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Sugar Maple Seed Production in Northern New Hampshire

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Abstract

Large numbers of sugar maple seed are dispersed every second or third year. Very little seed was damaged by insects or mammals prior to dispersal. The trapping methods used prevented major losses following seed fall. Seed production was positively correlated with tree diameter and density but not with age of seed trees.

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Introduction

Sugar maple (*Acer saccharum* Marsh.), one of the most important hardwood species, grows on 12.5 million hectares (31 million acres) in the United States and another 2.5 to 3.0 million hectares (6.2 to 7.4 million acres) in southeastern Canada (Fig. 1). Sugar maple trees seldom flower until they are at least 20 years old. Heavy flowering does not occur until trees are much older. Flower buds reach full bloom 1 or 2 weeks before leaves emerge. This can occur between late March and mid-May depending on the location (Olson and Gabriel 1974). Until recently it was thought that flowers only were pollinated by insects (Godman 1965; Kriebel and Gabriel 1969), but further investigation revealed that adequate amounts of pollen reach flowers in the absence of insect vectors (Gabriel and Garrett 1984). Climatic conditions that restrict insect pollination (precipitation, cold, high humidity, etc.) also would limit pollination by airborne pollen, and seed production would be expected to fluctuate due to climate at the time of pollen shedding.

Fruit ripens in about 16 weeks (late July to early September) and usually only one of the paired samaras contains a seed. Seeds are mature when the samaras turn yellowish green and the moisture content drops below 145 percent of dry weight (Carl and Snow 1971; Yawney 1969). Samaras begin to fall about 2 weeks after they ripen. Germination capacity in laboratory tests is extremely high in sugar maple with averages of 95 percent or higher.

Light crops of seed are reported for 40- to 60-year-old trees with a d.b.h. of 20 cm (8 inches). Moderate crops are reported for 70- to 100-year-old trees with a d.b.h. of 25 to 35 cm (10 to 14 inches). Larger trees produce greater quantities of seed. In northern Michigan during a good seed year, 22 million/ha (8.56 million/acre) were caught in traps in a virgin stand. About half of that total was trapped in a selectively cut stand of sugar maple (Lake States For. Exp. Stn. 1936).

In 32 years of observation in north-central Wisconsin, seed crops were rated as good or better about 45 percent of those years, the lowest percentage among the major hardwood species of that area (Godman and Mattson 1976). Crops were good as often as 4 successive years but poor crops did not extend longer than 2 successive years. The period between good crops ranged from 1 to 4 years in north-central Wisconsin, from 2 to 5 years in other portions of the United States, and from 3 to 7 years in Canada (Godman 1965; Wang 1974).

