



SEEDFALL AND LITTERFALL IN A MATURE WHITE SPRUCE STAND IN MANITOBA

Project MS-158

by
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INTRODUCTION

In 1954 a study was undertaken to investigate the periodicity of cone production of individual trees and to determine annual and seasonal distribution of seedfall in a mature white spruce (Picea glauca (Moench) Voss.) stand on the Riding Mountain Forest Experimental Area. Results from this study were published by Waldron (1965). Subsequently studies were undertaken to determine the chronological relationship between white spruce seedfall and litterfall, and the effect of the litter on germination (Cayford and Waldron 1962, Waldron 1963). Results from these studies indicated that in 1961 the heaviest period of seed dispersal preceded the heaviest period of litterfall by over one month and that germination of seed falling on thin layers of spruce needles and aspen leaves was significantly reduced. Thus it would appear that improved white spruce regeneration on prepared mineral soils may be obtained if seedfall precedes litterfall. To further test these results additional collections of seedfall and litterfall were made from 1962 to 1965.

METHODS AND MATERIALS

The study was carried out in a one-hundred-year-old white spruce stand containing, in 1961, a basal area of 180 square feet per acre; 9 square feet of which were trembling aspen (Populus tremuloides Michx.). The stand is situated on a moderately well drained, grey-wooded soil with a clay-loam texture. Minor vegetation consists of a light herbaceous cover with scattered, weakly-developed colonies of beaked hazelnut (Corylus cornuta Marsh).

In 1954 two 1/10-acre plots, each containing sixteen 1/4-millacre traps, were established in this stand. From 1961 to 1965 periodic (usually weekly) collections of seed and litter were taken from late July to late November. Between November 1964 and early summer 1965 additional monthly collections were made on plot number one only (Table 1).

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TABLE 1

DATES OF SEED AND LITTER COLLECTIONS FROM 1961 TO 1966

1961	1962	1963	1964	1965
Aug. 1-Aug. 6	July 30-Aug. 6	July 30-Aug. 6	Aug. 4-Aug. 12	Jan. 3*
13	13	12	17	31*
20	20	17	21	Feb. 28*
27	27	27	31	Apr. 12*
Sept. 4	Sept. 4	Sept. 3	Sept. 7	May 1*
17	17	9	14	June 4*
24	24	16	22	30*
Oct. 2	Oct. 1	23	29	July 28
8	10	30	Oct. 10	Sept. 2
15	25	Oct. 9	13	Oct. 1
Nov. 1		15	19	Nov. 1
27		21	26	
		26	Nov. 2*	
		Nov. 4	29*	

* Plot number 1 only

Cones were separated from the rest of the litter at the time of collection to prevent seed from the cones mixing with free-fallen seed thereby giving an erroneously high seedfall per acre. Similarly, traps showing evidence of squirrel contamination were not included in the collection for that date.

In the laboratory twigs and aspen leaves were separated from the rest of the litter for each plot collection. They were then weighed (air-dried) and discarded. The rest of the litter was run through a set of sieves which segregated most of the needles from "others" (bud scales, cone scales, bark and male flowers). The air-dried weight of the needles and the "others" were then found after which they were each searched for white spruce seed. The white spruce seed was removed and counted. To increase the accuracy of the seed counts check samples of litter from each collection data were re-examined. For each plot and collection period seed was tested for soundness using 10 per cent of the seed or all the seed up to 100, whichever was the largest.

Averaging the two plots, total air dried litterfall, needlefall, leaffall, twigfall, seedfall and sound seedfall, per acre and per acre per day, were computed for each period. The weight of "others" was included with the weight of twigs.

The cones collected in the seed traps were counted and an approximate weight for cone fall calculated using an average weight of .662 gms. per cone.

Using collection periods and seedfall and litterfall per acre per day, graphs were prepared for 1961, 1962, and 1964. Since inadequate seedfall occurred in 1963 and 1965, no comparison could be made of those years.

RESULTS AND DISCUSSION

Litterfall

Between 1961 and 1965 total litterfall during the late July to November interval averaged 1,426 pounds per acre; 63 per cent of which was needles, 20 per cent leaves, and the remainder twigs and other materials (Table 2).

