Determination of Interior Spruce Cone Efficiency

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INTRODUCTION

Typical cone and flower abortion losses for some seed orchard species are in the range of 20 - 40 % (Sweet 1975) and considerably higher losses have been reported (Bartram 1982, White et al. 1977). Presently no information has been quantified about seed production losses from interior spruce ramets. If the losses are of a significant magnitude to affect cone and seed production targets, the potential causes should be systematically investigated and corrective measures taken to prevent the losses; provided that those measures are economically justified. The objective of this study is to address the first problem area.

It is impractical to quantify cone/flower abortion losses exactly by monitoring every flower in an orchard. A sampling procedure as required which ideally will yield unbiased loss estimates of known precision. One approach that has proved successful in coastal Douglas-fir orchards is multistage sampling with:

1) equal probabilities of selection; and

2) replacement
at each stage. This method is operationally feasible and will yield unbiased estimates and standard errors that can be easily calculated if certain verifiable assumptions are valid\(^\text{1}\).

A multistage sampling approach identical to that employed in the Douglas-fir orchards to quantify abortion losses was used and the adequacy of this method is discussed for possible future use in interior spruce orchards.

OBJECTIVES

1. To provide a preliminary estimate of cone efficiency (=no. cones harvested/no. flower initiated in the East Kootenay breeding arboretum using a multistage sampling method.)

2. To ascertain if multistage sampling with equal probabilities of selection and with replacement at each stage is a satisfactory approach for interior spruce orchards.

MATERIALS AND METHODS

1. Specification of study population

The 235 ramets described in SX85602K "Can we attain our seed production goals with interior spruce?" constituted the study population. In April of 1985 each ramet, as identified in Appendix 1, was categorized as follows:

\(^{1}\) It must be assumed that the variable of interest is uncorrelated with unit size at each level of sampling. If this is the case, a simple arithmetic mean of sample values will yield an unbiased estimate of the population mean (Sukhatme and Sukhatme, 1970. p. 342).
1. no flowering branches
2. 1 to 20 flowering branches
3. > 20 flowering branches.

A flowering branch was defined as having at least three female strobili. Two populations were identified. Study population 'A' consisted of all ramets with at least one flowering branch. Study population 'B' consisted of all ramets with more than twenty flowering branches. Many ramets were included in both sample populations.

2. Estimation of cone efficiency

One hundred one ramets were randomly selected from study population 'A'. Each ramet was divided into crown segments (whorls). A segment was randomly selected as was an individual branch. This multistage sampling technique is described by Cochran, W.G. 1977, p. 286.

The total number of flowers on each selected branch and branch position was recorded in the Spring, 1985. During the Fall, 1985 all mature cones were collected from each sample branch.

3. Evaluation of multistage sampling

All ramets with more than twenty female flowers were used in study population 'B'. This study population was to be used to determine the efficiency of the sampling technique. However, as the results indicate, no comparison between sampling techniques could be determined as virtually no flower mortality was observed.
DATA ANALYSIS AND RESULTS

1. Cone Efficiency

Cone efficiency (CE) for sample population 'A' was calculated using the following formula

\[
CE = \frac{\text{no. cones harvested}}{\text{no. female flowers}}
\]

The cone efficiency for sample population 'A' (multistage sampling) was greater than 98.8%, based on, 543 cones collected from 50 of the 101 sample branches (Appendix 1). Because cone efficiency was so high, thus abortion very low, no further analysis were possible, i.e. between branches, position or segment. Similarly, no comparisons could be made between the multistage sampling technique and entire ramet counts.

DISCUSSION

Cone abortion was not a problem in 1985 in the East Kootenay breed arboretum located at the Kalamalka Research Station. However, as indicated in the Introduction, cone abortion has posed serious threats to potential seed production in some seed orchards and should be carefully monitored in all orchards in the interior of British Columbia.
LITERATURE CITED


APPENDIX 1


50 branches counted - initial # of cones = 543

40 had same number of cones as flowers in spring.

4 had more cones than counted flowers
(27-29 +2
  8-9  +1
15-17 +2
15-16) +1 = +6

6 had fewer cones than counted flowers
  9-7  -1
  38-37 -1
  15-14 -1
  15-14 -1
  17-16 -1
  14-13 -1 = -6

If we assume all increases were due to counting errors and all decreases were due to abortion:

max. abortion rate = \frac{6}{543} = 1.1%

\text{CE} = \frac{543}{549} = 98.9\%