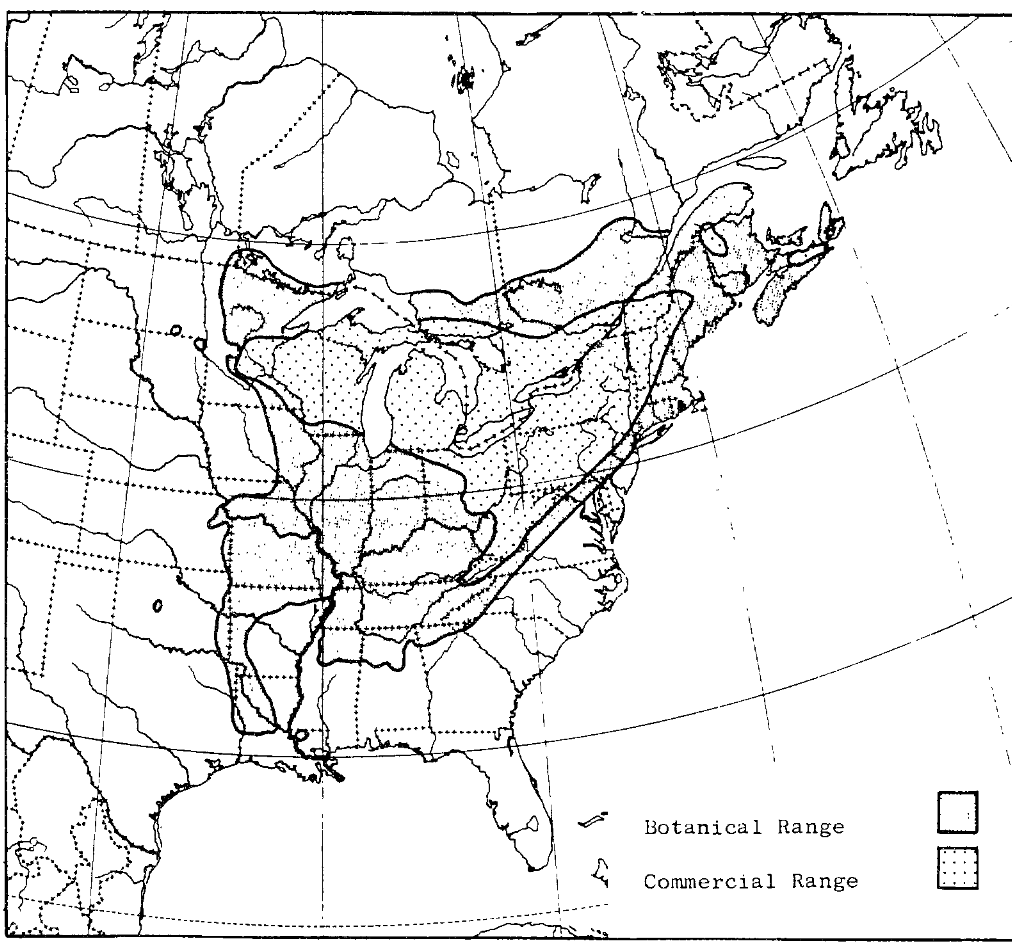

Figure 1.--Botanical and commercial range of sugar maple.

Methods

This study was conducted on the Bartlett Experimental Forest, White Mountain National Forest, near Bartlett, New Hampshire (39°20'N, 71°40'W). (Each plot was 1 hectare (0.04 acre) in size and located within a larger uniform stand. Thirty-seven plots located in stands where the trees were at least 20 years old and had the potential to produce seed were included in this study. Although maple seed can be transported at least 100 meters (330) from a seed source, no plots were used that did not contain sugar maple stems.

Twenty seed traps were distributed systematically in each study plot. Traps were metal cylinders 15.3 cm in diameter with hardware screen covers to prevent predation by small mammals. Seeds were collected at 2-week intervals during the snow-free period and at 6- to 8-week intervals during the winter. Viability was estimated by cutting tests throughout the growing season. Seed was classified as empty or filled (60 percent of the seed cavity filled, endosperm creamy white and firm, embryo visible and well developed).

The age of sugar maple trees on the selected plots ranged from 20 to 140 years. Sugar maple accounted for 1 to 69 percent of the total basal area on these plots. Most of the plots were observed for 5 to 6 years (1976 to 1981). The exceptions were plot 73, for which information is available only for 4 years, and Plots 21, 48 and 49, for which data were collected for 11 years.

For some hardwood species in this region, for example, beech, losses to insects, birds, and small rodents are considerable. Since recorded losses from these predators were small in sugar maple seed trapped during the study, they are not discussed.

Results

Traps were placed in Plots 21, 48, and 49 in 1971. Total and viable seed yield were plotted by year for an 11-year period (Fig. 2). Good crops were recorded in 1971, 1974, 1976, 1979, and 1981. Almost no seed was produced in 1973, 1975, 1977, and 1980. The first few years of the graph in Figure 2 correspond closely to sugar maple seed fall in northeastern Wisconsin, where good crops were reported in 1971 and 1974 and poor crops occurred in 1972 and 1973 (Godman and Mattson 1976).

On the basis of our results and the Wisconsin data, it appears that good crops occur every second or third season across the range of this species. General weather patterns tend to be similar across the northern portion of the range of sugar maple, which probably accounts for this similarity in seed production at sites separated by 2,400 km (1,500 miles).

