ESTIMATING THE NUMBER OF GROWING DEGREE DAYS NEEDED FOR KEY DEVELOPMENT STAGES IN WINTER WHEAT

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Figure 1. Winter wheat planting date study at Princeton, KY in 2016. All six planting dates are visible in the image: 29-Jan 2016 (green flags), 20-Oct 2015 (blue flags), 17-Mar 2016 (orange flags), 19-Feb 2016 (red flags), 25-Nov 2015 (yellow flags), and 18-Dec 2015 (white flags).

Weather conditions during the winter wheat growing season can vary substantially each year. For example, in 2014 a late spring freeze threatened the wheat crop. Fortunately, wheat across Kentucky in 2014 was not at a development stage that would cause damage from a freeze due to a very cold and prolonged winter. If the conditions had been more like a typical Kentucky winter then the risk of spring freeze in 2014 would have been great. It also highlights the fact that we do not have a good estimate of the number of days required for winter wheat to reach key development stages.

In the fall of 2015, an experiment was initiated to measure the number of growing degree days, or heat units, required to attain key developmental stages in soft red winter wheat in Kentucky. Three replications of 50 winter wheat cultivars (Table 1) were hand-planted into hill plots (Figure 1) at Princeton, KY on six dates: 20-Oct 2015, 25-Nov 2015, 18-Dec 2015, 29-Jan 2016, 19-Feb 2016, 17-Mar 2016. The date each hill plot attained six key development stages was measured: emergence, Feekes 3 ('green-up' in the spring), Feekes 5, Feekes 6 (jointing), Feekes 9 (flag leaf), and Feekes 10.5.3 (full flowering). Growing degree days (GDD) for each developmental stage was calculated as follows:
GDD = [(daily Maximum Temperature (°F) + daily Minimum Temperature (°F)) ÷ 2] - 32°F
Accumulated GDD are the sum of individual GDD and were calculated for the six developmental stages listed above.

Table 1. The 50 winter wheat cultivars (grouped by relative maturity) used to measure the number of growing degree days needed to reach key developmental stages at Princeton, KY in 2016. The cultivars were grouped by relative maturity using data obtained from the 2005-2016 University of Kentucky Small Grain Variety Testing Program (http://www.uky.edu/Ag/wheatvarietytest/).

Early-Season Cultivars	Mid-Season Cultivars	Late-Season Cultivars
AgriMAXX 412	Bess	Armor Havoc
AgriMAXX 413	Dyna-Gro 9042	Armor Octane
AgriMAXX 415	Dyna-Gro 9223	Armor Rampage
Beck's 113	Equity Brand Sienna	Armor Vandal
Beck's 120	Kentucky American Seed KAS 5058	Beck's 129
Clark	KY03C-1237-05	Delta Grow 7200
Dyna-Gro 9171	KY03C-1237-12	Delta Grow 9700
Kentucky American Seed KAS S1200	Progeny P 117	Dyna-Gro 9343
Pembroke 2016	Pioneer 25R32	Pioneer 25R40
Pembroke 2014	Pioneer 25R78	Southern States SS 8412
Pembroke 2008	Pioneer 26R10	Steyer Pierson
Seed Consultants SC 1321	Pioneer 26R20	Truman
Terral TV8525	Pioneer 26R41	UniSouth Genetics USG 3993
UniSouth Genetics USG 3612	Pioneer 26R53	
	Seed Consultants SC 1342	
	Southern States SS 8340	
	Southern States SS 8700	
	Steyer HUNKER	
	Syngenta SY 483	
	Terral TV8848	
	Terral TV8861	
	UniSouth Genetics USG 3251	
	UniSouth Genetics USG 3438	

Table 2. Accumulated growing degree days (GDD) to attain key developmental stages at the October and November planting dates for soft red winter wheat in 2016 at Princeton, KY.

	Planting Date	
Developmental Stage	**October**	**November**
Emergence	148	-
Feekes 3-(Green-Up)	1075	817
Feekes 5	1335	1165
Feekes 6-(Jointing)	1457	1230
Feekes 9-(Flag Leaf)	1636	1390
Feekes 10.5.3-(Full Flowering)	1902	1654

In 2016, it required approximately 1,000 GDD for winter wheat to attain green-up in the spring, 1,600 GDD for the flag leaf to fully emerge, and 1,900 GDD to reach full flowering for the October planting date. For the November planting date, GDD were reduced to about 800 for green-up, 1,400 for flag leaf, and 1,700 for full flowering.

A better understanding of the number of GDD to attain key developmental stages in winter wheat is important to aid in crop management. For example, if a late spring freeze occurs the number of GDD can help producers know whether their wheat crop is at a vulnerable stage or if it had not developed to a stage that would be injured.

This study will be repeated at Princeton and Lexington, KY for the 2017 to provide additional data to develop approximate GDD required to attain key winter wheat developmental stages in Kentucky. In addition, information on the photoperiod and vernalization genes will be obtained to better explain the response of different cultivars to varied planting dates. These data will be used to develop crop models and decision tools that will alert producers to impending weather conditions that may damage their wheat crop.