Groof Imperial Carolina Poplar Over a Range of Soil Types in Lower Michigan

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Imperial Carolina poplar planted as agricultural windbreaks in lower Michigan achieved its best growth on light, sandy soils. With weed control and fertilizer in the first 3 years, height growth of 2 meters per year can be expected.

Imperial Carolina poplar, *P. x. euramericana Eugenei* (Simon-Louis) Schelle was recently released by the Ecological Sciences and Technology Division, U.S. Department of Agriculture, Soil Conservation Service (SCS) and the Rose Lake Plant Materials Center, East Lansing, Mich. Imperial Carolina is the name chosen for release. However, this tree (and all other Eugenei's) are clonally derived from the same original mother tree at the Simon-Louis Nursery, Plan tieresies-Metz, France. The male poplar hybrid was grown at the Plant Materials Center from cuttings originally obtained from Andrews Nursery, Fairbault, Minn., in 1955. Rooted cuttings were distributed between 1960 and 1977 (under the former common name, Norway poplar) to various Soil Conservation Districts in the Lake States and Midwest for outplantings as agricultural windbreaks. Trees were given to landowners who were willing to cooperate with the Soil Conservation Districts by following planting directions and assisting with growth and survival records for a period of 10 years. These early field planting trials, which produced some impressive growth and performance records, led to the official release of Imperial Carolina poplar by SCS in the spring of 1978.

The rapid growing male hybrid has an upright growth form resulting from a cross between *P.* x *euramericana regenerata* x *P. nigra italica* and reaches heights of 15 to 25 meters. On good sites, it usually grows 1.2 meters per year and appears to be less susceptible to various diseases and insect damage than other cultivars tested by SCS. It is considered a valuable conservation plant for use in field and orchard windbreaks and has potential for use as a shade tree or for pulp or timber production. While SCS confirms excellent growth and performance on better sites, a Food and Agriculture Organization (FAO) forestry study (2) indicates that this poplar hybrid thrives on droughty soils.

The purpose of this study was to evaluate growth and performance of Imperial Carolina poplar over a wide range of soil types, with particular emphasis on dry, sandy sites found in the central and northwestern parts of Lower Michigan. A comparison of the hybrid's growth and performance was made between dry, light soils and the heavier agriculture soils that are recommended by SCS for best growth and performance.

Materials and Methods

In July 1980, windbreak planting sites were selected for evaluation from a list of cooperating landowners furnished by the Rose Lake Plant Materials Center in East Lansing. Study area 1 consisted of six sites in Tuscola County, representing heavier loams to organic soils. Study area 2 had 10 sand and sandy loam sites located in Oceana, Grand Traverse, and Antrim counties. Background information obtained from each landowner included previous land use of planting site, site preparation before planting, date of planting, use of herbicides and fertilizer in the first 3 years, and owner observation of insect and/or disease infestations. Measurements taken in the field included average height and diameters of dominant trees and the percentage of survival based on number of trees initially planted. Physical site factors such as aspect, slope, or unusual drainage conditions were also noted. Records on climate and precipitation for the past 14 years were obtained from the U.S. Department of Agriculture, Michigan

Weather Service, for the two study areas.

Results and Discussion

Performance on loams and clay/organic soils. Study area 1 with heavier soils is located in north-central Tuscola County in Michigan's "Thumb" area near Saginaw Bay, 40 miles west of Lake Huron. The terrain is level to gently rolling; soils are predominantly loams; and the major agricultural field crop is navy beans. The surrounding lakes contribute to increased cloudiness during the fall and winter months, which moderates cold temperatures. Precipitation is well distributed throughout the year, with the growing season (140 frost-free days) receiving an average rainall of 43.18 centimeters and an average snowfall of 86.26 cenimeters. Potential moisture evaporation during the growing season exceeds average precipitation by 39 percent, yet severe drought conditions are experienced. less than 3 percent of the time.' Soil drainage in this area ranges from good to poor, depending on surface and subsoil horizons. Growth and survival on the Tuscola sites are shown in table 1.

Survival was good to excellent on the heavier soils, and growth equalled the 1.22-meter-per-year prediction of SCS on most sites. Sites 4 and 5 were planted in fallow pasture, and the soil (a sandy loam) is classed as part of the Belding series, somewhat poorly drained with a sandy surface underlain by loamy material at varying depths. Plantings were made at the same time, yet site 4 grew 1.2 meters per year, whereas site 5 grew only .6 meter per year. The planting with 50 percent less growth was in a depressed area with indications (a stand of a marsh-type grass) of reduced internal drainage (fig. 1). No

[1]Palmer Drought Index, U.S. Department of Agriculture, Michigan Weather Service, 1405 South Harrison Rd., East Lansing, MI 48823.