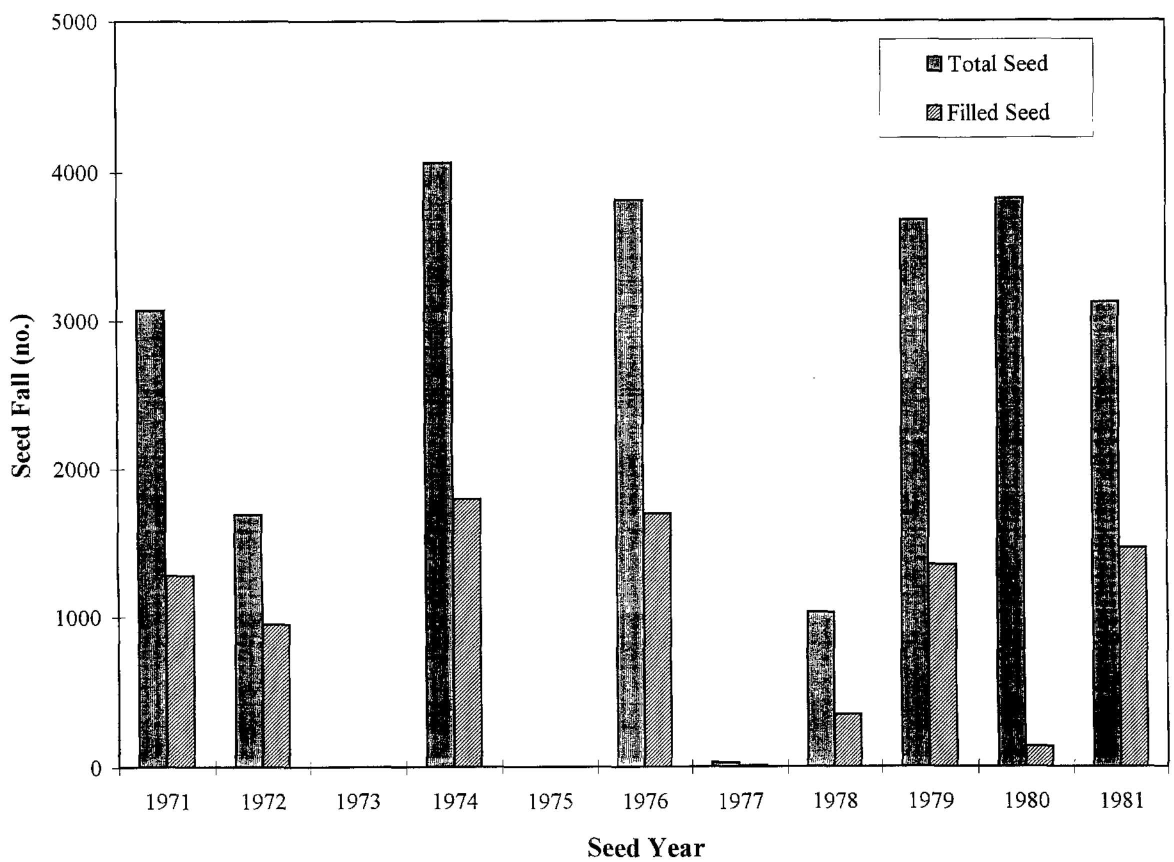

Figure 2.--Seed fall by year (1971-81).

Seed fall was combined for all years and all stands and plotted for 2-week intervals from May 1 to November 15. A peak occurred on June 1 and a much more pronounced peak was recorded on October 1 (Fig. 3). None of the samaras that fell before September contained viable seed. There are a number of possible reasons for the early abscission of samaras. Agamospermy, the development of viable seed in the absence of pollen, can occur in sugar maple (Gabriel 1967); however, most unpollinated ovules abort during development. Drought and high temperatures also can cause premature abscission. While extremely high temperatures generally do not occur in this region before June 1, there are years in which there are droughts of varying length and severity during late spring and early summer.

We then looked at stand conditions to evaluate the effect of tree age on seed production. Not all age classes were represented on the 37 plots but it appears that there was no significant age effect (Fig. 4). Several of the 50-year old stands produced above-average numbers of seed but production then leveled off through age 140. Because the oldest trees would have the largest diameters, diameter and seed production would be expected to follow the same pattern as age and seed production. There was an increase in production for trees 10 to 12 inches in diameter, which probably corresponds to the 50-year-old age class. The correlation for production and diameter is significant at the 0.05 level (Fig. 5).

Not all stands had equal numbers of potential seed trees, so seed production was plotted over density (basal area of sugar maple stems as a percent of total basal area of all stems on the plot). As expected, there was a strong correlation; the greater the density of sugar maple, the greater the number of sugar maple seed (Fig. 6).

