

POLLEN CONTAMINATION IN ALBERTA'S SEED ORCHARDS: A SUMMARY

Fall 2021

Overview

The Alberta Forest Genetic Resource Management and Conservation Standards (FGRMS, 2016) require pollen monitoring to be performed for each year a seed crop is collected. The data are collected using pollen monitors (traps) outside and inside the orchard, and a surrogate species is used to estimate the amount of pollen from outside the seed orchard under study (pollen contamination). The contamination rates are then used to correct the genetic gain of each year's crop. The amount of external pollen depends on wind direction, location, masting (in spruce), distance to nearby orchards, and how close the synchrony is between genotypes regarding pollen production and conelet receptivity. In 2020, pollen monitoring in seed orchards was not required, therefore companies and GoA reported the average historical pollen contamination rates of seed orchards from each Controlled Parentage Program (CPP) (Fig. 1). These average values were used (as optional) to calculate the genetic gain of the 2020 crops. The overall average from all orchards was 11.1% (lodgepole pine) and 23.5% (white spruce) based on historical pollen contamination levels.

Pollen contamination in lodgepole pine orchards

Lodgepole pine has historically shown lower pollen contamination levels compared to white spruce (Fig. 1). The lowest pollen contamination levels recorded have been found in the B1Ph1 (1.5%) and B2Ph1 (2.8%) orchards, and the highest levels were found in the P1 (23.2%) and A (18.5%) orchards (Fig. 1). Some examples of annual variation in pollen contamination are shown in Figure 2. Region A (2- years-old), B1Ph2 (16-years-old), and the B2Ph1 (27-years-old) orchards showed higher pollen contamination levels from 2007-2012, when the orchards may have been producing a smaller pollen cloud themselves. The B1Ph1 orchard (35-years-old) shows consistently low rates between 2007 and 2016 (Fig. 2).

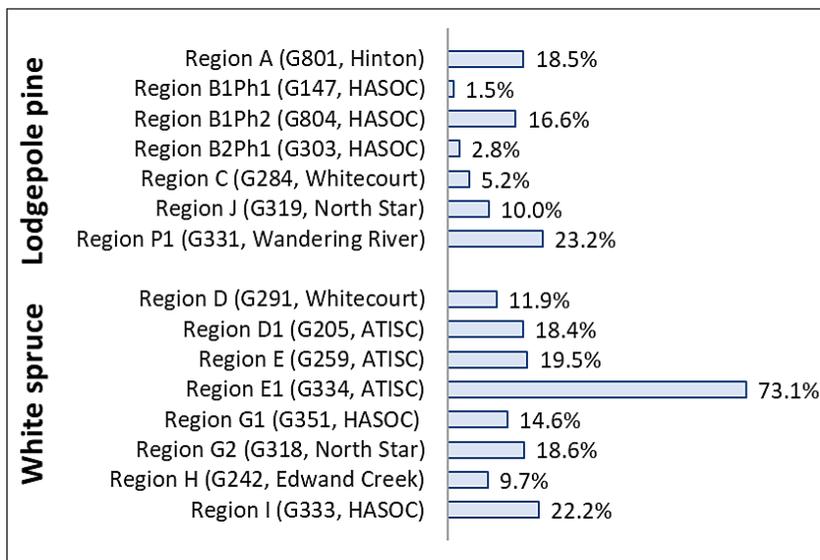


Figure 1. Average historical pollen contamination levels of the lodgepole pine and white spruce Controlled Parentage Program orchards in Alberta, reported in 2020. Data was obtained from the "Approval letter" for the use of average pollen contamination rates for genetic gain calculations, for each seed orchard (Government of Alberta, April 30, 2020).

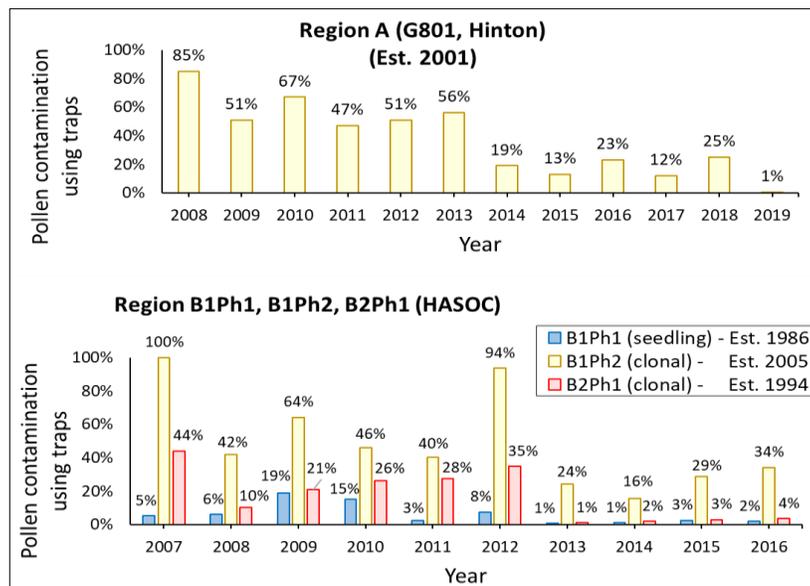


Figure 2. Pollen contamination levels from Region A (established in 2001), B1Ph1 and B2Ph1 lodgepole pine orchards in Alberta from different years. For the orchards at HASOC, the type of orchard (clonal or seedling) is also detailed in the figure. Est.= year of establishment. Data was provided by West Fraser and Incremental Forest Technologies.

