Catkin Growth, Seed Production, and Development of Seed Germinability in Quaking Aspen in Central Alberta

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*Initial release of seeds of quaking aspen (*Populus tremuloides *Michx.) differed by 2.5 weeks between 1984 and 1988 but began in both years when catkin moisture content was less than 70%. Germinability of freshly extracted seed increased as the collection date approached the time of release. Artificial ripening increased germination speed of seed collected 8 days before a release*. Tree Planters' Notes 40(20):25-29; 1989.

Populus tremuloides Michx., quaking aspen, is a widespread tree of northern and western North America and has become important as a source of fiber (1). *P. tremuloides* may be readily propagated from adventitious shoots (suckers) arising from large lateral roots (7) or via tissue culture (9), but propagation by seed may be a desired alternative for purposes of research or reforestation (3, 8).

Production of abundant seed crops in aspen may occur only at 3- to 5-year intervals (8). The seed mature and are released within a few weeks after fertilization (6). The seed become difficult to collect in quantity upon release and the viability of released seed declines rapidly under field conditions (8). Thus, proper timing of seed collection is important to maximize efficiency of seed collection and to ensure maximum viability of collected and stored seed.

It is unclear from the literature when maximum germinative capacity is reached relative to catkin development and seed release; it is also unclear how the timing of these events varies from year to year in a given area. The purposes of this study were to

1. Relate catkin moisture content and dry mass to germinative capacity of seed and timing of seed release during 2 years (1984 and 1988) of abundant seed production.
2. Describe gross qualitative characteristics of seed as related to seed germinability.
3. Estimate seed production per capsule and catkin as an aid to increasing efficiency of seed collection.

Methods

Pistillate catkins were collected from 3 to 5 aspen trees growing along the upper bank of the North Saskatchewan River in Edmonton, AB (53° 34' N, 113° 31', W; elev. 671 m). The trees were separated by distances of 50 m or more and were assumed to have been from separate clones. Catkins were collected from different trees in 1988 than in 1984.

Collections began when catkins were clearly visible, within a month of seed release. In 1984, catkins were collected on four dates during a 23-day period before seed release; in 1988, catkins were collected on six dates over a 16-day period.

Collected catkins were divided into subsamples for determinations of fresh and dry mass, moisture content, and germinability of freshly extracted seed. Dry mass and moisture contents were determined on 4 to 6 catkins after fresh mass measurements and ovendrying at 70 °C for 24 hours. Seed were extracted from individual flowers in a second subsample of catkins from each tree, teased free of attached fluff, and placed on moistened filter paper in petri dishes.

Seed collected in 1988 were allowed to germinate for up to 7 days under constant light and at 22 °C; seed collected in 1984 were allowed to germinate under the same conditions, but for shorter periods. The number of seed sampled per tree ranged from 25 in early collections to 65 in later collections. Although the duration of the test was shorter than recommended for aspen seed (8), normally developing seed germinates readily within 1 to 3 days at germination temperatures greater than 15 °C (10).

The 7-day germination test should therefore clearly indicate differences in seed maturation and germinability. The numbers of germinated seed (defined as

those with cotyledons lifted off the filter paper and with visible root elongation) were counted daily. Seed production per capsule and per catkin were also determined on this subsample of catkins.

A second sample of caktins, collected 11 and 7 days before release, was air-dried for 3 or 6 days. Seed were than extracted and germinated under the same conditions as were the freshly extracted seed. Additionally, seed produced per capsule and catkin were counted on catkins from 3 trees just before seed release in 1988.

Changes in catkin moisture contents, rates of dry matter accumulation (normalized as a proportion of final catkin dry mass), and timing of seed release were compared with climatic data collected at the Edmonton Municipal Airport (2). Maximum daily vapor pressure deficit (VPD) was calculated from recorded daily maximum temperatures and minimum daily relative humidities to indicate the "drying power" of the atmosphere on a given day.

Results

Seed release began 2.5 weeks earlier in 1988 than in 1984 (fig. 1). Catkin growth rates appeared to be greatest from 23 to 14 days before seed release in 1984 and from 11 to 7 days before seed release in 1988. The peak periods of catkin growth in each year may have been related to mean daily growing degree days (GDD) in the previous sampling period (table 1), although data were limited.