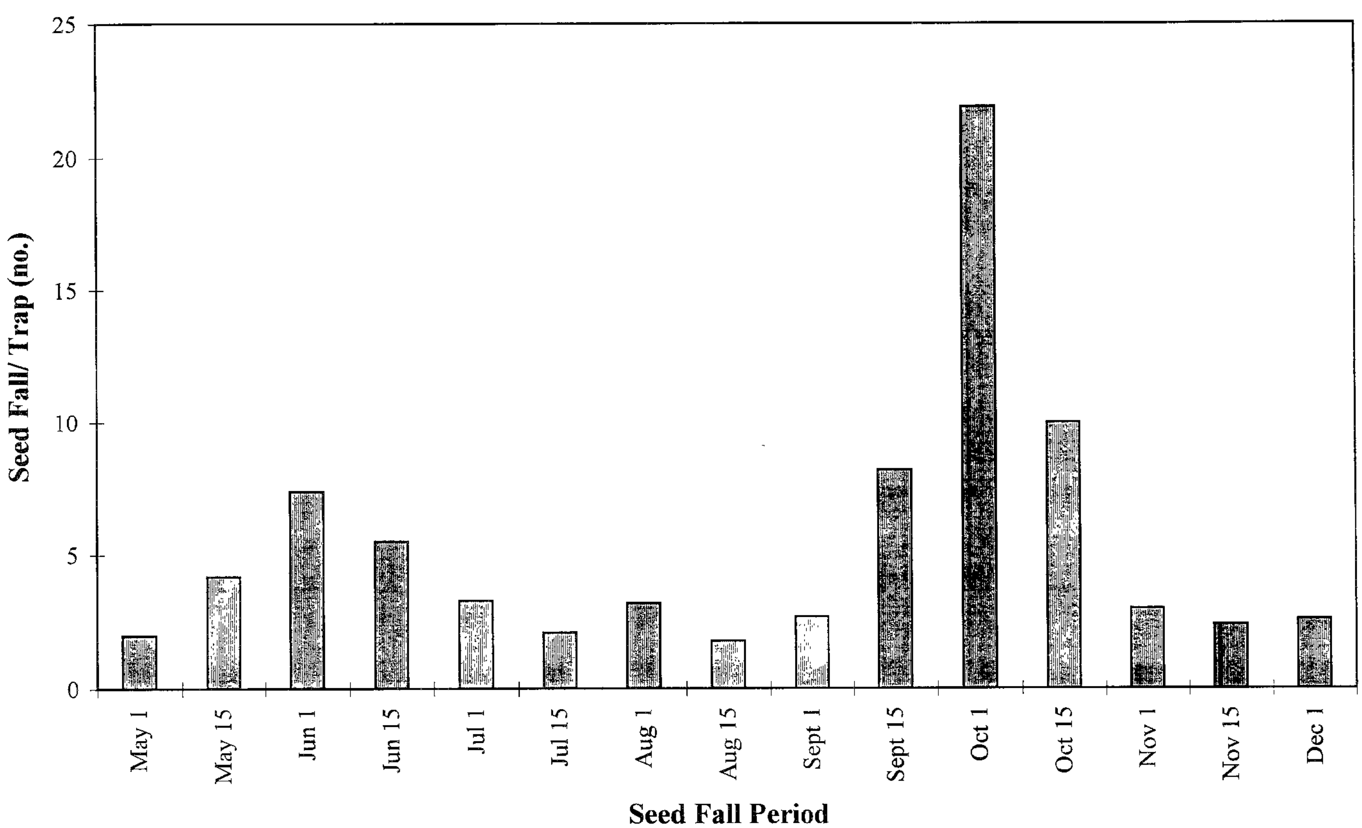

Figure 3.--Seed fall for all years by combined 15-day periods.

