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Aspen Root Suckering in Alaska: Effect of Clone, Collection Date, and Temperature

Many of the aspen (*Populus tremuloides* Michx.) stands in Alaska originated from root suckers after the parent stands were destroyed by fire (Lutz, 1956; Gregory and Haack, 1965). Although there has been extensive research in other parts of the species range on the capacity for aspen to sucker, there has been no research conducted on Alaskan genotypes. To obtain this basic information, initial sucker development on excised roots from three Alaskan clones as affected by date of collection, clone, and temperature was examined.

Materials and Methods

Three aspen clones located about 15 miles west of Fairbanks, Alaska (latitude 64°51'N, longitude 147°44'W), were selected for this study (Table 1). They were growing

TABLE 1. Stand data for study clones. Average of dominant and codominant trees.

Clone	Stem age (yrs)	D.b.h. ¹ (cm)	Height (m)
1	57	12.7	17.4
2	60	17.0	22.2
3	53	19.8	20.4

¹ Diameter at breast height, 1.37 m.

on south-facing slopes of the Yukon-Tanana Upland; soils on the three sites are derived from loess parent material. Stands 1 and 2 were defoliated one or more times from 1965 to 1968 by the large aspen tortrix (*Choristoneura confictana* Walker); stand 3 was completely defoliated from 1966 to 1968. Partial refoliation had generally occurred by mid-August in these years (Beckwith, 1968).

Root samples were collected four times during 1970: June 26, July 28, August 31, and October 2. The first collection was 31 days after bud break and the last, 14 days after leaf fall. Each collection consisted of 60 8-cm aspen root segments which were 1 to 2 cm in diameter. These segments were thoroughly washed and their ends dipped in paraffin prior to planting in a perlite-vermiculite (1:1) medium.

The samples for each clone were subdivided into 12 replications and planted in trays. Each tray contained five root segments from each clone. The 12 trays were divided into three groups of four and incubated in darkness at three temperature regimes: (maximum/minimum °C) 20/10°C; 25/15°C; and 30/20°C. These regimes consisted of six hours at maximum and minimum temperatures, seven hours of steadily increasing temperature (minimum to maximum), and five hours of decreasing temperature (maximum to minimum). Temperature ranges in the growing medium were 18/9°, 23/14°, and 28/19° (maximum/minimum).

The trays were examined at two- to three-day intervals and a record kept of sucker numbers appearing at the surface of the growing media. The trays were also watered when necessary. After 42 days, the root segments were removed from the growing medium, the number of suckers 5 mm and longer recorded, and the dry weight of suckers determined. Analysis of variance was used to determine if time of collection, clone, or temperature treatment had a significant effect on number or dry weight of suckers per cutting.

Results and Discussion

Collection date had a significant effect ($p=0.05$) on both numbers and dry weight of suckers per cutting (Table 2). Clone 3 produced its greatest number of suckers from roots collected on June 26, while clones 1 and 2 produced their greatest numbers from either August 31 or October 2 roots. Generally, seasonal trends in dry weight indicated that sucker growth reached a peak in late summer or fall, probably in response to the buildup in carbohydrate reserves (Kozlowski and Keller, 1966). Number of suckers does not follow weight trends because number is regulated by hormones (Eliasson, 1971).

Differences between clones in number and dry weight of suckers were significant. With only minor exceptions, clone 3 was superior to clones 1 and 2 in its response to the three temperature treatments (Table 2). Number and dry weight of clone 3 suckers were, in some cases, three to five times greater than the next most productive clone. Also, suckers from clone 3 were the first to appear at the surface of the growing media (Table 3). Maini (1968) and Tew (1970), studying suckering in Ontario and Utah, respectively, reported clonal differences in number of suckers.

Clonal differences can be explained by a combination of genetic and physiological variables. The nature of this variation has been covered by others (e.g., Barnes, 1966, 1969; Farmer, 1962; Tew, 1970; Schier and Johnston, 1971). The occurrence of preformed primordia on aspen roots and their importance in sucker production, however, has not been well covered. When collected, roots of clone 3 were observed to have approximately four and two times more primordia than the roots of clones 1 and 2, respectively. Thus, superior sucker development on clone 3 roots could have been predicted by a count of primordia. Schier¹ presents a detailed discussion and description of these primordia.

Temperature had a significant effect on number and dry weight of suckers; sucker development was poor in the 20/10°C regime (Table 2). Comparison of treatments at 25/15°C and 30/20°C shows that only differences in dry weight were significant. Development, as determined by dry weight and time elapsed before appearance of the

¹ In preparation; tentatively titled, "Origin and Development of Aspen Root Suckers."

TABLE 2. Average number of suckers and dry weight of suckers after 42 days' incubation.

Clone	Collection date and temperature treatment (°C)														
	June 26		July 28		Aug. 31		Oct. 2		20/10 ¹		30/20				
	20/10	25/15	30/20	20/10	25/15	30/20	20/10	25/15	30/20	20/10	25/15	30/20	20/10	25/15	30/20
Number of suckers															
1	2.7	8.1	5.1	0.1	2.6	2.0	0.4	9.4	11.3	—	—	—	—	—	—
2	0.5	1.9	0.6	0.7	3.5	2.2	0.2	1.3	2.6	—	—	—	—	—	—
3	1.5	18.8	20.8	0.8	12.6	10.6	1.8	13.4	14.8	—	—	—	—	—	—
Dry weight of suckers (mg)															
1	10	169	104	>1	50	140	3	223	296	—	—	—	—	40	149
2	2	49	15	8	196	153	>1	35	304	—	—	—	—	224	355
3	6	283	351	4	206	339	8	307	444	—	—	—	—	363	432

¹ Treatment discontinued because of faulty equipment.