Table 1.—*Study area-site characteristics, growth, and survival of Imperial Carolina poplar in Tuscola County*

Site number	Soil type	Land use before planting	Initial site preparation	Use of herbicides and fertilizer'	Age of trees	Average height of dominants	Periodic annual increment	Average diameter of dominants	Percent survival
						Meters	Meters	Centimeters	
1	Loam	Orchard	Strip cultivate	Paraquat, N&K, yearly	14	14.0	1.0	20.3	98
2	Loam	Agricultural crop	Strip cultivate	2,4-D, N&K, or 3-4-6, yearly	13	14.0	1.1	20.3	100
3	Sandy loam	Agricultural crop	Strip cultivate	Atrazine, 3-4-6, yearly	6	7.6	1.3	10.2	95
4	Sandy loam	Fallow pasture	Strip cultivate	None	2	2.4	1.4	3.8	98
5	Sandy loam	Fallow pasture	Strip cultivate	None	2	1.2	0.6	X2.5	95
6	Drained muck	Marsh	Clip vegetation	None	1	0.6	0.6	X2.5	95

[1] Considerable care must be used when applying herbicides, particularly on coarse-textured soils.

Figure 1.—*Planting in areas with reduced internal drainage results in 50 percent or greater reductions in growth and often contributes to heavy mortality.*

herbicides were used to combat plant competition.

Site 6 (drained muck) had a deep surface horizon (15 to 24 cm) of rich, organic material underlain by a deep (24 to 200+ cm) clay subsoil. Here, trees grew only .6 meter the first season. No initial cultivation was done for site preparation and no herbicides were used. The owner clipped a circle about 1 meter in diameter at planting and continued clipping two or three times during the growing season. Competition was severe, as evidenced by a 1.5-meter-high stand of nettles, plus a vigorous invasion of bindweed at ground level. Such vegetation can be expected on drained muck soils with a high organic matter content. SCS plant specialists indicate better performance of Imperial Carolina poplar has been noted on similar sites where herbicides were used to combat plant competition.

Performance on sandy and loamy sand soils. Study area 2, with lighter, sandy soils, consisted of 10 sites located in sections of Oceana, Grand Traverse, and Antrim counties. All three counties border the east shore of either Lake Michigan or Grand Traverse Bay. The influence of the lake or bay is quite strong throughout most of the year. With prevailing westerly winds, spring and early summer temperatures are cooler than those farther inland, while fall and winter temperatures are correspondingly milder. Precipitation is well distributed throughout the year, with the growing season (140 frost-free days) averaging 43.16 centimeters of rainfall. Average winter snowfall for the area is

2.13 meters. Potential moisture evaporation during the growing season varies between the three counties, however, extreme drought stress conditions have been experienced less than 3 percent of the time. In Oceana County, with a potential moisture evaporation during the growing season exceeding average precipitation by 91 percent, soil moisture replenishment in fall and winter is important to agriculture in the area. Potential moisture evaporation exceeding average precipitation in Grand Traverse and Antrim Counties is 58 and 48 percent, respectively. The loamy sand soils have moderate to rapid drainage, depending on subsoil texture and structure, slope of the terrain, and depth from the surface to the water table.

Growth and survival for the northwestern Michigan sites in study area 2 are shown in table 2. Survival was excellent on light, sandy soils with the exception of site 1. This windbreak was planted adjacent to an asparagus field, which was sprayed with the herbicide Sencor for control of sand burrs. The owner attributed the extreme mortality and poor growth of remaining trees to a heavy spray drift during yearly applications. Sites 2, 3, 4, and 5 produced excellent growth on loamy sand soils, averaging 1.8 to 2.0 meters per year. On site 2, trees grew to 14.0 meters in 7 years (fig. 2) on a loamy sand, whereas the same height was reached in 14 years on a loam soil in Tuscola County. Soil on these productive sites is a Montcalm loamy sand, with moderate to rapid permeability and moderate water-holding capacity. However, depth to the water table is about 1.5 meters on these sites,[2] which should have a positive effect on available soil moisture.

[2]Information provided by the Soil Conservation District Office, Shelby, Mich.

