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CUTTING DIAMETER INFLUENCES EARLY SURVIVAL AND GROWTH OF SEVERAL *POPULUS* CLONES

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ABSTRACT.—The effects of cutting diameter on early survival and growth of several *Populus* clones were studied in field tests in Wisconsin and Michigan. Generally, large diameter cuttings survived and grew better than small diameter cuttings. Response differences among clones were evident.

KEY WORDS: vegetative propagation; tree plantations; dormant hardwood cuttings.

Plantations of fast-growing clones of *Populus* hybrids and selections in the sections of Aigeiros and Tacamahaca are most efficiently established by planting dormant cuttings from 1-year-old stems. These clones possess preformed root primordia that enable them to root and grow when planted on favorable sites (Shapiro 1958, Smith and Wareing 1974). However, to obtain best survival and growth it is necessary to select the most vigorous cutting material. Because the factors responsible for cutting vigor are not well defined or understood, the propagator or nursery manager must rely on a variety of criteria such as stem age, collection time, overall appearance, and dimensions to collect the best material.

The possible correlation between cutting diameter and establishment success has been investigated only to a limited extent in *Populus*. Generally, it has been found that small diameter cuttings obtained from the tip portions of shoots have fewer preformed root primordia (Smith and Wareing 1974) and do not root or grow as well as those from basal portions (Bloomberg 1959, 1963, Hartmann and Kester 1975, Ying and Bagley 1977). However, overall results of this kind of research seem to have been inconsistent.

To determine the importance of cutting diameter on early field performance of some promising *Populus* clones, we studied the effect of a range of diameter classes on first-year survival and shoot growth at two locations in the Lake States.

MATERIALS AND METHODS

Two separate studies were begun in 1978— one in northern Wisconsin at the North Central Forest Experiment Station's Harshaw Experimental Farm near Rhinelander, Wisconsin, and the other in East Lansing, Michigan, at the Michigan State University Tree Research Center.

Data from both experiments were subjected to analysis of variance. Means from the Rhinelander study were compared using the method of Newman and Keuls and means from the East Lansing study were compared using the Least Significant Difference method (Snedecor and Cochran 1967).

Rhinelander Study

The three clones selected for the Rhinelander study were *Populus* cv. 'Betulifolia' x *P. trichocarpa* Torr. & Gray (NE 299);[1] *Populus nigra* L. x *P. laurifolia* Ledeb. (NE 1), and *Populus tristis* Fisch. x *P. balsamifera* L. cv. 'Tristis #1' (NC 5260). One-year-old coppice shoots of each clone were collected in January and cut into 20 cm lengths. The cuttings were then sorted into diameter classes of <6, 6, and 9 to 16 mm (measured in the middle of the cutting), sealed in heavy polyethylene bags, and stored at 2.8°C until planting.

On June 20, the cuttings were hand planted about 15 cm deep in a fertile, sandy loam soil in an area prepared by discing. Cuttings were planted 0.3 m apart within the row; rows were 0.6 m apart. The design was a randomized complete block design with 20 cuttings of a diameter class in each of 3 replications. Plots were hand weeded and irrigated as needed. Survival and shoot height were recorded for the various treatments at the end of the first growing season on September 21.

East Lansing Study

The three clones selected for the East Lansing study were *Populus* cv. 'rasumowskyana' x *P.* cv. 'incrassata' (NE 58); *Populus* x *euramericana* (Dode) Guinier cv. 'I45/51' (NC 5328), and *Populus deltoides* Bartr. x *P.* cv. 'caudina' (NE 353). Hardwood cuttings 25 cm long were harvested from 1-year-old coppice shoots in March and stored in polyethylene bags with moist sphagnum moss at 2°C. Cuttings were sorted into small-end diameter classes just before planting as follows: <6, 6 to 10, 10 to 13, 13 to 16, and 16 to 19 mm.

Cuttings were hand planted about 23 cm deep in nursery beds on June 30 and July 3. The sandy loam soil was rototilled several times before planting. Cuttings were planted at 0.3 by 0.6 m spacing in a split plot, randomized block design with eight cuttings per plot and four replications. Plots were hand weeded and irrigated as needed. Three weeks after growth began, each cutting was pruned to just one shoot. Plants were sprayed once with the insecticide Sevin in mid-August to control the cottonwood leaf beetle (*Crysomela scripta*). Height and survival of shoots were measured every 2 weeks beginning on July 21. On September 25, shoots of two trees from each treatment combination were randomly selected, harvested, oven-dried at 70°C, and weighed.

