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THE PRODUCTION AND DISPERSAL OF LODGEPOLE PINE SEED

by
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Project K. 68

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D. I. CROSSLEY

INTRODUCTION

Sound forest management cannot be undertaken without an accurate knowledge of seeding habits, particularly if reliance is to be placed on residual trees or adjacent uncut stands as a source of seed. Because the cones of lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm.) are usually serotinous, the dissemination of seed under normal conditions does not attract attention. However, this writer found, and reported in a previous publ cation (1), that all lodgepole pine stands in which he worked contained some trees bearing non-serotinous cones or a varying percentage of non-serotinous cones, and under such conditions it is obvious that there will be a varying seedfall from such stands under natural conditions. This investigation was therefore designed to gather information to provide answers to the following questions:

1. Assuming that the amounts of seed dispersed are a reflecti n of annual seed production, what is the seeding periodicity of lodgepole pine?
2. During what period of the year is seed released?
3. What amounts of seed are released?
4. To what distances is the released seed disseminated?

METHOD

The study commenced in the summer of 1952 on the Kananaskis Forest Experiment Station in the subalpine forest region in Alberta. A 58-year-old fully-stocked lodgepole pine stand was selected. While the main stand is even-aged, it does contain a few scattered pine specimens 86 years of age, as well as a few white spruce (*Picea glauca* (Mœnch Voss) var. *albertiana* (S. Brown) Sarg.) and a sparse understory of aspen (*Populus tremuloides* Michx.). (*See* Figure 1.)

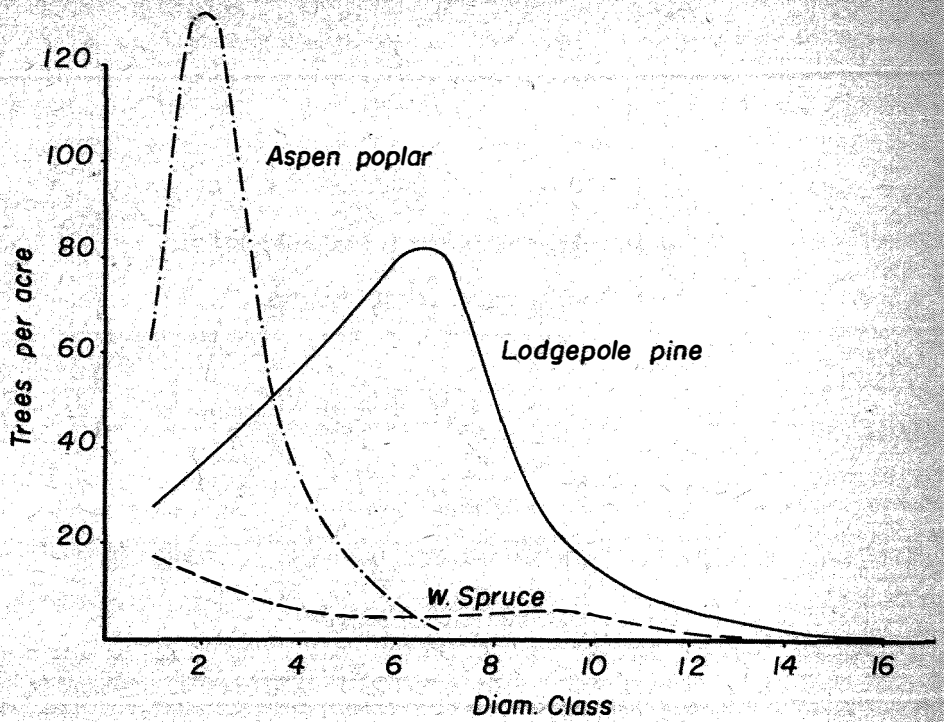

Figure 1. Stand composition in 1952.

Additional stand data are presented in the following table.

