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ASPEN SUCKER PRODUCTION AND GROWTH FROM OUTPLANTED ROOT CUTTINGS

Donald A. Perala, *Silviculturist,*
Grand Rapids, Minnesota

ABSTRACT.—Aspen suckers from 1-m-long root cuttings survived and grew better than those from 12.5-cm-long cuttings. Sucker survival and growth were also inversely related to parent root diameter. Discusses the practical implications for aspen management.

OXFORD: 231.5:161.4:176.1. *Populus tremuloides.* KEY WORDS: *Populus tremuloides,* regeneration, propagation, planting, site-preparation.

Suckering is a major regeneration mode of quaking aspen (*Populus tremuloides* Michx.). With rare exception, aspen will not sucker appreciably until (1) the flow of inhibitory auxin from apical meristems to roots is interrupted (Farmer 1962)—which occurs when the bole or roots are severed—and (2) the root temperature is raised above some critical level (Maini and Horton 1966).

Studies have shown that the number of suckers produced is governed by hormones (Eliasson 1971), and that initial sucker growth is dependent on stored carbohydrate reserves (Schier and Zasada 1973, Steneker 1972, Zasada and Schier 1973).

Full growth potential of new aspen sucker stands is further dependent on an intact parent root system. Zahner and Debyle (1965) found that parent roots of *Populus grandidentata* (Michx.) (especially those distal to the sucker) contributed more to sucker growth than did new roots until about age 25. Sectioning of parent roots appears to reduce sucker growth (Sandberg 1951, Steneker and Walters 1971).

Most quaking aspen suckers arise from parent roots less than 2.5 cm in diameter (Farmer 1962, Maini 1968a, Sandberg 1951), but it is not clear if large-diameter parent roots are poor sucker producers, or if they are simply less abundant.

To determine more about the relations between sucker growth and parent root systems, I outplanted long (1 m) and short (12.5 cm) quaking aspen root cuttings of varying diameter.

Survival, height growth, and biomass of the suckers were measured over a 6-year period, and the feasibility of establishing aspen by outplanting root cuttings was evaluated.

METHODS

On May 8 and 9, 1972 (about 10 days prior to bud burst), six 1-m root cuttings free of serious injury or defect were taken from one average tree in each of 10 widely separated mature, well stocked good site aspen stands in Cass and Itasca Counties, Minnesota. Root cuttings from each tree were relatively uniform in diameter but varied significantly between trees. There was no significant correlation of root diameter with any tree characteristic. Three of these six cuttings selected at random were immediately clipped into eight 12.5-cm cuttings to prevent polar redistribution of auxin (Maini 1968b). The cuttings were kept moist and cool during transport, and stored at 4C until outplanted. On May 26, 1972, the outplanting site (a former agricultural field) was prepared with a rototiller. After all fine roots were trimmed for the sake of uniformity, the cuttings were washed, blotted dry, and weighed. Because of within-cutting variation in diameter due to swellings and taper, average diameters were estimated from average cutting weight based on an independently determined relation of 58 g fresh weight per square centimeter cross-sectional area per meter length. Most of the cuttings exhibited sucker primordia, often clustered at swellings. A few primordia had already formed suckers up to 2 cm long. On May 30, the cuttings were planted horizontally at a depth of 2 to 3 cm, lightly mulched with straw to retard moisture loss, and thoroughly watered.

All cuttings from a tree were planted 0.5-m apart in adjacent 1.5-m^2 plots; long cuttings in one plot and short cuttings in the other. The short cuttings were laid end to end to make three 1-m aggregate lengths. Twenty-nine surplus short root cuttings were planted in sand in a greenhouse and automatically watered twice daily.

A maximum-minimum recording thermocouple installed at cutting depth showed the 1972 summer had favorable soil temperatures for sucker initiation (12.7 to 28.6C). Rainfall (26 cm) was generally adequate; however, irrigation (0.4 cm) was needed on both June 27 and July 6. During the first three summers, the plots were hand-weeded. Suckers were counted bi-weekly during 1972, weekly in 1973, and at the end of the 1974-1977 growing seasons. Survivor heights were measured after each summer; d.b.h. was measured in 1977.

The data were statistically analyzed using one-way analysis of variance or multiple regression, as appropriate. Logarithmic or square-root transformations were used to obtain homogeneous variance.