RESULTS AND DISCUSSION

In both the Rhinelander and East Lansing studies, cutting survival and shoot length growth were significantly influenced by cutting diameter (tables 1 and 2). In general, large diameter cuttings survived better and produced taller shoots than small diameter cuttings. Large diameter cuttings also produced shoots with a greater dry weight than small diameter cuttings in the East Lansing study (table 2).

Clones differed distinctly in their response to cutting diameter. For example, clone NC 5328 showed 100 percent survival regardless of the size of cuttings, whereas clone NC 5260 showed only 38 percent survival of small diameter cuttings and 93 percent survival of large diameter cuttings. The contrast in these two clones is also shown by the shoot length data. The difference in shoot growth between large and small cuttings for clone NC 5328 averaged only 14 percent but for clone NC 5260 was 250 percent. The four other clones represented a spectrum of intermediate responses. The ranking of clones, based on response to cutting diameter, showed clone 5260 most responsive followed by NE 1, NE 299, NE 58, NE 353, and NC 5328. These results are in accordance with Bogdanov (1968), who showed substantial variation in the survival and growth response to cutting diameter among six Populus clones.

Differences in height between cuttings of various diameters for the three clones used in the Michigan experiment were recorded from July 21 onward (fig. 1). In general, shoots from small cuttings were ⅓ to ⅔ as tall as those from large cuttings during the first 5 weeks after planting. This is the period when unrooted cuttings are most susceptible to environmental stress and weed competition (Aird 1962, Schreiner 1945). The sooner cuttings become established and gain dominance over weed competition, the greater will be the first-year success of a plantation.

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[1]*Northeastern Forest Experiment Station (NE) numbers are used where possible to designate clones mentioned in the text. Otherwise, North Central Forest Experiment Station (NC) numbers are used. NE 1 = NC 5272; NE 299 = NC 5331.*

Table 1.—*Effect of cutting diameter on survival and shoot length of hardwood cuttings of three* Populus *clones after 13 weeks growth in Rhinelander, Wisconsin*

Cutting Diameter (mm)	Clone[1] NC 5260 Survival	NC 5260 Shoot length	NE 1 Survival	NE 1 Shoot length	NE 299 Survival	NE 299 Shoot length
	Percent	*cm*	*Percent*	*cm*	*Percent*	*cm*
<6	38 c	14 c	43 b	56 c	57 b	39 b
6	63 b	26 b	85 a	68 b	77 ab	50 ab
9-16	93 a	35 a	93 a	95 a	95 a	58 a

[1]For each clone, means followed by the same letter are not significantly different at the 5 percent probability level (Newman-Keuls test).

Table 2.—*Effect of cutting diameter on survival and shoot growth of three* Populus *clones 11 weeks after planting in East Lansing, Michigan*

Cutting diameter (mm)	Clone[1] NE 58 Survival	NE 58 Shoot length	NE 58 Shoot dry weight	NE 353 Survival	NE 353 Shoot length	NE 353 Shoot dry weight	NC 5328 Survival	NC 5328 Shoot length	NC 5328 Shoot dry weight
	Percent	*cm*	*g*	*Percent*	*cm*	*g*	*Percent*	*cm*	*g*
<6	69 a	54 a	16 a	97 a	98 a	25 a	100 a	65 a	28 a
6-10	88 b	61 b	18 a	100 a	102 a	36 ab	100 a	69 ab	26 a
10-13	97 bc	70 c	21 ab	100 a	90 a	33 a	100 a	73 bc	28 a
13-16	100 c	71 c	22 ab	100 a	115 b	50 b	100 a	74 c	34 ab
16-19	97 bc	80 d	28 b	—	—	—	100 a	74 c	39 b

[1]For each clone, means followed by the same letter are not significantly different at the 5 percent probability level (least significant difference).

In the present experiments the difference in growth rate between cuttings of various diameters was less after the first 5 weeks (fig. 1). However, if weeds had not been controlled or if supplemental water were not applied, differences in growth rate between cuttings of various sizes probably would have been greater. Again, contrasts between clones were evident. Clone NE 58, which was moderately responsive to cutting diameter, showed differential growth throughout the first 7 weeks, whereas the unresponsive clone NC 5328 evidenced little effect of cutting size on growth after the first 5 weeks. Clone NE 353 showed a more complex growth response but was generally intermediate between NE 58 and NC 5328.

CONCLUSIONS

Establishment of plantations of *Populus* hybrids showing high survival and good growth requires that many conditions be met, one of which is to use high quality hardwood cutting stock. An important measure of cutting quality revealed by this study is diameter— survival and growth generally increase with increasing cutting diameter. Although clones differed in their response to cutting diameter, cuttings <6 mm average diameter of all *Populus* clones should not be used for field plantings.