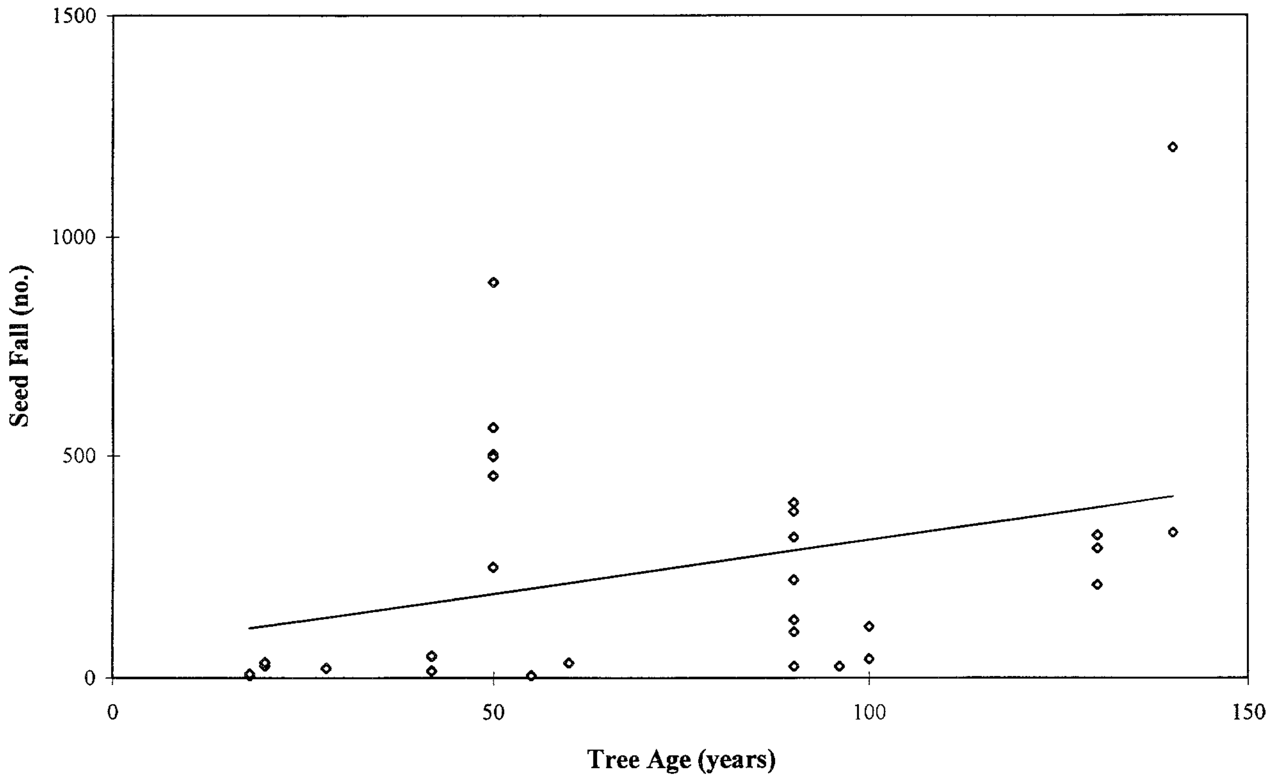

Figure 4.--Total seed fall plotted over average age of seed-bearing sugar maple trees on each plot.