RESULTS AND DISCUSSION

Suckers began to emerge 14 days after outplanting and continued to come up rapidly through the third week of July (fig. 1). Suckering then quickly decreased. Although the first three suckers arose from the short cuttings, suckers emeraged faster from the long cuttings . However, total numbers of suckers on both cutting lengths were equal at the end of the first growing season. Five additional suckers were produced by long cuttings during the second year, while none emerged from the short cuttings. The number of suckers did not vary significantly by cutting diameter, except that fewer were produced on short cuttings greater than 2.5 cm diameter (table 1).

Suckers began to die 20 days after the first ones appeared. Most mortality on short cuttings occurred during the first year. Loss of suckers on long cuttings was more gradual and for the most part was evenly distributed from July 1972 to September 1974. Overall, cutting length significantly affected survival; this was mostly accounted for by the highest survival on long cuttings less than 1.6 cm diameter (table 1). Neither long nor short cuttings greater than 2.5 cm diameter had any survivors.

In the green house, 41 suckers emerged (many more were initiated but did not reach the sand surface) but only 6 survived. Excavation of all these cuttings after 67 days revealed that only the survivors had initiated root systems.

The percentage of long cuttings with suckers declined from 80 percent after the first year to 30 percent after the sixth year, and for short cuttings, from 53 to 17 percent (table 2). These calculations are on a per meter cutting bases. If individual short cuttings are considered ($3\times10\times8=240$), only 2.1 percent of them had surviving suckers after the sixth year.

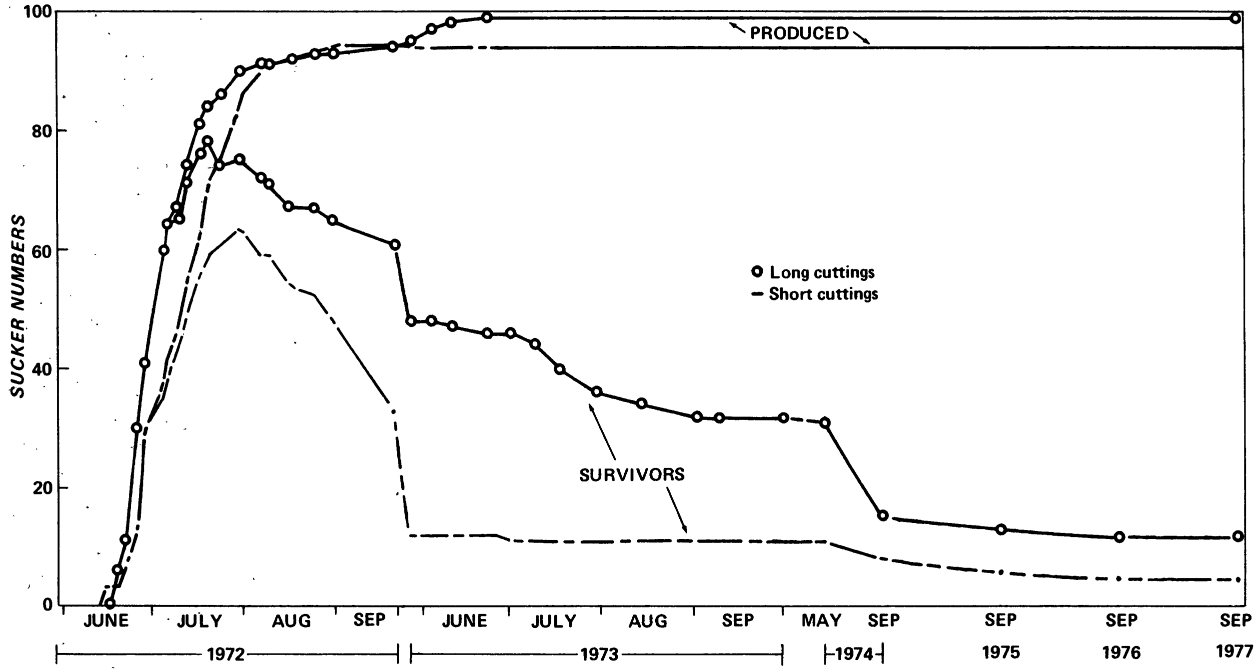

Figure 1.—*Accumulated production and survival of quaking aspen suckers on long and short root cuttings (cutting diameters combined). Note change in seasonal scale after 1973.*

Height growth of dominant suckers surviving the study period was significantly greater (5 percent level) for long cuttings (fig. 2). Sucker biomass and d.b.h. after 6 years tended to vary directly with cutting length and inversely with cutting diameter, although not significantly (table 3).

