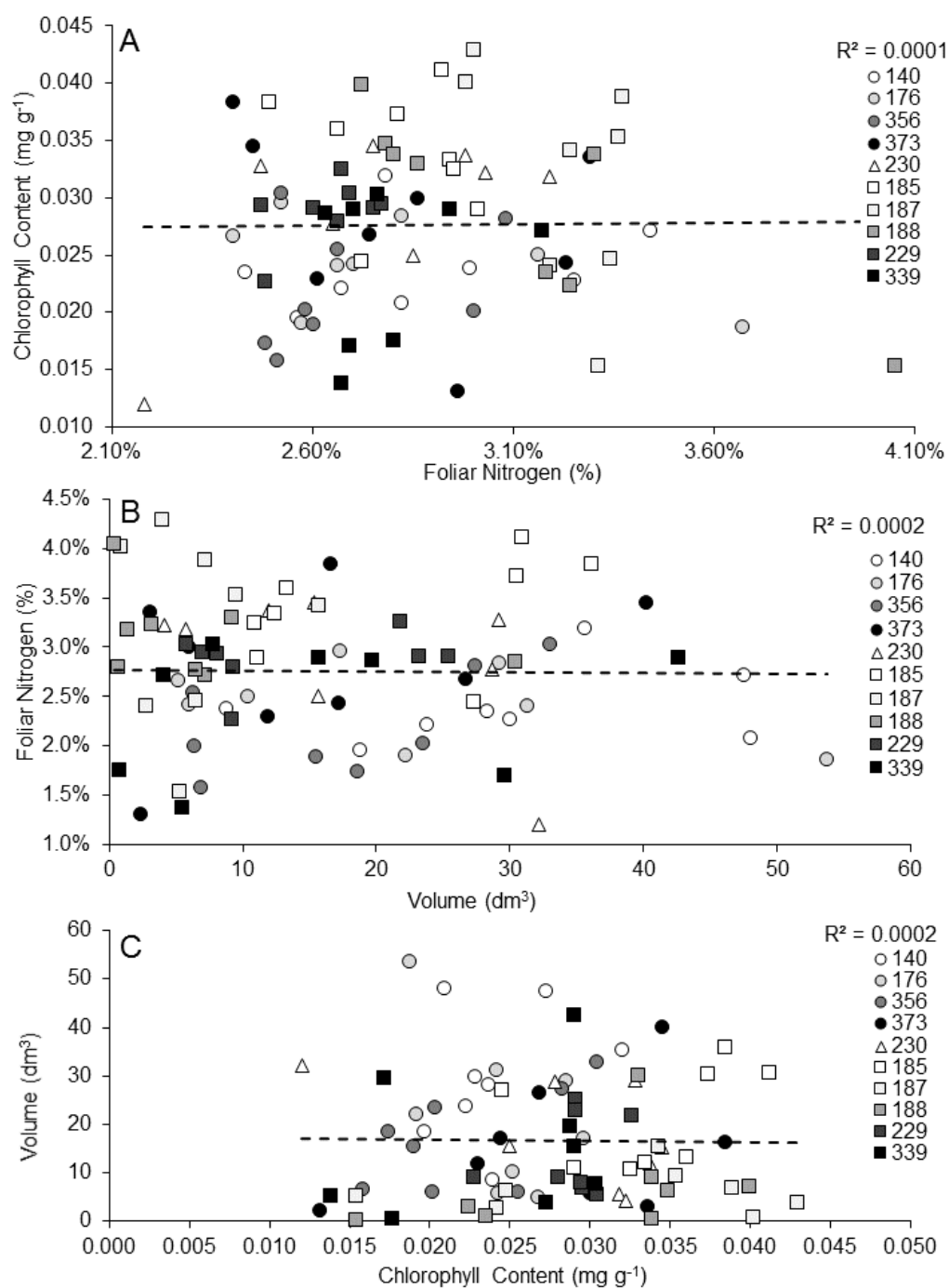


Figure S1. Cross-plots of (A) chlorophyll content (mg·g⁻¹) vs. foliar nitrogen (%); (B) foliar nitrogen (%), vs. volume index (dm³); and (C) volume index (dm³) vs. chlorophyll content (mg·g⁻¹) for *Populus* genotypes. Circles (O) represent *P. deltoides* genotypes, triangles (Δ) represent a *P. deltoides* × *P. maximowiczii* genotype, and squares (□) represent *P. trichocarpa* × *P. deltoides* genotypes. Trend lines are shown as dashed lines. R^2 values are located in the top right of each cross plot.