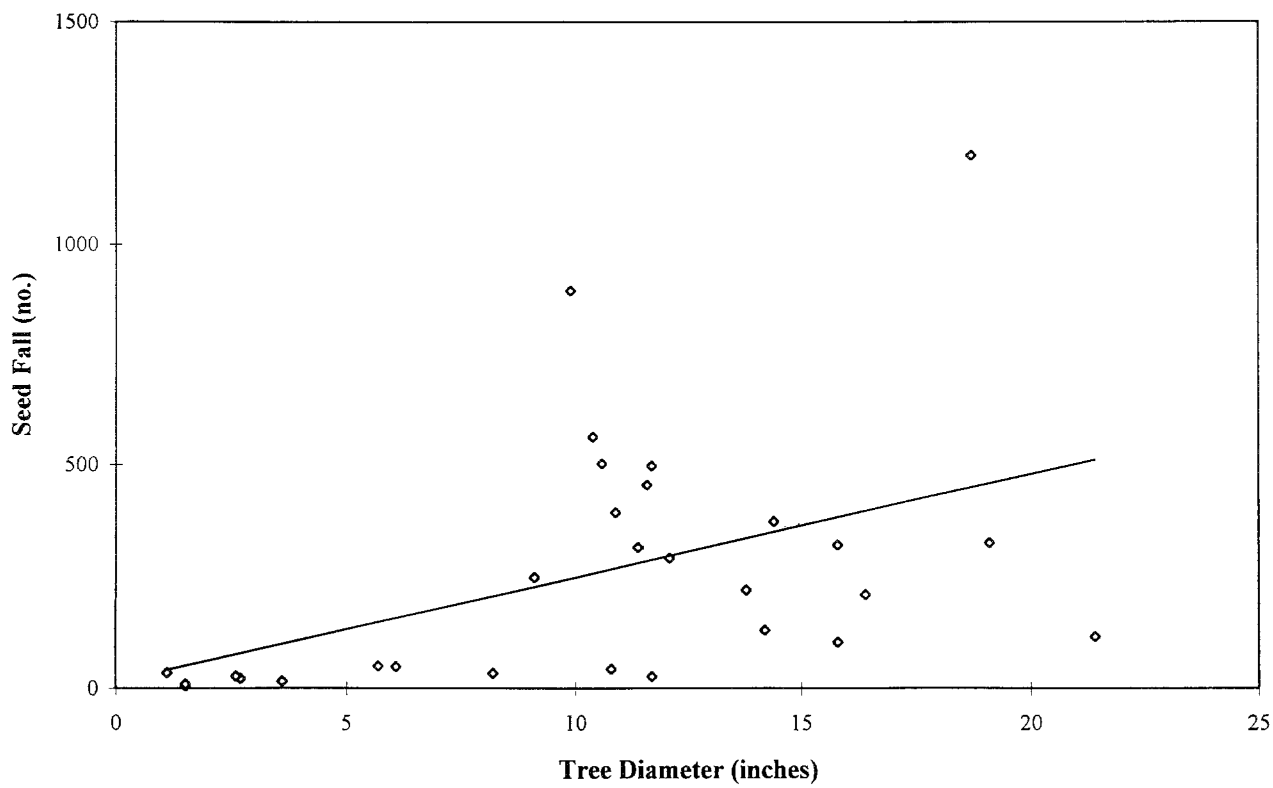

Figure 5.--Total seed fall plotted over average diameter for seed-bearing sugar maple trees on each plot.