Figure 2.—*Trees reached heights of 14.0 meters in 7 years on a loamy sand on site 2.*

Table 2.—*Study area 2-site characteristics, growth, and survival of Imperial Carolina poplar in Oceana, Grand Traverse, and Antrim Counties*

Site number	County	Soil type	Land use before planting	Initial site preparation	Use of herbicides and fertilizer[1]	Age of tree	Average height of dominants	Periodic annual increment	Average diameter of dominants	Percent survival
							Meters	*Meters*	*Centimeters*	
1	Oceana	Sand	Agricultural crop	Strip cultivate	Sencor, yearly	6	3.6	0.6	7.6	25[2]
2	Oceana	Loamy sand	Orchard	Strip cultivate	Paraquat, N&K, yearly	7	14.0	2.0	15.2	100
3	Oceana	Loamy sand	Orchard	Strip cultivate	Cultivation, N&K, yearly	6	10.6	1.7	12.7	100
4	Oceana	Loamy sand	Orchard	Strip cultivate	Paraquat, N&K, yearly	6	10.6	1.7	12.7	100
5	Oceana	Loamy sand	Orchard	Strip cultivate	Paraquat, N&K yearly	2	3.6	1.8	6.3	100
6	Grand Traverse	Loamy sand	Agricultural crop	Strip cultivate	Atrazine, 6-24-24, yearly	2	3.3	1.6	6.3	100
7	Grand Traverse	Loamy sand	Fallow pasture	Strip cultivate	None	2	1.3	0.6	2.5	90
8	Grand Traverse	Loamy sand	Fallow pasture	Strip cultivate	None	2	0.6	0.3	2.5	90
9	Antrim	Loamy sand	None	None	None	2	0.4	0.2	2.5	90
10	Antrim	Loamy sand	None	None	None	1	0.3	0.3	2.5	90

[1]Considerable care must be used when applying herbicides, particularly on coarse-textured soils.
[2] Severe mortality due to drift from Sencor herbicide.

Four other loamy sand sites (sites 7 through 10) showing very poor growth and performance have particular site conditions that appear to have a direct effect on tree performance. Two former fallow pasture plantings (sites 7 and 8), averaging 1.4 and 0.6 meters in growth in 2 years, were planted on a Menomiee loamy sand with rapid permeability and slopes of 40 percent. These two plantings occurred near the top and on the southeast (driest) side; no surface horizon was evident; and ground cover consisted of lichens and a few annuals. Growth was 0.3 meter per year. On the west side, quackgrass was the dominant vegetation, and growth was 0.7 meter per year. While growth was still poor, the west slope apparently had more soil moisture. Site 9, with only a .2-meter-per-year growth, was on a west-facing, 40-percent slope, on an Emmet loamy sand with a seasonally high water table within 0.6 to 1.2 meters of the surface in winter and spring. This site is subject to high winds off Grand Traverse Bay and is usually kept free of protective snow cover. The poplars were planted during the summer of 1978, and during the severe 1978-79 winter, they suffered numerous frost cracks on the main stems. Cytospora (*Cytospora* spp.) cankers, which apparently fol-

lowed frost damage, were identified during field examination. Site 10 was planted in a thick stand of quackgrass with no initial site preparation and no care during the first growing season. Growth was only 0.3 meter in 1 year.

Summary and Conclusions

Best growth of Imperial Carolina poplar was achieved on light, loamy sand soils receiving yearly weed control and fertilizer applications. On these sites, growth averaged 1.7 to 2.0 meters per year. Growth was somewhat less on heavier, loam soils, but equalled the exceptional growth (1.2 m/year) identified by the SCS. With one exception, these sites also received yearly weed control and fertilizer. Poorest results appear to be associated with site factors other than soil texture. On all soil types observed, failure to provide initial site preparation and lack of subsequent weed control, at least in the first one to three growing seasons, caused height growth reductions to as low as 0.3 to 0.7 meter per year. This was indicated by severe vegetative competition on these sites. The effects of fertilization are only implied and not directly observable. In recent poplar fertilization studies, however, Einsphar and Wycoff (1) have shown that nitrogen and phosphorus are most effective in increasing and maintaining growth. The sites with the best growth of Imperial Carolina poplar occurred on orchard or crop sites receiving regular applications of nitrogen and phosphorus before and after planting poplar cuttings. In contrast, the majority of poor growth sites were former fallow fields where fertility probably limited growth. Plantings made on steep slopes, either east-facing or west-facing and wind-swept, where water drainage is excessive, did not produce favorable results. One of these sites (site 9, study area 2) had the only incidence of stress-induced disease.

A survey was made of average precipitation on the two study areas over the last 15 years, using Michigan Weather Service records. Precipitation has been heavier than normal for the majority of these years. This situation could have contributed to the better performance on the lighter soils. However, there were severe drought conditions in 1977 and only normal precipitation in 1978 and 1979. Plantings made on sandy soils in the latter 2 years still achieved growth of 1.7 and 1.8 meters per year when treated with herbicides and fertilizers. No comparable plantings were made on the heavier soils during those years in this study.

This study suggests three factors, which appear to be essential to the successful establishment and growth of Imperial Carolina poplar: (1) adequate internal soil drainage, with depth from the surface to the water table equal to or greater than 1.5 meters, (2) site preparation with weed control and fertilization in the first 1 to 3 years, and (3) avoidance of steep, droughty, climatically stressed sites.

Literature Cited

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