PERFORMANCE OF HYBRID POPLAR CLONES ON AN ALKALINE SOIL THROUGH 2007

Clinton C. Shock and Erik B. Feibert
Malheur Experiment Station
Oregon State University
Ontario, OR

Introduction

With timber supplies from Pacific Northwest public lands becoming less available, sawmills and timber products companies are searching for alternatives. Hybrid poplar wood has proven to have desirable characteristics for many nonstructural timber products. Plantings of hybrid poplar for sawlogs have increased in the Treasure Valley.

Many hybrid poplar clones are susceptible to nutrient deficiencies and excesses in alkaline soils, leading to chlorosis, poor growth, and eventual death of trees. Poor growth on alkaline soil can be partly a result of iron deficiency caused by the low solubility of iron compounds in alkaline soil. A symptom of iron deficiency is yellow leaves or "chlorosis". Chlorosis can also be caused by other nutrient problems. Foliar analyses often reveal high levels of many nutrients in poplar grown on alkaline soils.

Previous clone trials planted in 1995 in Malheur County demonstrated that clone OP-367 (hybrid of *Populus deltoides* x *Populus nigra*) was the only clone performing well on alkaline soils at that time. Growers in Malheur County have made experimental plantings of hybrid poplars and found that other clones have higher productivity on soils with nearly neutral pH. New poplar clones are continually being developed. The current trial seeks to provide poplar growers with updated information on the relative vigor and adaptability of a larger number of clones on alkaline soils.

Materials and Methods

2003 Procedures

The trial was conducted on Nyssa silt loam with 1.3 percent organic matter and a pH ranging from 7.7 at the top of the field to 8.4 at the bottom. The field had been planted to wheat the fall of 2002. On March 28, 2003, the wheat was sprayed with Roundup® at 1.5 lb ai/acre. Based on a soil analysis, on April 9, 2003, 20 lb magnesium (Mg), 40 lb potassium (K), 1 lb boron (B), and 1 lb copper (Cu) per acre were broadcast. The field was again sprayed with Roundup at 1.5 lb ai/acre on April 9. On April 10, 9-inch poplar sticks of 24 clones (Table 1) were planted in a randomized complete block design with 5 replicates. Tree rows were spaced 5 ft apart and trees were spaced 5 ft apart within the rows. Each plot consisted of four trees, two rows wide and two trees long. Goal® herbicide at 2 lb ai/acre was applied on April 11. The field was irrigated with 0.6 inch of water on April 11.

Three of the clones were designated as Malheur 1, 2, and 3 corresponding to 3 selections of eastern cottonwood (*Populus deltoides*) found growing vigorously in Malheur County.

Drip tubing (Netafim Irrigation, Inc., Fresno, CA) was laid along the tree rows prior to planting. The drip tubing has two emitters (Netafim On-line button dripper) spaced 12 inches apart for each tree. Each emitter has a flow rate of 0.5 gal/hour. The field was irrigated when the soil water tension at 8-inch depth reached 25 kPa. Each irrigation applied 0.6 inch of water based on an 8-ft^2 area for each tree. This irrigation strategy was able to maintain the soil water tension below 25 kPa until around mid-July, when the irrigation rate was increased to 1 inch per irrigation. The increased irrigation rate was not effective in maintaining the soil water tension below 25 kPa due to inadequate irrigation frequency, so starting in mid-August the field was irrigated 5 to 7 times per week until the last irrigation on September 30. Soil water tension was measured with six Watermark soil moisture sensors model 200SS (Irrometer Co., Riverside, CA) installed at 8-inch depth. The soil moisture sensors are read every 8 hours by a Hansen Unit datalogger (Mike Hansen Co., Wenatchee, WA).

Analysis of leaf samples (first fully expanded leaf from clone OP-367) taken on July 11 showed the unexpected needs for B and sulfur (S) fertilization (Table 1). On July 28, S at 10 lb/acre as ammonium sulfate and B at 0.2 lb/acre as boric acid were injected through the drip system.

2004 Procedures

On March 25, 2004, Casoron® 4G at 4 lb ai/acre was broadcast for weed control. Based on a soil analysis, nitrogen (N) at 80 lb/acre, Cu at 1 lb/acre, and B at 1 lb/acre were injected through the drip tape on May 10. Analysis of leaf samples (first fully expanded leaf from clone OP-367) on July 8 showed the need for B (Table 1). On July 19, B at 0.2 lb/acre was injected through the drip system. On August 20, a soil sample consisting of 20 cores was taken from each replicate and analyzed for pH.