The sucker production from long and short cuttings supports other findings that sucker production is independent of cutting length (Schier 1978, Steneker and Walters 1971). On the other hand, sucker growth was much better on long cuttings than on short ones, presumably because long cuttings have a greater store of available carbohydrates (Schier and Zasada 1973, Steneker 1972, Zasada and Schier 1973).

Table 1.—*Total aspen sucker production and 6-year survival by cutting length and diameter*

(In numbers per meter)

Cutting	Total sucker production		6-year survival	
diameter (cm)	Long cuttings	Short cuttings	Long cuttings	Short cuttings
<1.6	2.80 a[1]	3.88 a	0.88 c	0.25 d
1.6-2.0	3.14 a	3.38 a	.43 cd	.25 d
2.1-2.5	3.00 a	3.10 a	.50 cd	.10 d
>2.5	3.73 a	0.25 b	.00 d	.00 d
Mean[2]	3.30	3.13	.40	.17

[1]Values followed by the same letter are not statistically different ($p<0.05$).

[2]Overall means differ from column means due to unequal number of observations per cutting diameter class.

Table 2.—*Cuttings (1-m basis) with surviving suckers 1 and 6 years after planting, and by cutting length and diameter*

(In percent of cuttings)

Cutting	First year		Sixth year	
diameter (cm)	Long cuttings	Short cuttings	Long cuttings	Short cuttings
<1.6	100	75	63	25
1.6-2.0	71	50	29	25
2.1-2.5	75	60	50	10
>2.5	73	0	0	0
Mean[1]	80	53	30	17

[1]Overall means differ from column means due to unequal number of observations per cutting diameter class.

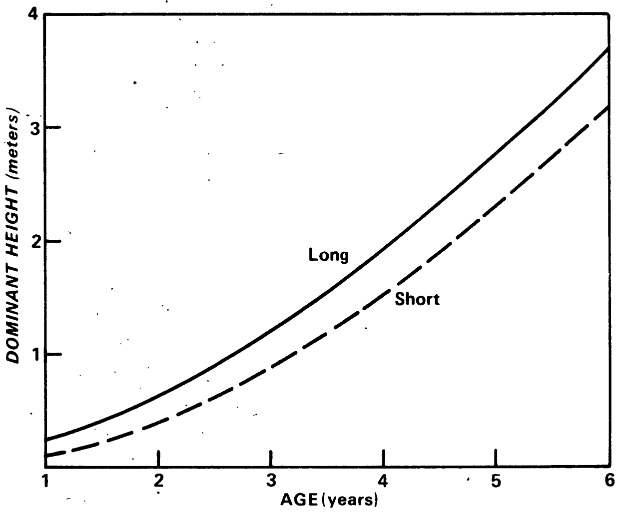

Figure 2.—*Mean height growth of dominant suckers on long and short quaking aspen root cuttings.*

Table 3.—*Sixth-year sucker measurements by root cutting length and diameter*

Cutting diameter (cm)	Mean sucker biomass[1] Long cuttings	Mean sucker biomass[1] Short cuttings	Mean sucker d.b.h. Long cuttings	Mean sucker d.b.h. Short cuttings
	------------- grams -------------		---------- centimeters ----------	
<1.6	421	301	2.4	1.9
1.6-2.0	280	63	2.0	1.1
2.1-2.5	243	159	1.9	1.6
>2.5	0	0	0	0
Mean[2]	389	177	2.2	1.5

[1]Biomass calculated according to Zavitkovski (1971), based on a biomass index of d^2h, where d is dbh (cm) and h is tree height (m).

[2]Overall means differ from column means due to unequal number of observations per cutting diameter class.

The reason for poorer production, survival, and growth of suckers from cuttings with greater diameters (particularly short cuttings) is not known.

CONCLUSIONS

This study provided further evidence that disruption of the parent root system can be detrimental to the establishment and growth of aspen suckers. The practical implication is that disking or roller-chopping are questionable practices for regeneration of aspen sucker stands. The best silvicultural practices in aspen appear to be those that leave the parent root system intact.

Establishment of aspen by planting root cuttings is inefficient because of the extremely low ratio of suckers established per unit length of cutting. Survival of suckers under field conditions is extremely poor, even with site preparation and control of competing vegetation. Efficient greenhouse techniques to vegetatively propagate large numbers of suckers from a minimum of root cuttings have been developed by Starr (1971) and Zufa (1971), although little is known of their survival after outplanting.

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