TABLE 1.—PER ACRE STAND STATISTICS IN 1952

—	Number	Av. Diam.	B. A.
Lodgepole pine	484	6·1″	98 sq. ft.
White spruce	80	5·4	12
Douglas fir	2	2·0	—
Aspen poplar	318	2·7	12
Total	884		122

The stand borders an open meadow. The prevailing winds blow from the south, or from the stand into the open.

The pattern of the experiment was borrowed from Jemison and Korstian (4), who were working in loblolly pine, and was set up in the spring of 1952 in a 6 × 6 Latin square design (Figure 2) with 2 seed traps placed at random in each cell of the square. Five rows of cells are in the open and contain standard $\frac{1}{3}$-milacre seed traps using 4-mesh hardware cloth as a top and fourdrinier cloth as a base upon which the seed collects. (*See* Plate 1.)

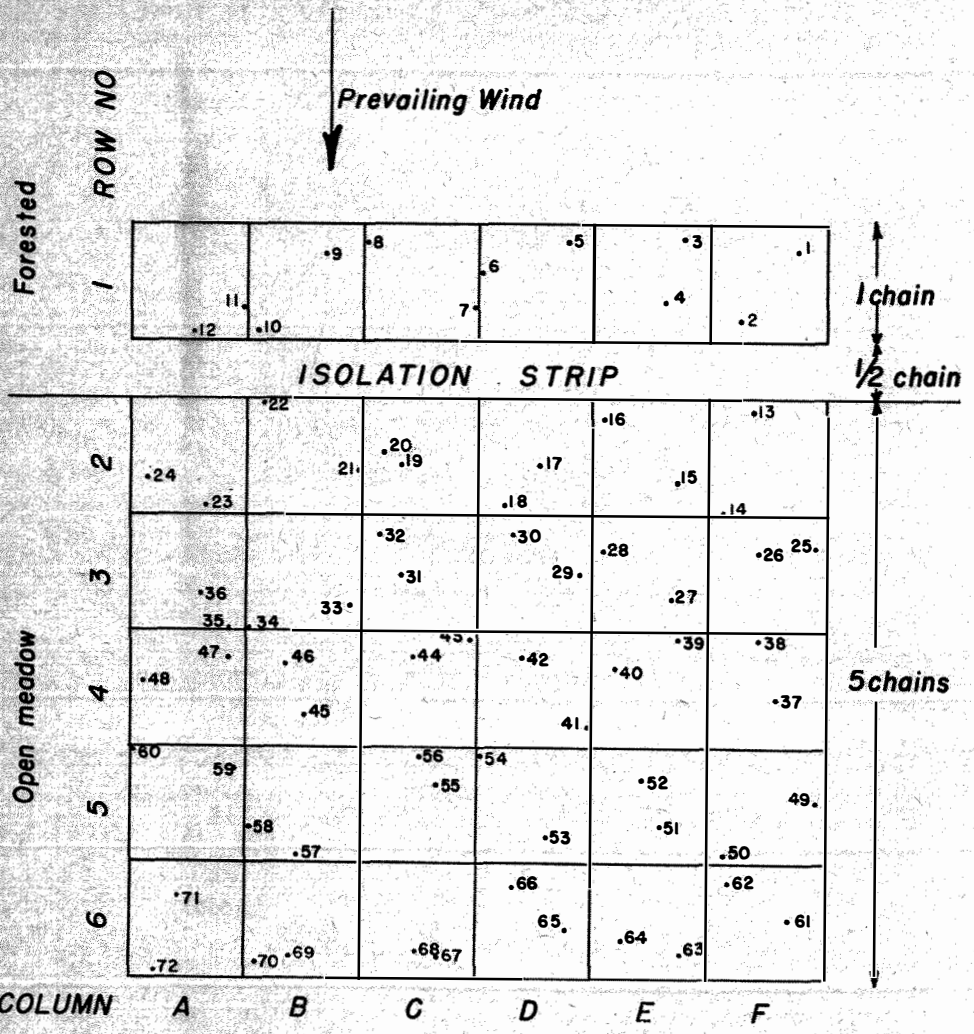

Figure 2. Design of the experiment. Numbers indicate the original location of seed traps.

