Using Growing Degree Days to Predict the Growth and Development of Perennial Ryegrass in Manitoba

Growing degree days (GDD) are a measurement of heat accumulation, which are used to predict crop development. GDD based models for crop development have been developed for many different crop types. GDD have other applications as well, such as predicting pest outbreaks. By incorporating GDD into management decisions, producers can improve their practices. It was recognized that research regarding GDD for forage seed crops in Manitoba was not available. As explained in the 2013 Manitoba Forage Seeds Association GDD report, data from other regions, cannot be used in Manitoba. As a result, a project was initiated to develop a model to predict perennial ryegrass (PRG) crop development based upon GDD in Manitoba. The formula for calculating GDD is:

$$GDD = \frac{T_{\max} + T_{\min}}{2} - T_{\text{base}}.$$

In PRG T_{base} = 0°C.

Over the past three years, 2012-2014, 18 fields were used in the study. For an accurate representation of the entire province, fields were selected from the different growing regions including the eastern region, the south/central region, the interlake region, and the north/west region. Reliable weather data was critical for this study. If a MAFRD or Environment Canada weather station was near one of the selected fields, information from that station was used to determine the accumulated GDD. If a weather station wasn't nearby, a portable weather station would be set up in the field in the field. Daily maximum and minimum temperatures were recorded so that GDD could be calculated. Fields were scouted to determine crop stages throughout the growing seasons. The crops were scouted on a weekly basis while they were maturing rapidly. Once all of the data for the season was collected, accumulated GDD were matched with the growth stage of the crop. The Zadocks scale was used for crop staging.

Results

A summary of the data that was collected during the past three years can be seen in Table 1 below:

Growth Stage		Zadocks Scale	GDD °C Average
Stem Elongation	1st node detectable	31	350-400
	2nd node detectable	32	400-450
Booting	Flag Leaf sheath extending	41	500-550
	Infloresence nearly visible	49	500-600
Inflorescence	Half of Inflorescence emerged	55	650-700
Anthesis	Begining of Anthesis	60	750-950
	Anthesis Completed	69	950-1200
Swathing		92	1300-1500

Table 1: Summary of PRG GDD Values for the Different Crop Stages.

This data should be used by producers as a guide for scouting. Agronomic recommendations can then be made after scouting takes place. For example, it is recommended that plant growth regulator applications take place at the second node stage. This means at 400 GDD producers want to be in their fields to confirm plant stages. Similarly, fungicide application may take place at 50 percent inflorescence, and at 650 GDD producers should be in their fields to confirm plant stages.

It is important to understand the variability within this data. Table 2 below illustrates this variability for some of the critical growth stages:

Growth Stage	Average GDD	Standard Deviation GDD	Coefficient of Variation GDD
2nd Node	415	63	15
5o% inflorescence	674	56	8
Swathing	1416	166	8

Table 2. Variability in GDD of Crop Growth Stages

After examining the standard deviation, it is evident that field scouting is necessary to confirm crop stages. While the variability was relatively low at some of the early crop stages, it increased significantly at swath timing.

Discussion

PRG GDD data can be used to help predict crop development. Of course this data is a guideline, and each year poses its own unique challenges which affect crop development in addition to GDD. If we look closer at the three seasons used in this study, 2012, 2013, and 2014, it is easier to understand some of these differences. In 2012 there was an early start to the growing season; however, a hard late frost set back the crop development. Then, above normal temperatures meant that there was a fast accumulation of GDD in the season. From this experience in 2012, it is important to note that the day in which we begin to collect GDD is critical. Typically we want to begin accumulating GDD when the PRG "greens up", but if there is a hard frost which sets the crop development back, it may be necessary to

reset the accumulation of GDD to zero. This was the case in 2012. 2013 was more of an average year, but some of the PRG fields became quite dry in July. In 2014, many PRG fields were under heavy moisture stress early spring, resulting in a delayed development. As a result more GDD were required to produce a crop in this season than the other two seasons.

Other than GDD, there are other factors that influence crop development. For instance, if PRG was fall seeded, rather than spring seeded, more GDD were required to produce a crop. Therefore, with fall seeded crops, you should expect your crop to develop towards the end of the expected GDD range, for any particular crop stage. Crop variety also can influence development. Several different varieties of PRG were used in this study, but there is not enough data to be able to compare the individual varieties for differences. Additionally, there are many microclimates within Manitoba which influence crop development. Again, there is not enough data to compare whether or not there is a significant difference amongst the different regions within Manitoba.

While this is the first PRG GDD model available for Manitoba growers, more work can be done to increase its accuracy. Data collection over several more years, would increase the accuracy of this model. Even then there would be variation, since there are other factors which affect development, which has been discussed already. All of this should be considered when trying to predict crop development. Other applications for the GDD model include predicting the life stages of insects, and estimating crop yield. Moving forward this is the type of information that could be used with the Manitoba PRG crop development model.

Growers will need access to GDD information, with a base temperature of 0°C throughout the season in order to utilize this information. While this service is already available for some of the other provinces, the province of Manitoba should have this information available online in 2015.

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