Needlefall was much larger than average in 1961 and much smaller than average in 1962 (Table 2). The excessive temperature (averaged 6.5 degrees above normal in August) and drought (2 inches of rainfall in June, July and August as against almost 9 inches of rainfall in an average year) in 1961 could account for the abnormally large needle mortality in that year, and conversely for the reduced needlefall in the following year.

Leaffall remained approximately the same throughout the five years, while "other" litter, mostly twigs, showed a large increase (Table 2). This increase in "other" litter may have occurred as a result of the 15 per cent mortality of the white spruce trees on the plots between 1961 and 1965.

Total litterfall over a one-year period (July 24, 1964 to July 28, 1965) was slightly more than 3,300 pounds per acre; 40 per cent of which

TABLE 2
TOTAL SEASONAL LITTERFALL, 1961 TO 1965

Year	Interval	No. days	Needles lbs./acre	Leaves lbs./acre	Twigs and others lbs./acre	Total lbs./acre
1961	Aug. 1 - Nov. 27	119	1462.9	347.1	82.2	1892.2
1962	July 30 - Oct. 25	87	406.4	206.1	213.2	825.9
1963	July 30 - Nov. 4	97	886.0	306.2	166.2	1358.4
1964	July 24 - Oct. 26	94	788.0	328.4	367.0	1483.8
1965	July 28 - Nov. 1	96	775.5	208.5	418.8	1402.8
Weighted average		98.6	900.4	283.7	241.7	1425.8
Per cent			63.1	19.9	17.0	100

was needles, 30 per cent twigs and others, 11 per cent leaves, and 19 per cent white spruce cones (Table 3). Approximately 1.2 ounces, per square foot, of air-dried litter fell during the 369 days.

Maximum needlefall per acre per day occurred in late September after which gradually decreasing amounts fell until a minimum needlefall rate occurred in January (Table 4). Needlefall then increased during early spring to a fairly static rate throughout the summer. Most leaffall was confined to late September and early October, while twigs and other litter fell generally throughout the year although somewhat more slowly during the winter months. The unusually high twig and other litterfall during June may be accounted for by the collection of male flowers and bud scales. A high percentage of the cones fell between late September and late February.

Seedfall

Seedfall, during the July - November collection periods over the five years, varied from negligible to heavy (Table 5). The largest seedfall occurred in 1964 with over six and a quarter million seeds falling per acre while the smallest seedfall - less than 13 thousand seeds per acre - occurred in 1963. Seed soundness appeared to be related to abundance of seed; the greater the amount of seedfall the higher the viability.

Total seedfall for an approximate seed year (369 days) during 1964 and 1965 was very large (Table 6). An estimated 37.9 pounds² or 9,105,000 white spruce seed fell on each acre of this stand. Ninety-one per cent of all the seeds fell on the 94 days between July 24 and October 26; 68 per cent of these were sound. During the remainder of the year 803,000 seeds per acre fell; 34 per cent of these seeds were sound.

Maximum seedfall per acre per day occurred during September and early October with a rapid decrease in seedfall until late November (Table 7). During the winter, spring, and early summer the rate of seedfall was very low. Periodicity of sound seedfall was similar to that of total seedfall. Seed soundness was highest during the period of peak seedfall, and then decreased during late autumn to a low in mid-winter. However, in the spring, soundness of the seedfall increased substantially. Possibly the improved soundness was due to the opening of late maturing cones by the higher temperatures in the spring.

Relationship between seedfall and litterfall

In the three years (1961, 1962 and 1964) with large seed crops, maximum daily seedfall occurred on or before the date of maximum daily needlefall and leaffall (Figure 1, Table 8). On the average only 19 per cent of the needles and leaves had fallen by the date when 60 per cent of the seed was dispersed.

It can be noted that peak falls of leaves and needles occurred on the same dates. The period of maximum leaffall was comparatively brief, taking

² Assuming 240,000 white spruce seeds equal one pound (Anon. 1948).

TABLE 3

LITTERFALL FOR AN APPROXIMATE YEAR (369 DAYS) IN 1964-65¹

Interval	CONES			NEEDLES		LEAVES		TWIGS AND OTHERS		ALL
	No./acre	Lbs./acre	% of litter-fall	Lbs./acre	% of litter-fall	Lbs./acre	% of litter-fall	Lbs./acre	% of litter-fall	Lbs./acre
July 24/64- Oct. 26/64	163,500	238.6	12.3	913.2	47.2	366.7	18.9	417.2	21.6	1935.7
Oct. 26/64- July 28/65	264,000	385.3	27.1	431.7	30.4	3.0	0.2	600.1	42.3	1420.1
Total	427,500	623.9	18.6	1344.9	40.1	369.7	11.0	1017.3	30.3	3355.8

¹ Plot number 1.