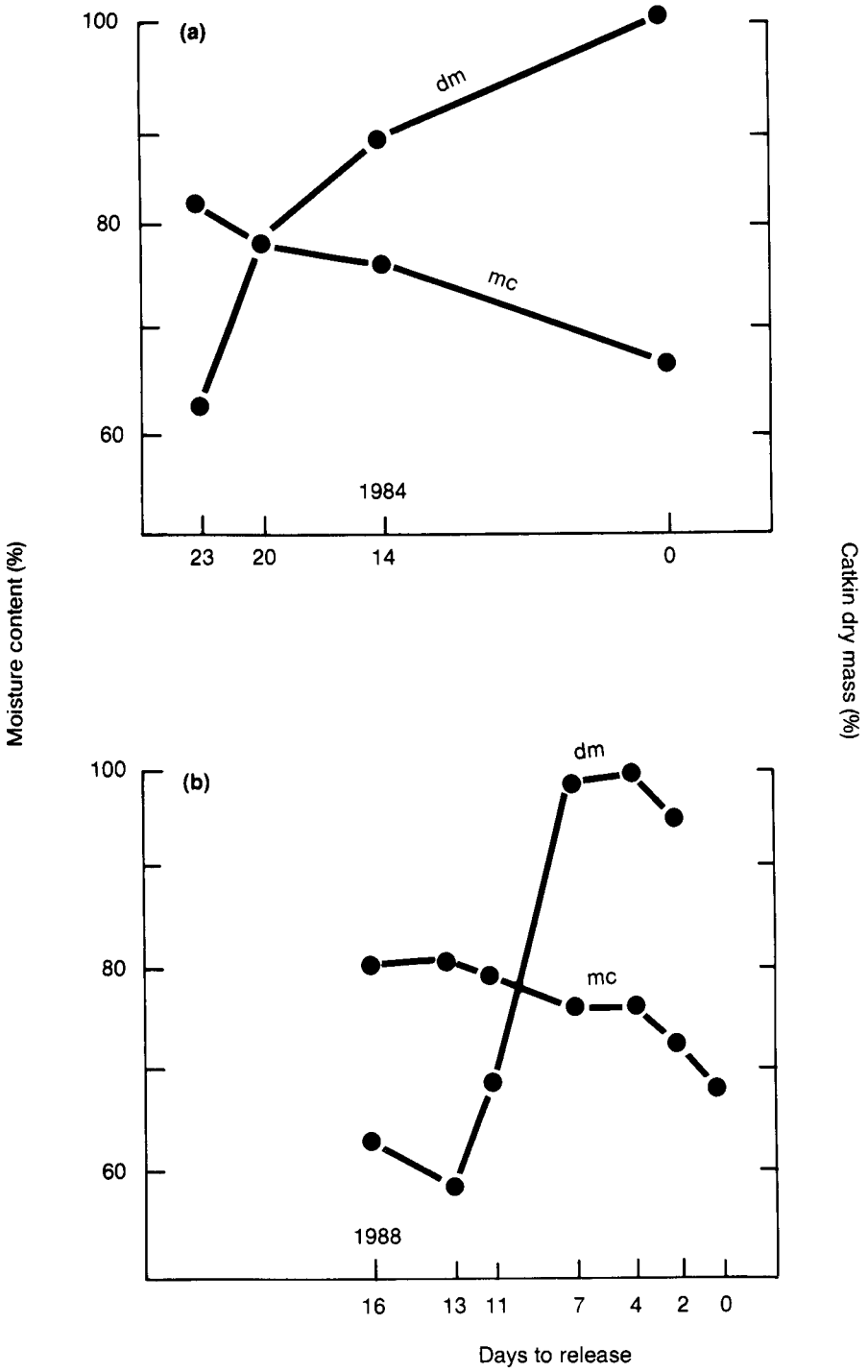

Figure 1—*Change in mean catkin dry mass and mean moisture content over time in 1984* **(A)** *and 1988* **(B)**. *Day 0 represents the day seed release began in each year (May 24 in 1984, May 9 in 1988). MC = moisture content (% of fresh mass), dm = percent of final catkin dry mass.*