TABLE 3. Time span, in days, between planting and appearance of first suckers above growing medium. Values represent average of four replications.

Sample date	Temperature Treatment					
	25/15°C			30/20°C		
	Clone 1	Clone 2	Clone 3	Clone 1	Clone 2	Clone 3
June 26	22	21	20	20	0 ¹	13
July 27	28	24	26	26	26	22
Aug. 31	29	33	22	23	24	17
Oct. 2	32	29	19	31	23	17

¹ No suckers appeared above medium in this treatment.

first suckers (Table 3), was generally better in the 30/20°C treatment. However, there was evidence that clones responded differently to temperature treatment and that the optimum temperature for sucker production of a single clone varied with time of collection. For example, for clone 2, roots collected on June 26 and July 28 produced the greatest dry weight of suckers at 25/15°C, while roots collected August 31 and October 2 produced the greatest dry weights at 30/20°C. This result was in contrast to that for clone 3 which, in all cases, produced maximum sucker dry weights at the higher temperature regime. Maini (1968) also observed clone x temperature interactions in the development of aspen root suckers. He reported that number of suckers was greatest at a constant temperature of 16°C, decreased somewhat at 22°C, and then declined rapidly at higher temperatures. Working with a single clone, Maini and Horton (1966) found that, in a range of constant temperatures from 14° to 30°C, the greatest number and growth of suckers occurred at 24°C. Apparently temperatures higher than about 23°C are inhibitory if held constant. However, they are not inhibitory when part of a temperature regime which includes lower temperatures (e.g., 25/15°C and 30/20°C).

The poor response at the 20/10°C treatment was due to the slow rate of metabolic process at these low temperatures. Although the process is slow, suckers will eventually develop at low temperatures. Although no suckers developed on root segments from three clones after 42 days at a 15/5°C, 8/16 hr, regime, suckers developed when the incubation period was extended. After 120 days, the number of suckers produced was 10 to 25 percent of that produced by a 25/15°C regime at 42 days.²

The inhibiting effect of low temperature on root suckering is probably an important reason aspen stands do not thrive on cooler eastern and western exposures. In interior Alaska aspen stands are found chiefly on southern exposures (140-240°) (Gregory and Haack, 1965) which are the warmest, driest sites in this subarctic region. Aspen may be limited to these sites because soil temperatures are suitable for vegetative reproduction. For example, average daily maximum/minimum temperatures 5 cm below a mineral soil surface on an open, south-facing slope during June and July of 1971 were 23/15°C; the highest temperature observed was 27°C.³ This temperature range resulted in good initial sucker development in this study.

In conclusion, the results of this study support evidence found elsewhere that clone

² Unpublished data on file at Forestry Sciences Laboratory, Logan, Utah.

³ Unpublished data on file at Institute of Northern Forestry, Fairbanks, Alaska.

and date of collection are important factors in sucker development in aspen. Additionally, the data indicate that both number and dry weight of suckers should be determined in evaluating the capacity of aspen clones to produce suckers.

Acknowledgments

The authors thank Donald Lovig for assistance during this project.

Literature Cited

- Barnes, B. V. 1969. Natural variation and delineation of clones of *Populus tremuloides* and *P. grandidentata* in northern lower Michigan. *Silvae Genet.* 18:130-142.
- . 1966. The clonal growth habit of American aspens. *Ecology* 47:439-447.
- Beckwith, R. C. 1968. The large aspen tortrix, *Choristoneura conflictana* (Wlkr.) in interior Alaska. USDA Forest Serv. Res. Note PNW-81. 10 pp. Pac. Northwest Forest & Range Exp. Stn., Portland, Oreg.
- Eliasson, L. 1971. Growth regulators in *Populus tremula*. III. Variation of auxin and inhibitor level in roots in relation to root sucker formation. *Physiol. Plant* 25:118-121.
- Farmer, R. E., Jr. 1962. Aspen root sucker formation and apical dominance. *Forest Sci.* 8:403-410.
- Gregory, R. A., and P. M. Haack. 1965. Growth and yield of well-stocked aspen and birch stands in Alaska. USDA Forest Serv. Res. Pap. NOR-2. 28 pp.
- Kozłowski, T. T., and T. Keller. 1966. Food relations of woody plants. *Bot. Rev.* 32:293-382.
- Lutz, H. J. 1956. Ecological effects of forest fires in the interior of Alaska. U.S. Dept. Agr. Tech. Bull. 1133. 121 pp.
- Maini, J. S. 1968. Silvics and ecology of *Populus* in Canada. In J. S. Maini and J. H. Cayford, eds., Growth and utilization of poplars in Canada. Can. Dept. Forest. & Rural Dev. Forest Br. Pub. 1205, pp. 20-69.
- , and K. W. Horton. 1966. Vegetative propagation of *Populus* spp. I. Influence of temperature on formation and initial growth of aspen suckers. *Can. J. Bot.* 44:1183-1189.
- Schier, G. A., and Johnston, R. E. 1971. Clonal variation in total nonstructural carbohydrates of trembling aspen roots in three Utah areas. *Can. J. Forest. Res.* 1:252-255.
- Tew, R. K. 1970. Root carbohydrate reserves in vegetative reproduction of aspen. *Forest Sci.* 16:318-320.

Received September 19, 1972.

Accepted for publication December 21, 1972.