TABLE 4
 PERIODIC DAILY LITTERFALL OVER A ONE YEAR PERIOD¹

Date	Needlefall lbs./acre/day	Leaffall lbs./acre/day	Twigs and others lbs./acre/day	Conefall lbs./acre/day
1964				
August 4	2.4	0.1	2.8	0.0
12	3.2	0.7	7.9	0.8
17	1.5	0.1	1.3	0.1
21	2.1	0.1	2.6	0.0
31	1.2	0.3	1.6	0.5
September 7	6.4	0.6	6.2	0.8
14	8.3	0.7	2.3	0.2
22	20.4	5.2	3.5	0.4
29	41.3	25.1	4.3	4.6
October 10	16.0	11.0	11.4	2.5
13	4.3	0.6	1.4	12.6
19	10.3	1.1	3.1	2.4
26	3.8	0.1	3.7	0.8
November 2	1.6	0.1	2.0	0.4
29	0.8	0	1.4	1.3
1965				
January 3	0.4	0	1.4	1.9
31	0.3	0	1.1	5.4
February 28	0.5	0	1.4	2.6
April 12	0.7	0	2.2	0.8
May 1	1.3	0	1.9	0.2
June 4	2.5	0	2.7	0.3
30	5.6	0	5.9	0.2
July 28	2.5	0	1.7	0.2

¹ Plot number 1

TABLE 5
TOTAL SEASONAL SEEDFALL, 1961 TO 1965

YEAR	INTERVAL		SEEDFALL		
	Period	No. days	Total number seed per acre	No. of sound seed per acre	Seed sound-ness (%)
1961	Aug. 1 - Nov. 27	119	1,408,817	995,416	70.6
1962	July 30 - Oct. 25	87	1,489,364	592,562	39.8
1963	July 30 - Nov. 4	97	12,735	459	3.6
1964	July 24 - Oct. 26	94	6,256,376	4,284,103	68.5
1965	July 28 - Nov. 1	96	30,084	8,901	29.6

TABLE 6
SEEDFALL FOR AN APPROXIMATE YEAR (369 DAYS) IN 1964 - 1965¹

Interval	Seedfall		Seed soundness %
	Total number of seed per acre	Number of sound seeds per acre	
July 24 - Oct. 26/64	8,302,000	5,633,760	67.9
Oct. 26/64 - July 28/65	803,000	276,152	34.4
Total	9,105,000	5,909,912	64.9

¹ Plot number 1 only

TABLE 7
 PERIODIC DAILY SEEDFALL OVER A ONE-YEAR PERIOD¹
 1964-1965

Date	Seedfall		
	Total number seeds per acre per day	Number sound seeds per acre per day	Seed soundness %
Aug. 4, 1964	1,045	91	8.7
12	625	219	35.0
17	1,200	200	16.7
21	4,938	997	20.2
31	4,300	1,978	46.0
Sept. 7	204,678	159,854	78.1
14	229,250	153,368	66.9
22	253,438	164,228	64.8
29	147,464	89,806	60.9
Oct. 10	129,295	94,127	72.8
13	48,250	26,055	54.0
19	55,333	39,397	71.2
26	36,750	20,212	55.0
Nov. 2	23,178	13,443	58.0
29	5,213	1,720	33.0
Jan. 3, 1965	2,936	734	25.0
31	4,875	1,024	21.0
Feb. 28	2,866	487	17.0
Apr. 12	1,814	716	39.5
May 1	3,158	1,105	35.0
June 4	963	336	34.9
30	154	86	56.2
July 28	205	75	36.8

