# The Variability of PAPER BIRCH Seed Production, Dispersal, and Germination

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# The Variability of PAPER BIRCH Seed Production, Dispersal, and Germination

PAPER BIRCH trees are generally considered prolific seeders that produce at least some seed every year and very large crops of seed periodically. Seed dispersal is widely assumed to begin in early fall and to continue through the winter months. Germinative capacity has been assumed to be fairly low.

However, observations taken during the course of several studies of natural regeneration have provided some new information about paper birch seed-crop characteristics for three widely-separated stands in the Northeast. These observations, coupled with published information, revealed appreciable variation among years in paper birch seed crops as well as some important deviations from the commonly accepted beliefs.

## Seed Production

Occasionally huge crops of paper birch seeds blanket some areas with millions of seeds. In a 70-year-old pure paper birch stand in northwestern Massachusetts, the 1955 seed crop was estimated to average about 36 million seeds per acre. In the White Mountain area of New Hampshire, the 1958 seed crop was estimated at about 26 million paper birch seeds per acre in a stand of northern hardwoods about 70 to 75 years old that contained an appreciable amount of paper birch. In eastern Maine, a 70-year-old stand composed largely of paper birch, but including smaller amounts of red maple, aspen, and other species, produced an estimated 17 million paper birch seeds per acre in 1960.

But such large numbers are more likely to be the exception rather than the rule. For example, the Maine stand mentioned above produced only about 1,300,000 seeds per acre in 1958 and 800,000 per acre in 1959.

## Frequency of Good Seed Years

Since seed production can vary so greatly from year to year, knowledge of the cyclic occurrence of good seed years can be of great value in planning for natural regeneration.

The *Woody Plant Seed Manual (19)* states that good seed crops (in contrast to light crops) occur almost every year. But published reports in the Northeast and the Lake States suggest that the frequency of reasonably productive seed years is probably about every other year. Between 1957 and 1960, medium[1] or better seed crops were reported for New Hampshire, Massachusetts, and Connecticut about 50 percent of the time; and for Maine and Vermont about 75 percent of the time *(1, 2, 3, 4)*. Good[1] or better crops of paper birch seed were reported about 50 percent of the time in northern

[1]A *medium* crop is defined as: some seeds on all trees, many on some trees (up to 75 percent).

A *good* crop in the Lake States is defined as 61 to 90 percent of a full crop. In this paper, good crops in the Lake States and medium crops in the Northeast are considered to be about equal.

A *bumper* crop is defined as 91 to 100 percent of a full crop.

Minnesota and northeastern Wisconsin between 1949 and 1962 *(5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18)*.

These reports cited above, in addition to revealing certain moderate differences in seed crops among reporting areas, also show that there are variations within individual reporting areas. Thus, while the 1959 crop of paper birch seed in northern Maine was rated as medium, a smaller crop was reported in the rest of the State. Similarly, the 1960 seed crop in northern Minnesota ranged from less than good up to bumper.[1]

Because of these variations in the frequency of medium-or-better seed crops, seed-crop data for a very extensive area are suitable only for general use. When seed-crop data are to be used for a specific purpose such as seed collection or planning a regeneration cut, then they should be gathered in the same local area in which they are to be used.

## Time of Seed Dispersal

Knowing when seed dispersal occurs is essential if full advantage is to be taken of the seed crop. The *Woody-Plant Seed Manual* states that seed dispersal takes place from September 1 to April 1. But this is too broad a period to be useful in timing regeneration measures. Information about the proportion of the total seedfall by month of dispersal would be more helpful. Knowing when the bulk of the seed usually falls would suggest the approximate date by which all needed seedbed-preparation treatments should be completed.

In the Maine stand previously described, the time of seed dispersal was found to vary from year to year. In 1958 nearly two-thirds of the total seedfall was dispersed in October; in 1959 and 1960 more than half fell in August. The lowest proportion of the total seed crop was dispersed consistently in the December-spring period (table 1).

In the New Hampshire stand almost two-thirds of the 1958 seed crop was dispersed in October (table 1). And seedfall of paper birch has been observed here as early as July 4.

There appears to be no relationship between time of dispersal and size of seed crop; and in both the Maine and New Hampshire stands the bulk of the seed was dispersed every year before the ground was snow-covered. There is an advantage in this: seed dispersed on prepared seedbeds before snow falls will be held in place; seed falling on snow-covered seedbeds might be blown off.