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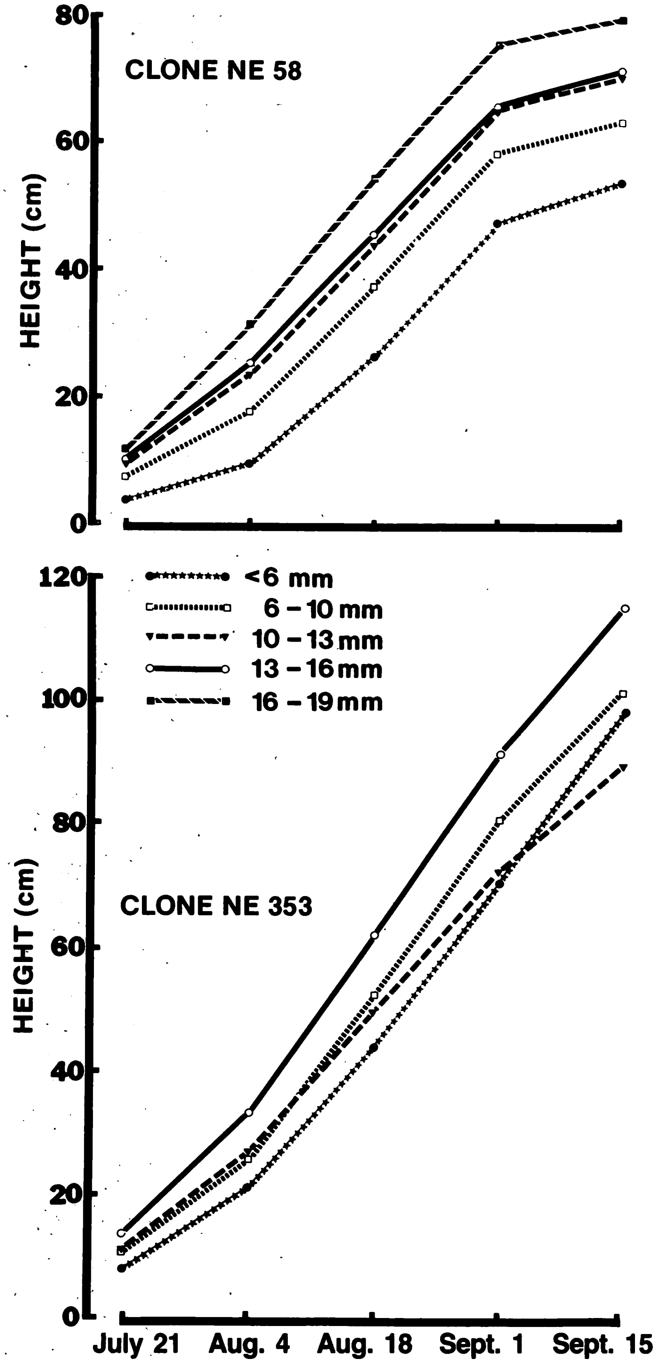

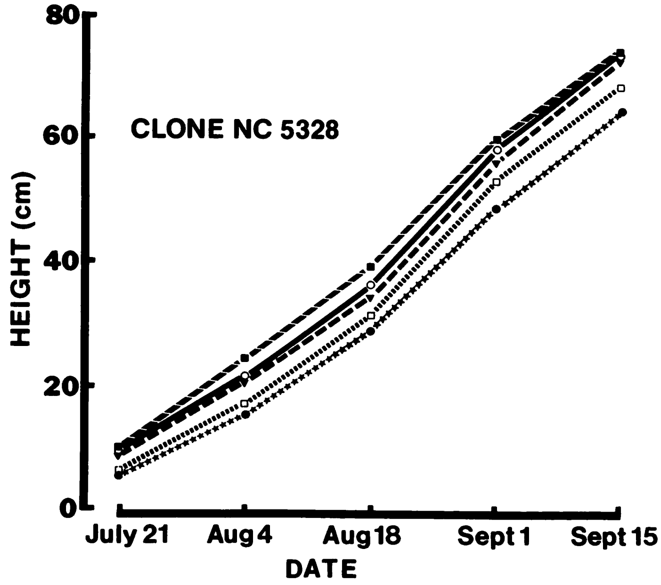

Figure 1.—*The effect of cutting diameter on height growth of three Populus clones during the first 11 weeks after planting in East Lansing, Michigan.*

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