On August 10, leaf chlorophyll content was measured on two leaves per tree using a Minolta SPAD 502 DL meter (Konica Minolta Photo Imaging U.S.A., Inc., Mahwah, NJ). On August 20, trees in all plots were evaluated subjectively for visual symptoms of leaf chlorosis. On September 10 the trees in all plots were evaluated subjectively for stem defects. The heights and diameter at breast height (DBH, 4.5 ft from ground) of all trees in each plot were measured in October of 2003 and 2004. Stem volumes (cubic feet, excluding bark and including stump and top) were calculated for each tree using an equation (Stem volume = $10^{(-2.945047+1.803973*LOG10(DBH)+1.238853*LOG10(Height))}$) developed for poplars that uses tree height and DBH (Browne 1962). To evaluate the sensitivity of the clones to soil pH, a regression analysis of leaf chlorophyll content against soil pH was separately run for each clone. If the regression analysis had a probability level of 5 percent or less, the clone was considered to be sensitive to soil pH.

2005 Procedures

In February the stand was thinned to a 10 ft by 10 ft spacing by removing every other row of trees and every other tree in the remaining rows. The stumps were painted with a 30 percent by volume 2,4D solution. On March 24, Casoron 4G at 4 lb ai/acre was broadcast for weed control. The field was irrigated and the trees were measured as previously described in 2003 and 2004.

On May 17, three log sections of OP-367 and three of Malheur 3 were sent to the Wood Materials and Engineering Laboratory at Washington State University in Pullman for wood quality testing. Each log section measured approximately 4 ft in length by 10 inches in diameter. Log sections for OP-367 were taken from 8-year-old trees at the Malheur Experiment Station. Log sections for Malheur 3 were taken from the two trees of unknown age from which the original cuttings were taken. The logs were air dried to 12 percent moisture and cut into 2-inch by 2-inch by 30-inch specimens for the flexure tests and into 2-inch by 2-inch by 6-inch pieces for the hardness tests. Flexure testing was done by incrementally applying a known load at the center of the 30-inch span and periodically recording the specimen flexure until rupture occurred. Modulus of elasticity is a measurement of the capacity of the wood to flex and to recover in response to a strain. The higher the modulus of elasticity, the more rigid the wood. Modulus of rupture is a measurement of the maximum load the wood can take before rupturing. Hardness was determined by measuring the load necessary to embed a steel sphere halfway into the specimen on the radial, tangential, and end surfaces.

2006 Procedures

On March 24, Casoron 4G at 4 lb ai/acre was broadcast for weed control. The field was irrigated and the trees were measured as previously described in 2003 and 2004.

2007 Procedures

The field was irrigated and the trees were measured as previously described.

All Years

Clonal differences in height, DBH, and wood volume were compared using ANOVA and least significant differences at the 5 percent probability level, LSD (0.05). The LSD (0.05) values at the bottom of Table 2 should be considered when comparisons are made between clones for significant differences in performance characteristics. Differences between clones equal to or greater than the LSD (0.05) value for a characteristic should exist before any clone is considered different from any other clone in that characteristic.

Results and Discussion

2004 Leaf Chlorophyll Measurements

Chlorotic leaves were observed on trees in replicates 2, 3, and 4 of the trial. The soil pH was 7.7, 8.2, 8.4, and 8.4 for replicates 1 to 4, respectively. Relative leaf chlorophyll content rankings ranged among clones from 25.8 to 49.3 percent (Table 2). For the clones sensitive to soil pH, leaf chlorophyll content decreased with increasing soil pH.

The leaf chlorophyll content of the clones insensitive to soil pH (12 clones) averaged 42.4 percent. The leaf chlorophyll content of the clones sensitive to soil pH (12 clones) averaged 31.8 percent. There was a linear relationship ($R^2 = 0.62$, $P = 0.001$) between leaf chlorophyll content and the visual rating of leaf chlorosis. The trees insensitive to soil pH averaged a subjective visual rating of leaf chlorosis of 0.52 (0 = no visual symptoms of chlorosis, 5 = very chlorotic). The trees sensitive to soil pH averaged a visual rating of leaf chlorosis of 2.15. The three *P. deltoides* selections from Malheur County had among the darkest green leaves, and leaf sizes were smaller. For the clones sensitive to soil pH, tree growth decreased with increasing severity of leaf chlorosis and with decreasing leaf chlorophyll content. For the clones insensitive to soil pH, tree growth was not related to leaf chlorosis or leaf chlorophyll content.

Subjective rating of stem defects (0 = no defects, 2 = more than half of trees have either split tops or crooked stems) ranged from 0 defects for clone 57-276 to 1.75 for clone 49-177 (Table 2).

2005 Wood Quality Analysis

Results of the wood quality tests showed that OP-367 was slightly more rigid (higher modulus of elasticity) and stronger (higher modulus of rupture) than Malheur 3 (Table 1). Malheur 3 was slightly harder than OP-367.