**Table 1.—Paper birch seed dispersal in percentage of total seedfall, by period of dispersal, stand location, and year; and estimated total numbers of seeds per acre**

| Stand location and year | Aug. | Sept. | Oct. | Nov. | Dec.-spring | Total No. seeds per acre |
|---|---|---|---|---|---|---|
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Millions* |
| Maine, 1958 | 6 | 13 | 63 | 14 | 4 | 1.3 |
| Maine, 1959 | 58 | 25 | 13 | 3 | 1 | 0.8 |
| Maine, 1960 | 51 | 13 | 20 | 14 | 2 | 16.8 |
| New Hampshire, 1958 | — | 7 | 63 | 28 | 2 | 26.0 |

**Table 2. — Germinative capacity of paper birch seed by year and seedfall period; Penobscot Experimental Forest, Maine, 1958-1960[1]**

| Period | 1958 | 1959 | 1960 |
|---|---|---|---|
| | *Percent* | *Percent* | *Percent* |
| August | 0 | 22 | 75 |
| September | 1 | 20 | 78 |
| October | 11 | 41 | 74 |
| November | 24 | 32 | 80 |
| December-spring | 34 | 18 | 79 |
| Weighted average[2] | 13 | 24 | 77 |

[1]The seeds were stratified for 30, 51, and 35 days in 1958, 1959, and 1960 respectively, and the durations of the tests were 45, 40, and 20 days.

[2]The weighted averages were determined by combining the germination data from proportionate samples taken in each month or period of seedfall.

## Germination

Results from germination tests suggest that there is a relationship between abundance of seed and its germinative capacity. In the two poor years 1958 and 1959 in the Maine stand, germinative capacity — the percentage of seed germinating regardless of time — was low, averaging 13 and 24 percent respectively (table 2). In the bumper year 1960 the germinative capacity averaged 77 percent — significantly better than the germinative capacity for either of the two previous years.

The pattern of germination (data for all seedfall periods combined) varied considerably between the seed crop of 1960 and the crops of 1958 and 1959 (fig. 1). In 1960 the first germinates appeared 4 days after the start of the germination test. Germination continued at a rapid rate during the next 5 days and then tapered off until, on the twentieth day, germination stopped. Thus for 1960 the germinative energy[2] was estimated at 71 percent in 9 days.

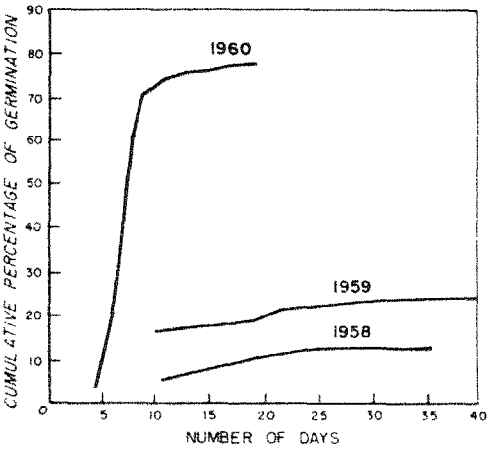


Figure 1. — Paper birch seed produced in the bumper year of 1960 germinated faster and better than that produced in the relatively poor seed years of 1958 and 1959. Data for all seedfall periods are combined.

In 1958 and 1959, germination counts were not made until the tenth day after the start of the test and thereafter only at irregular

[2]In this paper, *germinative energy* is defined as the cumulative percentage of germination and the number of days up to the point where daily germination drops below 5 percent.

and long intervals. For this reason true germinative energy cannot be determined. However, the data for these 2 years do show a much more gradual increase in cumulative percentage of germination than in 1960, and a longer period of germination (fig. 1). These data indicate that germinative energy is high for a large crop of paper birch and low for a small crop.

Since germinative energy gives some idea of how rapidly germination progresses, it is perhaps better than germinative capacity as a standard for comparing years and as a practical measure of the average viability of a seed crop. Rapidity of germination can have an important bearing upon seedling survival. Seeds with high germinative energy will germinate early and thus produce seedlings that will have a maximum length of time to become established before summer drought and high temperatures increase the risk of mortality.

## Seed Weight

Germination appears to be related to seed weight as well as abundance of seed. Paper birch seed from the Massachusetts stand was separated into four broad weight classes. From each of these classes, five samples of 20 cc. each were taken, accurately weighed, and tested for germinative capacity. The results showed that the seed in the heaviest weight class had an appreciably greater germinative capacity than the other weight classes:

| *Average weight per 20 cc. of seeds (mg.)* | *Germinative capacity (percent)* |
|---|---|
| 3.901 | 72 |
| 3.097 | 49 |
| 2.430 | 50 |
| 2.298 | 46 |

The investigation in Maine showed similar results. Here, however, the average weight per seed was determined for each of 3 years and was related to the germinative capacity for the same year:

| *Year* | *Average weight per seed (mg.)* | *Germinative capacity (percent)* |
|---|---|---|
| 1958 | 0.30 | 13 |
| 1959 | .29 | 24 |
| 1960 | .37 | 77 |

However, seed weight is influenced not only by size but also by soundness (the percentage of seeds that are fully developed). Since the seeds used in the tests mentioned above were not sorted on the basis of soundness before testing, the better germination of the heavier seeds might be a valid relationship or simply a reflection of a higher proportion of sound seed.

## Conclusions

The results on seed production, dispersal, and germination reported here provide only limited knowledge of paper birch seedcrop characteristics. Need exists for more detailed information if we are to utilize the seeding habits of paper birch to best advantage. Yet there is a practical implication in the data we already have: to encourage the successful establishment of a new paper birch stand, regeneration cuts should be made during a good seed year, and seedbed preparation treatments should be completed by the end of summer.

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