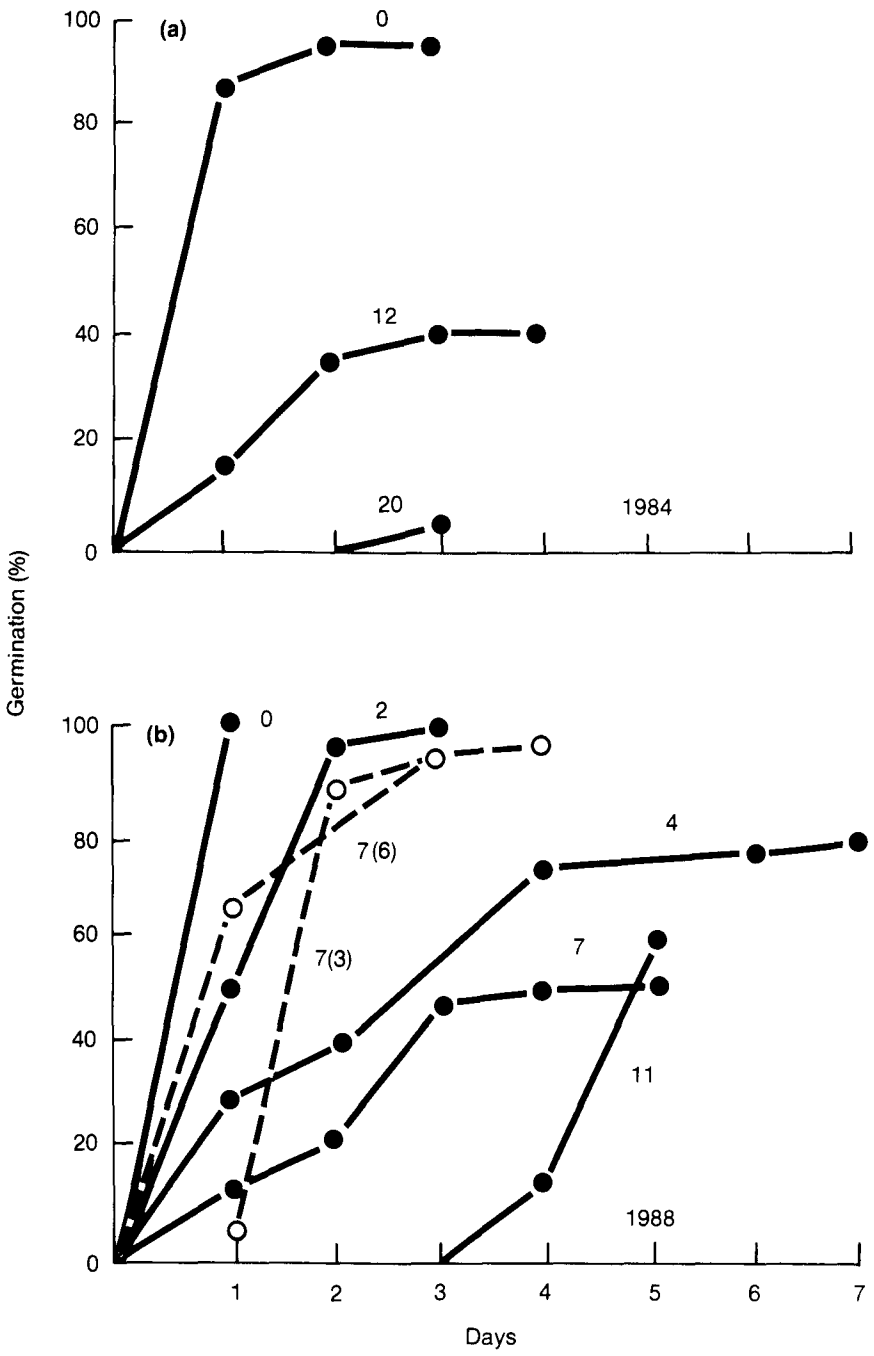

Figure 2—*Percentage germination over time as a function of collection date for 1984* **(A)** *and 1988* **(B)**. *The number adjacent to each line indicates the number of days before seed release that seed was collected; the artificial ripening period, if any, is shown in parentheses.*

In both years, catkin moisture contents decreased from about 80% at the first collection to less than 70% at the time seed was released (fig. 1). In 1988, decreased moisture contents from 16 to 7 days before release were due to increases in catkin dry mass; subsequent decreases were due to water loss from the catkins. Rates of moisture loss nearer the time of release (14 to 0 days in 1984 and 7 to 0 days in 1988) were related to vapor pressure deficits (table 1).

The date of collection and extraction had significant effects on germination of freshly extracted seed after 2 and 4 days (table 2). Germination speed (indicated by the time required for 50% germination) increased with each successive collection date (fig. 2a). No seed collected 13 or 16 days before seed release in 1988 germinated.