The 6th row of cells is under the stand of timber, ½-chain inward from the edge. Each cell in this row contains 2 circular seed traps especially designed for use throughout the year. They are patterned after an expendable seed trap designed by Easley and Chaiken (3). The circular hopper, ⅓-milacre in orifice area, made of galvanized iron, collects falling seeds that slide down through an opening at the base into a small pan hanging below, the top of which is covered with 4-mesh wire screening and the bottom with fourdrinier cloth. (*See* Plate 2.)

The fact that the seed trap used in row No. 1 within the stand is of a design different from that used in the open should not invalidate subsequent analyses because both designs have the same catchment area.

The standard seed traps rapidly fill up with snow in the winter and are useless during that season of the year. On the other hand the conical traps can, with care, be used throughout the year. At the time of the first snowfall the small pan is removed and replaced by a large bucket. After each snow

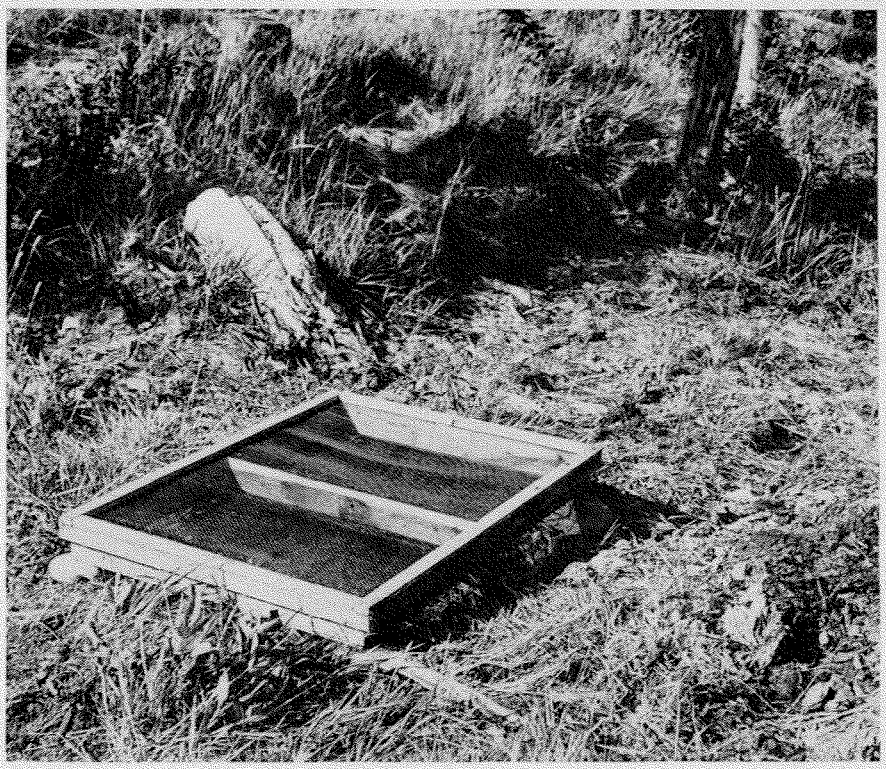

Plate 1. Standard seed trap used in the open.

Plate 2. Circular seed trap used under the stand.

storm, and during the storm if it is severe, the snow slides or is pushed down the hopper into the bucket. After replacing this bucket with an empty one, the first is taken to a heated room, the snow allowed to melt and the seeds collected by screening out.

Seed collecting commenced on the 1st of July, 1952, and has continued for almost 3 years (until April 4th, 1955) without interruption, with the exception that the collections from the standard traps in the open were discontinued as soon as they filled up with snow each year, new collections commencing again in the spring. The weekly collections made throughout the year in the conical traps provide the data on the periodicity and amount of seed released from the stand under study. The weekly collections from the standard traps in the open provide data on the distance of seed dispersal during the snow-free period. It is quite possible that the seed liberated during the winter months is disseminated to greater distances than that liberated during the other seasons of the year, simply because much of it could scud with the wind on the surface crust of the snow. We have not yet devised a method of verifying this possibility.