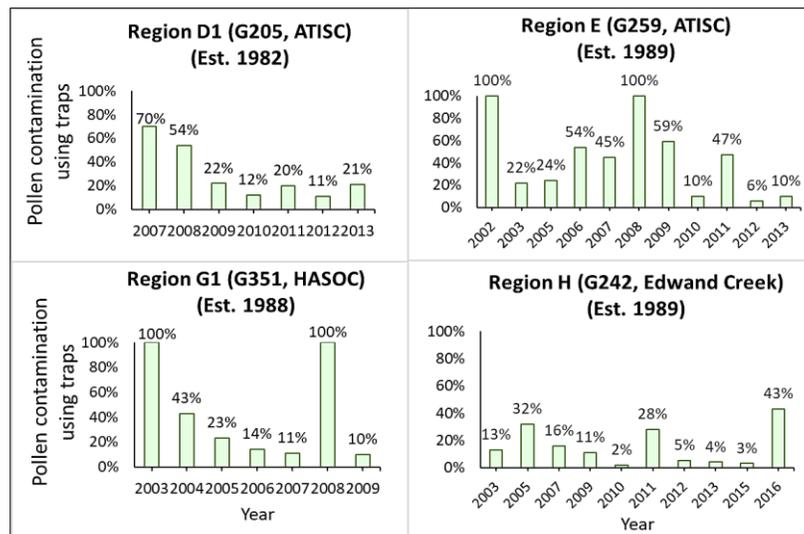


Figure 3. Pollen contamination levels from Region D1, E, G1 and H white spruce orchards in Alberta at different years. Data was provided by ATISC and Incremental Forest Technologies companies. Est.= year of establishment.

Pollen contamination in white spruce orchards

The highest pollen contamination levels among all white spruce orchards in Alberta is in the Region E1 (73.1%) and E (19.5%) orchards, and the lowest rate is in the Region H (9.7%) orchard (Fig. 1). White spruce orchards show contrasting rates, going from 11%-70% (D1), 6%-100% (E), 10%-100% (G1 orchard), and 2%-43% (H) (Fig. 3). It is surprising that Region E (ATISC) and Region G1 (HASOC) programs have reported rates of 100% pollen contamination for years 2002, 2003 and 2008, and could benefit from corroboration using alternative methods (i.e. genotyping) which may improve the genetic gains calculated for those seedlots.

Pollen contamination estimates using genomic profiles (SNPs)

Overall, the pollen contamination levels calculated by pollen traps were not correlated with the genomic profiles, for the Region G1 orchard (Table 1). However, levels of pollen contamination estimated with genomic profiles showed a strong correlation ($r=0.92$) with wind direction during the time period when pollen is at maximum dispersal and conelets are at maximum receptivity in Alberta (between 15 and 31 May) (Table 1). This correlation showed that with a minimum of 11 days with a prevailing wind direction (Table 1) coming from a relatively close (1000 m away) pollen source, to the target orchard during peak pollen production and conelet receptivity, has resulted in up to 50% pollen contamination (Fig. 4). These findings demonstrate the potential advantages of using genomic profiles to calculate pollen contamination levels in Alberta.

Seedlot	Pollen contamination		Wind direction (average)	Days with west wind direction
	Using traps	Using SNPs	Degrees	No.
2003	100%	51%	236°	11
2005	23%	26%	201°	6
2007	11%	28%	223°	7
2009	10%	12%	191°	8
2018	n/a	18%	201°	6

Pearson correlation: 0.92

Table 1. Pollen contamination levels using pollen traps (HASOC) and SNPs (Thomas lab) for each year, at the G1 orchard. The information was taken from Nature Scientific Reports (2021) 11:4990.

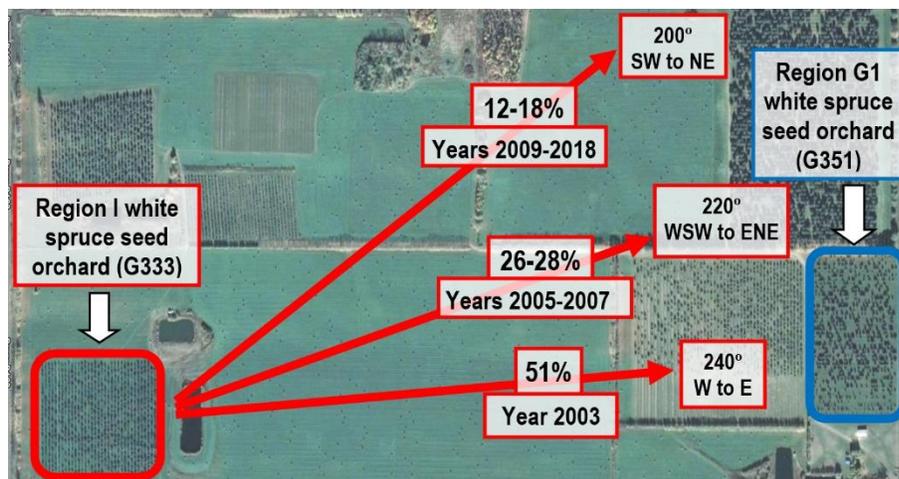


Figure 4. Diagram showing the wind (pollen) direction at HASOC, mainly going from west to east every year. Region I orchard is a potential contamination source of pollen for the Region G1 orchard, with variable levels depending on the specific wind direction and duration each year.

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