2007 Measurements

By November of 2007, Malheur 3, 184-401, and 59-289 had among the highest wood volume and height (Table 2). By November of 2007, clones Malheur 3, 184-401, and OP-367 had among the highest DBH. Clones Malheur 3, 184-401, PC2, and OP-367 were among the clones with the highest wood volume increment in 2007.

Clones 15-29, 50-184, 55-260, 311-93, and DTAC-7 were eliminated from the data analysis due to tree death, resulting in an inadequate number of replicates.

References

Browne, J.E. 1962. Standard cubic-foot volume tables for the commercial tree species of British Columbia. British Columbia Forest Service, Forest Surveys and Inventory Division, Victoria, B.C.

Table 1. Wood quality characteristics for clones Malheur 3 and OP-367, Malheur Experiment Station, Oregon State University, Ontario, OR.

	Clone	
Parameter	Malheur 3	OP-367
Modulus of elasticity, psi	851,300	1,123,000
Modulus of rupture, psi	6,087	7,185
Radial and tangential hardness, lb	483.9	448.3
End surface hardness, lb	795.6	585.8

Table 2. Performance of hybrid poplar clones planted on April 10, 2003 at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2007.

No.	Clone	Cross	November 2007 measurements			2007 growth increment			2004 measurements		
			Height	DBH	Wood volume	Height	DBH	Wood volume	Leaf chlorophyll content	Leaf chlorosis symptoms	Trunk defects
			ft	inch	ft³/tree	ft	inch	ft³/tree	0 - 100	0 - 5[a]	0 - 2[b]
3	50-197	P. trichocarpa X P. deltoides	23.3	4.2	0.77	0.2	0.6	0.19	30.3	3	0.3
4	52-225	P. trichocarpa X P. deltoides	28.3	4.3	0.99	1.9	0.4	0.24	26.6	3	0.5
6	56-273	P. trichocarpa X P. deltoides	22.4	3.5	0.52	0.3	0.3	0.09	40.8	1	1
7	57-276	P. trichocarpa X P. deltoides	20.2	3.7	0.54	0.6	0.4	0.13	36.3	1.8	0
8	58-280	P. trichocarpa X P. deltoides	25.9	4.9	1.16	1.8	0.8	0.37	44.4	0.8	0.8
9	59-289	P. trichocarpa X P. deltoides	30.2	4.8	1.33	1.1	0.3	0.22	42	0.5	0.8
10	184-401	P. trichocarpa X P. deltoides	32.5	5.1	1.62	4.8	0.7	0.62	34	0.5	1
11	184-411	P. trichocarpa X P. deltoides	25.2	3.8	0.70	1.3	0.7	0.23	32.4	1.5	0.5
12	195-529	P. trichocarpa X P. deltoides	20.9	4.3	0.71	-0.1	0.6	0.18	32.2	1.5	0.8
13	309-74	P. trichocarpa X P. nigra	27.9	4.6	1.16	1.4	0.6	0.28	26.3	2.8	0.8
15	NM-6	P. trichocarpa X P. maximowiczii	28.1	4.0	0.86	3.3	0.5	0.26	43.5	1.5	1.3
17	OP-367	P. deltoides X P. nigra	24.3	5.0	1.14	2.3	1.1	0.53	40.6	0	0.3
18	PC1	P. deltoides X P. nigra	28.8	4.9	1.28	1.0	0.7	0.36	45.8	0	0.3
19	PC2	P. trichocarpa X P. deltoides	26.8	4.4	0.97	5.0	1.2	0.54	45.3	0.3	0.5
20	49-177	P. trichocarpa X P. deltoides	24.9	3.7	0.81	2.3	0.6	0.34	33.5	1.5	1.8
21	Malheur 1	P. deltoides, Malheur County, OR	24.8	4.1	0.84	0.8	0.9	0.30	49.3	0	0.5
22	Malheur 2	P. deltoides, Malheur County, OR	29.2	4.2	1.00	2.2	0.4	0.25	46.7	0	0.5
23	Malheur 3	P. deltoides, Malheur County, OR	32.6	5.7	2.02	3.3	0.9	0.70	42.2	0	0.3
24	**DN-34**	P. deltoides X P. nigra	**29.6**	**4.0**	**0.99**	2.4	0.4	0.25	43.8	0.5	0.3
LSD (0.05)			5.1	0.95[c]	0.62	1.9[c]	NS	0.24[c]	8.8	1.6	0.9

[a]Subjective evaluation of leaf chlorosis on a scale of 0-5: 0 = no symptoms, 5 = very chlorotic.
[b]Subjective evaluation of trunk defects on a scale of 0-2: 0 = all trees have single tops and straight stems, 1 = less than half of trees have either split tops or crooked stems, 2 = more than half of the trees have either split tops or crooked stems.
[c]significant at 0.10 probability level.