At the time of collection each week the standard traps in each cell were moved to a different location within the cell. The conical traps were not moved because the le s were sunk into the ground and moving would have been too laborious.

After the seed was collected, cutting tests were made on each sample and the amount of full seed recorded by species. It was originally intended to record full and empty seed and thus obtain an estimate of viability. However, much of the empty seed had broken into fragments by the time of collection from the traps and it was therefore impossible to obtain an accurate count.

RESULTS

Data have been collected for almost 3 years (July 1st, 1952, to April 4th, 1955)[1] and the results obtained are presented in Figures 3 and 4 which graphically portray the seasonal distribution of lodgepole pine and spruce seedfall within the stand, and in Figure 5 in which the seed distribution downwind throughout the 3 years of study is presented.

The significance of the results has been tested by an analysis of variance.

TABLE 2.—ANALYSIS OF VARIANCE OF LODGEPOLE PINE SEED PRODUCTION OVER A 3-YEAR PERIOD

Source of var.	D.F.	Ss	Ms	F	Significance
Rows*	5	2,832	566·4	28·462	Highly significant
Columns	5	200	40·0	2·010	Non-significant
Years	2	222	111·0	5·578	Highly significant
Error	95	1,890	19·9		
Total	107	5,144			

* Rows correspond to distance from seed source.

[1] All data relates to full seed.