¹ Plot number 1 only

TABLE 8

DATE OF MAXIMUM AND DURATION OF SEEDFALL,

NEEDLEFALL, AND LEAFFALL

1961, 1962, 1964

Year	Date of maximum seedfall	Date of maximum needlefall and leaffall	Date of 60 per cent seedfall	Per cent of total needlefall and leaf-fall by that date	No. days for 80% seedfall	No. days for 80% needlefall	No. days for 80% leaffall
1961	Aug. 31	Oct. 5	Sept. 18	11.1	58	40	12
1962	Sept. 27	Sept. 27	Sept. 24	26.3	34	59	14
1964	Sept. 18	Sept. 25	Sept. 15	19.8	34	42	21

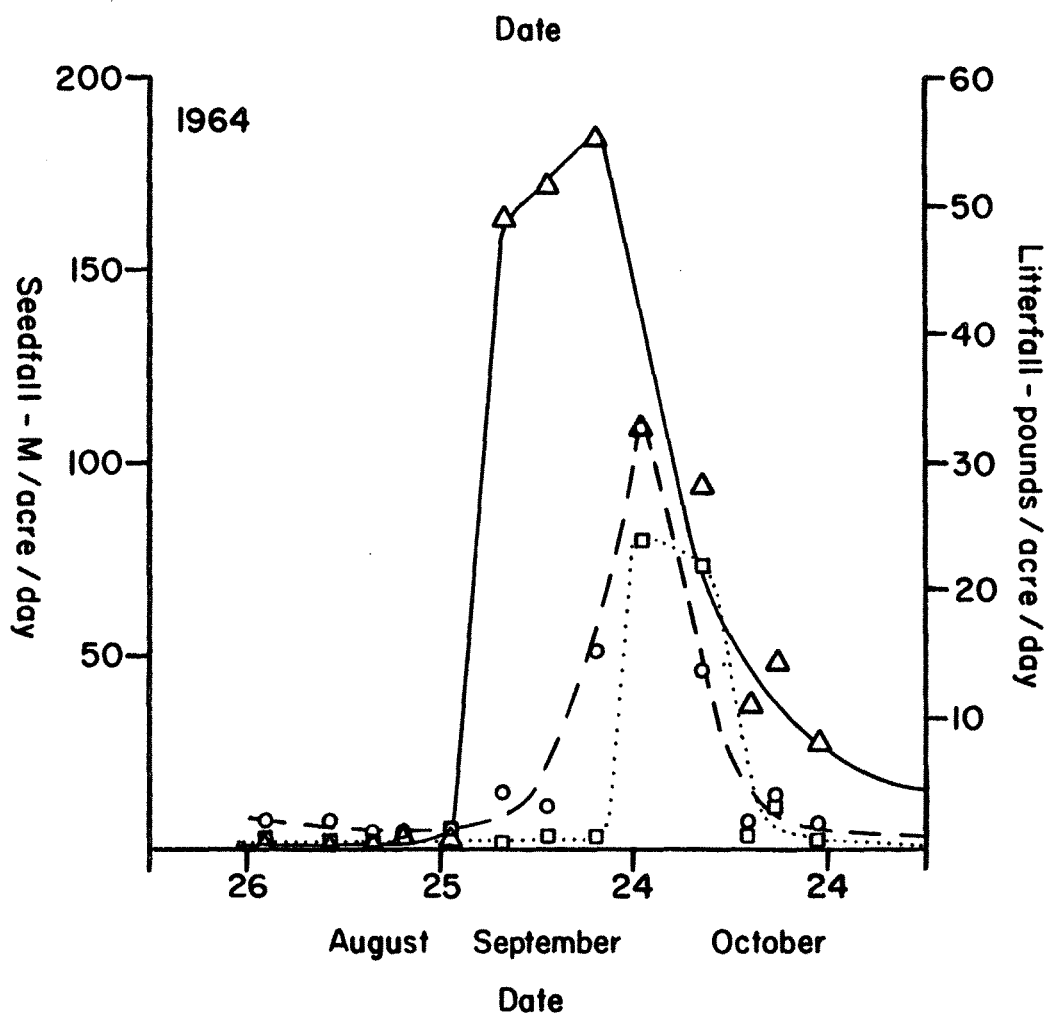
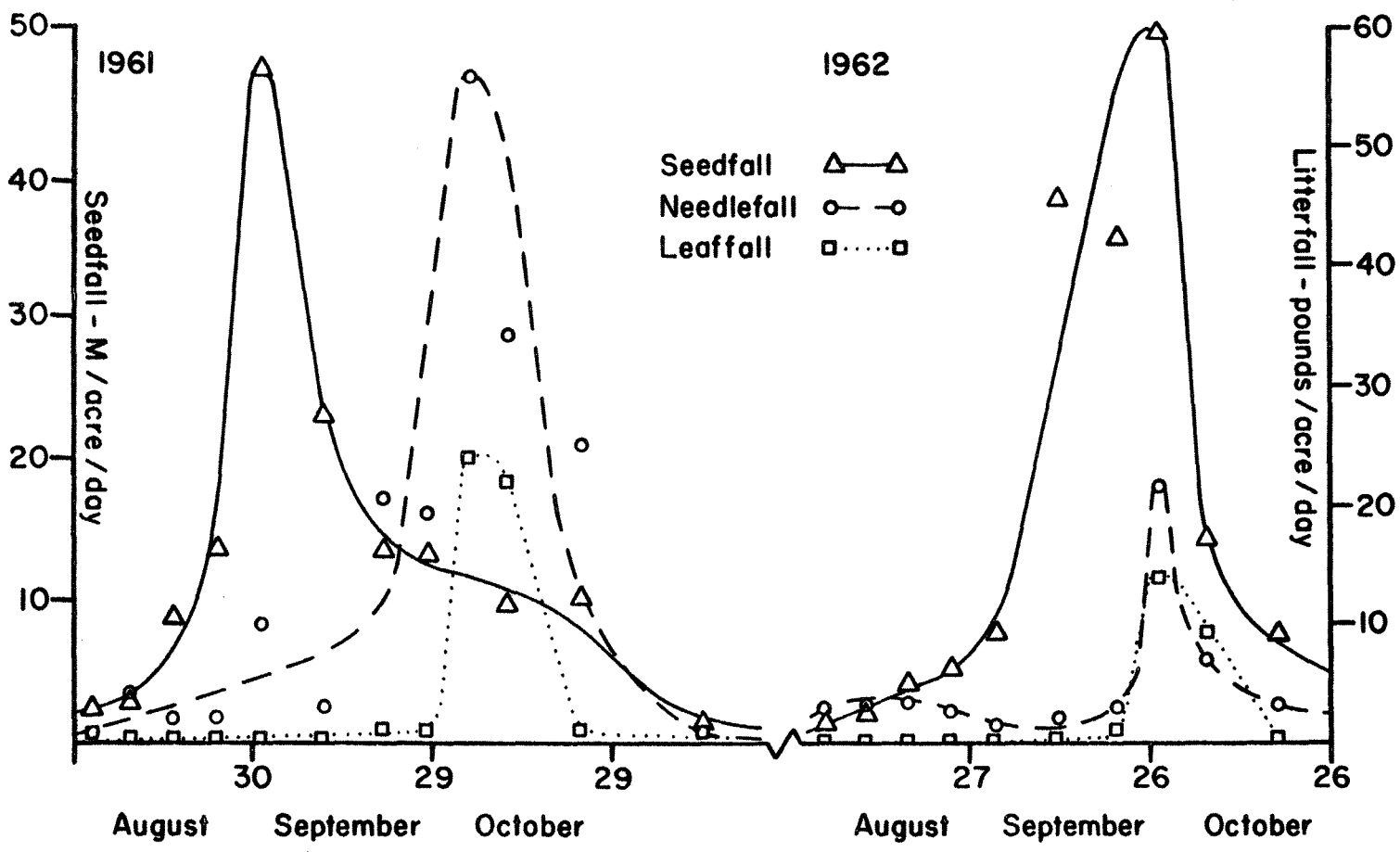


Figure 1. Relationship between seedfall and litterfall in a mature white spruce stand for three seed crop years

an average of 18 days for 80 per cent of the leaves to fall, while needlefall occurred over a 43-day period. On the average, 80 per cent of the seed was dispersed in a little over a month. The hot dry weather in August of 1961 seems to have instigated considerable cone opening as early as the middle of the month and thus increased the period taken for 80 per cent of the seed to fall. Roe (1946) found 80 per cent of the seed fell in a 5-week period.

FUTURE WORK

Since the results for the two plots are proportionately consistent, collections will be made on plot number one only beginning in July, 1966. Traps will be emptied monthly during the winter and early summer and fortnightly during late summer and autumn.

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