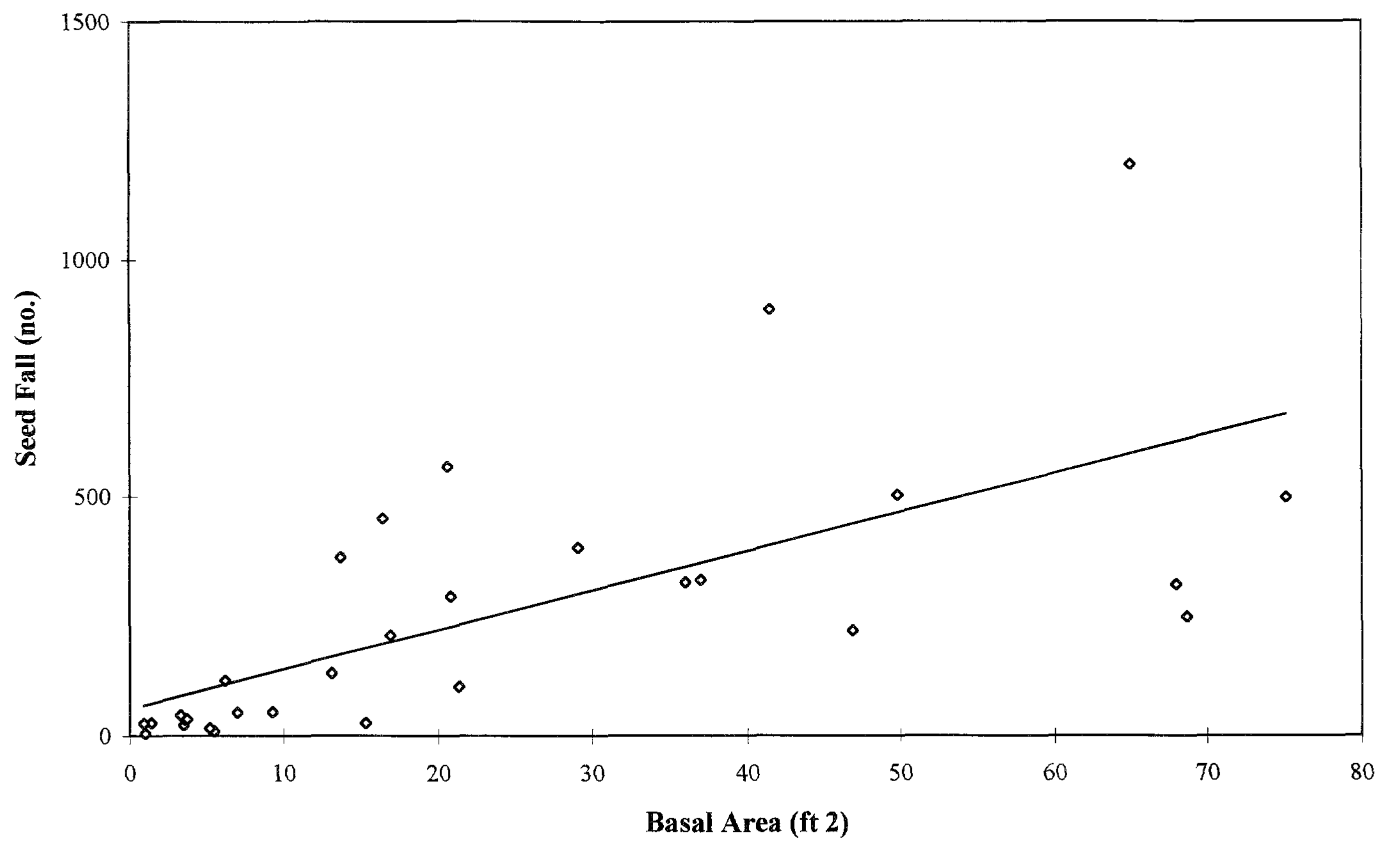

Figure 6. -- Total seed fall plotted over basal area of sugar maple as a percentage of total basal area of all trees on each plot.

Light or heavy seed production seems to be a heritable trait and some trees contribute unequal numbers of seed to annual crops. In the two 140-year-old plots shown in Table 1, Plot 44 had more than half the basal area of Plot 45 but only 19 percent as much seed. This is even clearer in the 50-year-old plots. Plot 46 had only 55 percent as much basal area as Plot 21 but over 2.2 times as much seed. Plot 8 had only 28 percent as much basal area as Plot 21 but equal amounts of seed. One explanation for these results is that one or more of the heavily producing trees on some plots were responsible for the large numbers of seed.

Table 1.--Comparison of total seed fall in plots of similar age

Plot	Age	Basal area	Seed fall
	Years	*Ft²*	*Number*
45	140	65.0	2,223,866
44	140	37.0	428,220
46	50	41.5	2,821,860
21	50	75.0	1,262,700
19	50	50.0	1,328,580
8	50	21.0	1,262,700

Conclusion

Large numbers of viable seed were trapped every other year, or every third year, but the methods used in this study exclude predation that normally occurs between the time the seed reaches the ground and the time it germinates. Species like beech suffer substantial losses from insects and small mammals after the seed ripens but while it is still on the tree. Losses of this type in sugar maple apparently occur after the seed falls. In this study, loss to insects, mammals, and birds was so slight that it was ignored. In parts of the Champlain River Valley, loss of maple seed to the maple seed borer is serious and could result in considerable seed loss before desemination (Pers. commun., Art Rye, USDA For. Serv., 1993).

Seed production is seasonal and probably is related to climatic factors during the period of pollen dispersal, and possibly at the critical points when buds still develop into floral or vegetative tissue. Early abscission produces substantial shedding of samaras but most of those contain nonviable seed. Lack of pollination and weather are primary causes for seed fall prior to ripening.

Seed production was positively correlated with diameter of parent trees and strongly correlated with density of parent trees, but was not correlated with age of parent trees between ages 50 and 140 years. While seed yields in stands 100 to 140 years old generally are adequate, several of the 50-year-old stands in this study produced more seed than the oldest stands in a good seed year (1979). The variation observed between plots of the same age, diameter, or density might be attributed to the presence of high-yielding individuals near the seed traps.

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Keywords: *Acer saccharum*, seed production

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