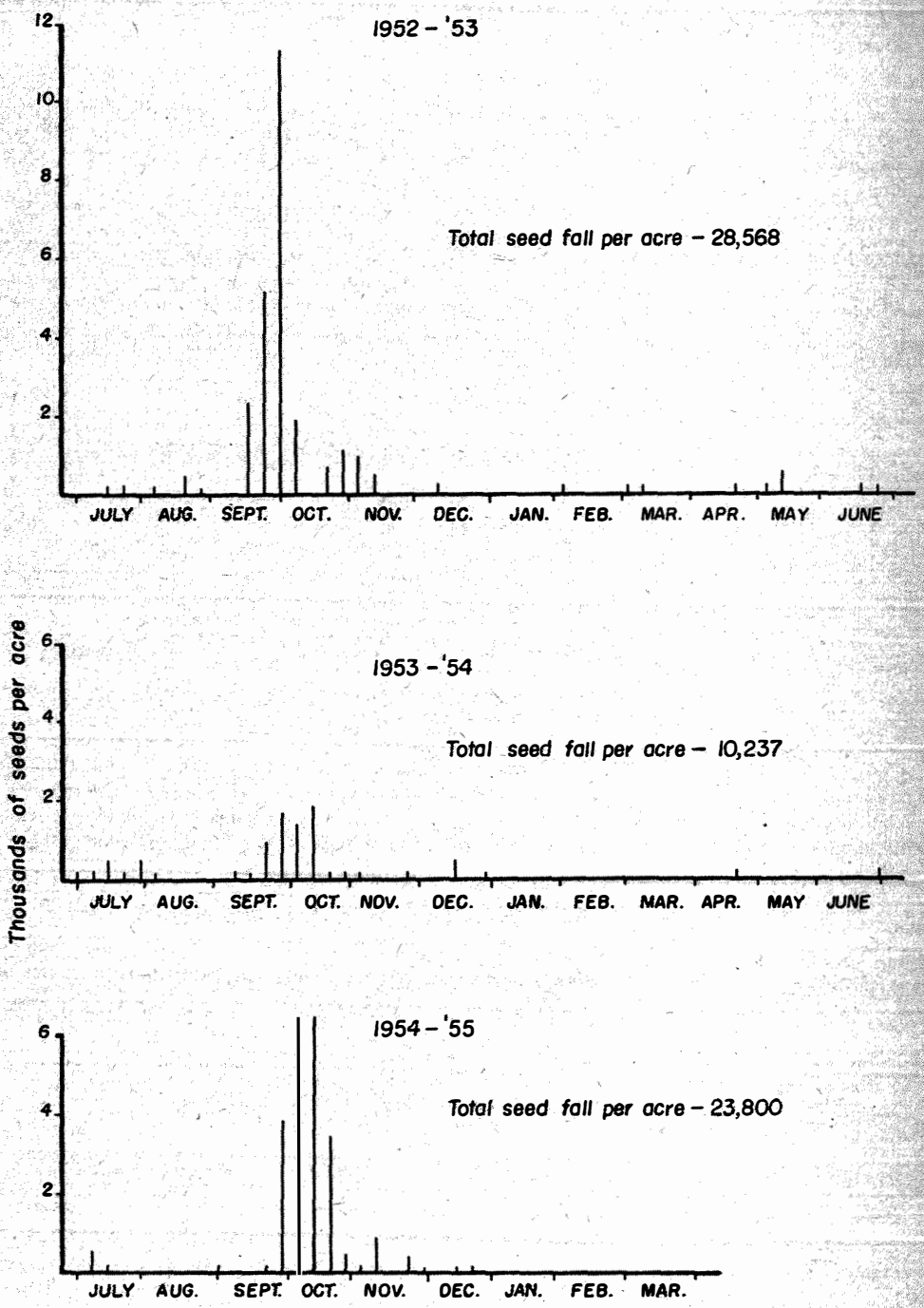

Figure 3. Seasonal distribution of lodgepole pine seedfall.