Air-drying of catkins collected 7 days before seed release in 1988 enhanced both germination speed and percentage relative to that of seed collected at the same time, but extracted and tested immediately (fig. 2b). The ripening procedure had no effect, however, on seed collected 11 days before seed release (data not shown).

The seed contained in catkins collected early in the 1984 and 1988 sampling periods were a pale whitish-green and the cotton was moist, making extraction of seed difficult. Within 14 days of seed release in 1984 and at 4 days before seed release in 1988, seed were straw or tan colored. Cotton appeared much drier at

Table 1—*Change in catkin dry mass (DMI) and moisture content per day (MCI), and mean daily vapor pressure deficit (VPD) and growing-degree days (GDD) by sampling interval for the 1984 and 1988 collection periods (DMI is normalized such that maximum dry mass for a given tree = 100; GDD is calculated relative to a 5 °C base daily mean temperature*

Days*	DMI(%/day)	MCI (%/day)	VPD (kbar)	GDD
1984				
26–23	—	—	—	3.7
23–20	5.5	−0.013	0.77	2.6
20–14	1.7	−0.003	0.85	2.2
14–0	0.9	−0.007	0.96	5.2
1988				
20–17	—	—	—	1.9
17–11	0.7	−0.007	1.50	8.4
11–7	7.5	−0.008	1.54	5.3
7–4	0.3	0.000	1.16	3.0
4–2	−2.5	−0.015	1.35	6.2
2–0	—	−0.025	2.00	10.6

Correlations

DMI and GDD†				MCI and VPD			
Year	Days	r	n	Year	Days	r	n‡
1984	23–0	0.99	3	1984	20–0	0.85	6
1988	20–4	0.83	4	1988	11–0	—	—
1984	23–0	0.76	7‡				
1988	20–4	—					

*Days prior to initiation of seed release.
†Mean daily growing-degree days (base 5 °C) during previous sampling period.
‡Data from 1984 and 1988 pooled.

Table 2—*Analysis of variance for percentage of germination (arc sine-transformed) after 2 and 4 days as affected by collection/extraction dates of seed in 1988 (DF = degrees of freedom)*

Source	DF	Mean square	F	
2 day				
Total				
Date	4	40.29.8	10.1	P≤0.001
Error	12	397.2	—	
4 day				
Total				
Date	4	2705.7	15.7	P≤0.001
Error	12	172.0	—	

the time of seed extraction and expanded rapidly when capsules were artificially opened; seed were readily teased free of the cotton.

The mean number of capsules per catkin, but not seed number per flower, varied considerably among the trees sampled in 1988 (table 3). Seed production of individual catkins ranged from 98 seed (tree 4) to 831 seed (tree 2); mean production was 450 seed per catkin. Seed production per catkin was estimated from catkin fresh mass by the relation

[1] $S = 381.7\ FM + 184$

$(r = 0.76, n = 19, P = 0.001)$

where S = seed number and FM = catkin fresh mass (in grams).

Discussion

Dates of initial flowering and seed release of aspen in the Edmonton area may vary by as much as 5 and 3 weeks, respectively (4, 5). Seed release began in 1984 at a time typical of reported values for the area (4). The earlier release of seed in 1988 may have been releated to weather conditions, which were warmer and drier than normal (2). It must be reiterated that catkins were collected from the south sides of a small number of trees in a localized area. My data, while comparable for 1984

Table 3—*Catkin fresh mass (FMASS), seed production by capsule (S/CP), and capsule production per catkin (CA/CT) for seed collected in 1988*

Tree	FMASS (g)		S/CP		CA/CT	
	Mean ± SE	N	Mean ± SE	N	Mean ± SE	N
2	1.01 ± .06	5	6.9 ± 0.7	24	98.0 ± 6.9	5
3	0.56 ± .03	5	6.4 ± 0.6	24	77.2 ± 2.6	5
4	0.55 ± .23	3	6.5 ± 0.5	21	48.2 ± 9.5	6
5	1.07 ± .03	6	6.6 ± 0.6	10	76.3 ± 3.4	6

and 1988, may not be directly comparable with earlier data (4).

Careful timing of seed collection is required to ensure maximum germinability of collected aspen seed, at least in this portion of its range. Seed collected several days before release may be artificially ripened. These data indicate that, before extensive collection of catkins, visual inspection of catkins and cotton and seed within capsules, combined with moisture content measurements on catkins, may be useful in ensuring maximum germinability of collected seed.

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