Tree Improvement Branch

Cone and Seed Improvement Program
BCMoF Tree Seed Centre

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Growing Degree Days and Seed Maturation

Here is a listing of articles related to degree-day summations and cone crop development. It isn't a thorough literature review, but a capture of references readily available in my files. Please forward any additional references and we'll include them in the next Newsbulletin. In Table 1, I've tried to summarize the pertinent information from these references related to growing degree days (GDD) and seed development including the minimum GDD accumulation for normal seed development, the starting point, threshold used and basis of accumulation. Most of the references used a similar method of calculating GDD using the daily mean temperature and a threshold of 5°C, but not all studies used the same starting point.

Reference	Species	Minimum GDD	Starting Point	Threshold / basis
Mercier & Langlois 1999	*Picea glauca*	1276 ± 112 **1943 ± 155 TU**	temperature >0°C	> 5° C / daily mean **Thermal Units**
Meunier *et al.* 2007	*Picea mariana*	800-940	temperature >5°C	> 5° C / daily mean
Mosseler 1992	*Picea mariana* *Picea glauca*	900 1100	after pollination	> 5° C / daily mean > 5° C / daily mean
Mosseler *et al.* 1993	*Picea mariana* *Picea glauca*	800 900	after pollination	
Sirois 2000	*Picea mariana*		temperature >0°C in growing season	> 5° C / daily mean
Noland *et al.* 2006	*Pinus strobus*	1996 period – 321 2000 period - 356	April 1 to June 15	> 5° C / daily mean
Sirois *et al.* 1999	*Picea mariana*	800-944	starting June 6th	> 5° C / daily mean
Tanaka & Cameron 1979	*Pinus ponderosa*	1310	Starting June 1st	> 5° C / daily mean
Winston & Haddon 1981	*Picea glauca*	1222-1275	Starting May 22 (pollen shed)	> 5° C / daily mean
Zasada 1973	*Picea glauca*	681-751	after pollination	> 5° C / daily mean
Zasada 1987	*Picea glauca*	670-700 for 75% embryo growth	after pollination	> 5° C / daily mean

Most of the articles deal with white or black spruce indicating we have very little information available on GDD requirements for other tree species. The date to start accumulation of GDD was the least consistent variable and explains a large part of the different minimum GDD estimates for white spruce between the Zasada (1973) and Mercier and Langlois (1999) paper. The latter paper is interesting as it uses fireweed as an indicator plant to integrate environmental factors together. Mercier and Langlois (1999) found the strongest correlation between germination - and fireweed

capsule bursting (r=0.92), followed by thermal units (r=0.88), and then GDD (r=0.84). In terms of temperature accumulation it appears that thermal units are worthy of further exploration. Previous studies have suggested other variables (i.e. solar radiation, precipitation, latitude, humidity and wind) may interact with GDD to influence seed maturation and should be considered further (Winston & Haddon 1981; Zasada 1973). Fortunately a variety of programs are available today that can provide additional climate variables to assist in this type of exploration (i.e. Climate BC[1]). Lastly, I'll draw your attention to Figures that illustrate megagametophyte and embryo development across GDD in Sirois et al (1999 –Figure 21) and Meunier et al (2007 – Figure 2). Imagine those images integrated with the initiation of cone attack on cone phenology images presented in Turgeon and DeGroot (1992) and you have a very powerful extension and planning tool.

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[1] Climate BC - http://www.genetics.forestry.ubc.ca/cfcg/climate-models.html

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