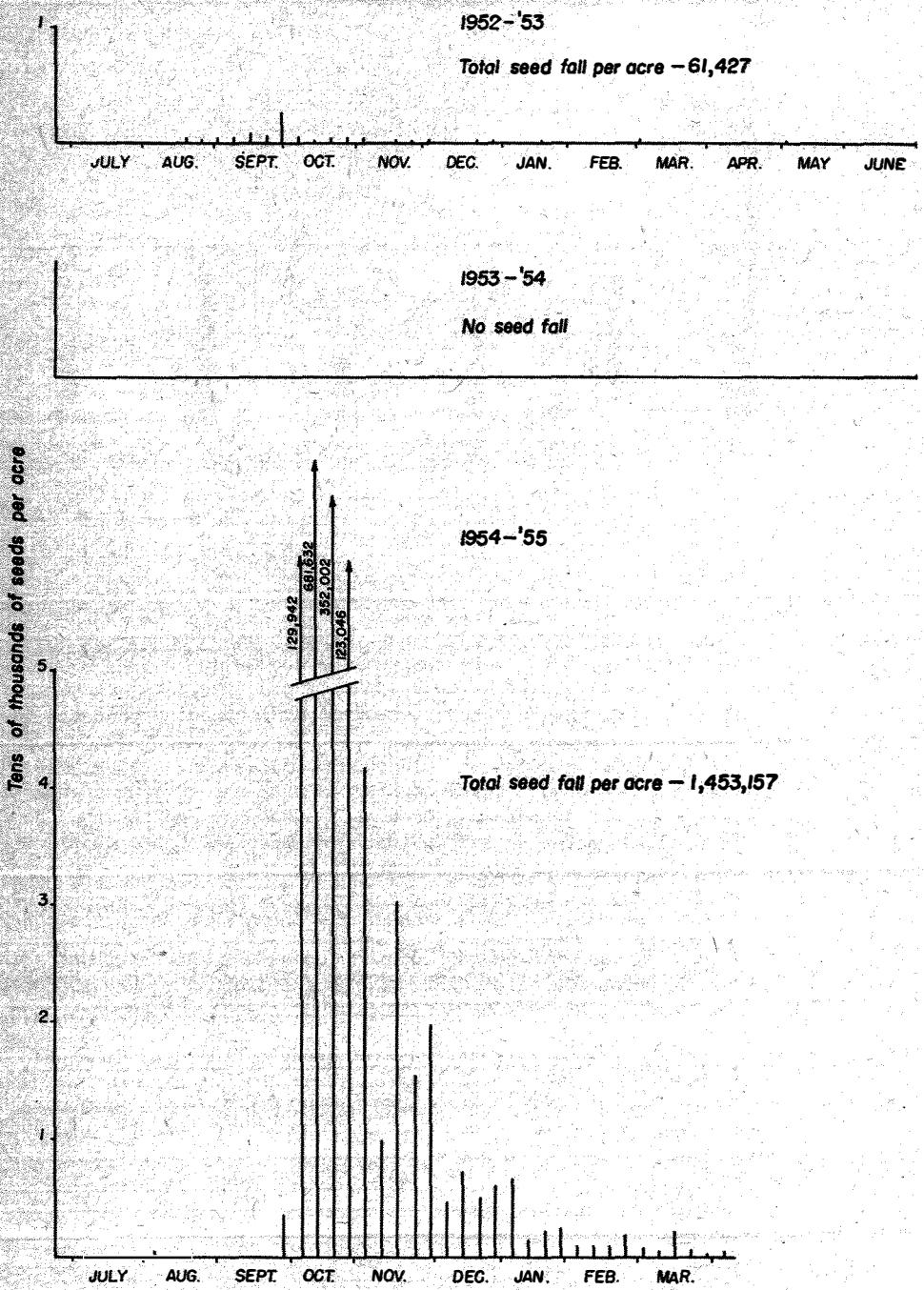

Figure 4. Seasonal distribution of white spruce seedfall.

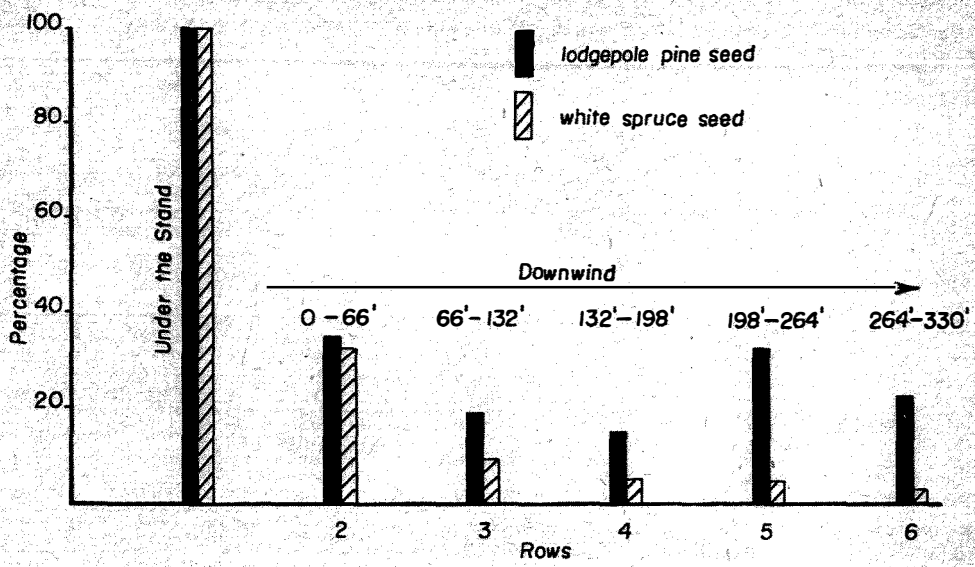

Figure 5. Relationship of downwind seed distribution in comparison to the amount falling within the stand.

In the light of the results of the analysis of variance, t-tests of the significance of the individual row distances, and also the differences between various yearly crops, were carried out. These results may be interpreted as follows:

1. The amount of lodgepole pine seed falling immediately beneath the uncut stand was significantly higher than that falling in any of the rows in the open (Figure 5). However there were no significant differences in seed catch between the 5 rows in the open. The failure of the experiment to show a strong decrease in seed catch with increasing distance from the primary seed source may have been due in part to seeding on the open area from leeward stands.

2. There was also a significant difference in total annual pine seedfall between the three years during which the study took place. Both 1952-53 and 1954-55 showed significantly higher seedfall than 1953-54. However, there was no significant difference between the 1952-53 and 1954-55 crops.

While this was not intended as a study of white spruce seed production and dispersal, the fact that there is a small percentage of this species in the pine stand does provide the opportunity of comparing the behaviour of the two species. The amount of spruce seed collected in the conical traps under the stand is graphically portrayed in Figure 4. When comparing this with Figure 3, it should be noted that the abscissa scale in Figure 4 is ten times as great. Since the spruce constitutes only 14 per cent of the coniferous portion of the stand, the tremendous difference between spruce and pine seedfall is apparent.

Analysis of variance carried out on the spruce collection data showed parallel results to that undertaken on the lodgepole pine data; i.e. the differences between annual seedfall and between distances from seed source were significant.

DISCUSSION AND CONCLUSIONS

While 3 years' collection of data is scarcely sufficient on which to base any conclusions about the seeding periodicity of any species, the resu ts to date do indicate that lodgepole pine cones release small amounts of seed continuously from stand trees; that such release is at a maximum at the time of annual cone ripening; and that there is evidence of significant differences in the amount of seed released annually.

The study was not designed to provide the answer to the effectiveness of the pine seedfall actually experienced. Nothing is known of the amount of seed required to re-stock a clear-cut acre to 1,000 established lodgepole pine seedlings, and therefore it is not intended in this publication to do other than comment on the adequacy of the seed-fall experienced. Annual pine seedfall to leeward during the 3 years of the study varied from 550 to 2,450 viable seeds per acre, with an average of 1,517 seeds. It is generally recognized that there is a considerable loss of seed to birds and rodents, and it is therefore sur ised that the amount of pine seed released during the period of this study to date has been completely inadequate for the purpose of re-stocking the 5-chain-wide strip to leeward, nor does it appear sufficient to adequately re-stock even the chain-wide strip adjacent to it. Unfortunately, no data are available on stocking. The open area to leeward is a natural meadow and is not receptive, but such a conclusion appears justified since the pine seedfall is insignificant in comparison with the spruce in spite of the fact that the spruce constitutes only 14 per cent of the coniferous portion of the stand.

On the other hand, reports on two previous strip-cutting projects in pine (1 and 2) showed that in both cases adequate stocking has been obtained when the only source of seed appeared to be the marginal stands.

The seeds of pine and spruce are very much alike. Size and weight are about the same and they are similarly winged. One would therefore expect leeward distribution to be very similar. That such is not the case (Figure 5) can possibly be explained by the fact that the heavy seedcast of pine took place in late September and early October in all 3 years during which records have been kept. On the other hand, the autumn of 1954 was the only one, out of the 3 recorded, during which much spruce seed was released and the preponderance of spruce seedcast took place about a month later than pine. Since the distance of seed dissemination depends upon the amount of wind, comparisons would be possible only if both species released their seed at the same time.

SUMMARY

Three years' records of seed production and dispersal in a fully-stocked 60-year-old stand of lodgepole pine on the Kananaskis Forest Experiment Station in the subalpine forest region of Alberta show the following:

1. Small amounts of pine seed were released continuously, and such release was at an annual maximum at the time of cone ripening.
2. Maximum annual pine seedfall occurred over a 4- to 5-week period, which, during the 3 years of the study, climaxed around the first of October.
3. While no year resulted in a nil shedding of pine seed, there was a significant difference in the amount of seed shed annually.
4. Seed was disseminated from the marginal stand a distance of at least 5 chains (330 feet) downwind during the snow-free period of the year.

5. The nature of the study does not permit an evaluation of the adequacy of pine seedfall for the purpose of regeneration and stocking, other than to say that it appeared to be very meagre in comparison with spruce seedfall.
6. Some seed of both pine and spruce fell during the winter months and was thus in a position, provided conditions were right, to scud for considerable distances over the snow crust.

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