Agronomy Guide
Purdue University Cooperative Extension Service

Corn AY-312-W

Delayed Planting & Hybrid Maturity Decisions

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- Delayed planting of corn shortens the available growing season.
- Fortunately, corn hybrids adjust to shortened growing seasons.
- Adapted hybrid maturities can be planted in Indiana and Ohio until early June.

Frequent and/or excessive rainfall can delay the planting of field corn in the eastern U.S. Corn Belt beyond the optimum late April to early May time frame. Additionally, fields planted during the optimum time frame occasionally require replanting at later dates when early-season weather stresses or pests cause excessive plant mortality. When planting is delayed, one of the obvious decisions that grain producers need to consider is whether or when to switch from normal hybrid maturities to earlier maturities in response to the ever-shortening growing season and the increased risk of fall frost damage to immature corn grain.

Traditional relative maturity ratings of hybrids (i.e., “days to maturity”) are of little help in determining whether a hybrid will safely mature before a killing fall frost. The “days to maturity” ratings of hybrids are simply indicators of relative grain moisture differences among hybrids of a given company at harvest and do not refer to absolute calendar time from planting to maturity.

A potentially better description of the growing season requirements of a corn hybrid is one based on the thermal time required between planting of the hybrid and physiological maturity (kernel black

Calculating GDDs

GDD values represent the amount of heat accumulated over a period of time. The Modified 86/50 Cutoff method for calculating GDD accumulations is the one most commonly used in the U.S. for relating heat accumulation to corn growth and development. The basic formula for number of GDDs per day is the daily average air temperature minus 50. The daily average temperature is calculated simply as the average of the daily high temperature + daily low temperature, with the caveat that the daily high temperature is limited to no more than 86^{o} F and the daily low temperature is limited to no less than 50^{o} F.

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layer) of its grain. Terms used to describe thermal time include "growing degree days" (GDD), "growing degree units" (GDU) and "heat units" (HU). A shorter growing season due to delayed planting means fewer available GDDs to mature the corn crop (see text box: Calculating GDDs). We should be able to match those expected GDDs with the GDD requirements of various hybrid maturities to determine whether earlier maturity hybrids are necessary for delayed plantings.

Tables 1 and 2 list both the "comparative relative maturity" (CRM) and growing degree days (GDDs) for commonly grown hybrid maturities planted in late April to early May for geographic areas of Indiana and Ohio. Growers should recognize that seed companies do not always follow similar procedures for determining hybrid "days to maturity" values or GDD values to maturity.

Because of the absence of uniform industry standards for hybrid maturity ratings, we elected to define hybrid maturities in this publication in terms of CRM values and GDDs that correspond most closely with those used with Pioneer™ brand hybrids[3] since most growers can probably relate to those definitions. Another reason we chose to use Pioneer™ brand hybrid ratings in this publication is that we know from their sales literature (Pioneer Hi-Bred Int'l, 2001) that their hybrids are rated according to GDD accumulations from planting to kernel black layer.

Consequently, we can describe the relationship between relative hybrid maturity ratings and growing degree days to kernel black layer (Figure 1.)

One can then use this relationship to estimate the GDDs from planting to black layer for other companies' hybrids of similar relative maturities. For example, if you believe that the relative maturity of one of your hybrids is comparable to a 112-day (CRM) Pioneer™ brand hybrid maturity, then Figure 1 suggests that the GDDs from planting to black layer for your hybrid would be approximately 2700. With this estimate in hand, growers can then begin the process of determining safe hybrid maturities for late planting situations.

We hesitate to use the terms "full season" or "adapted" because of geographical differences in how growers define those terms (see text box: Hybrid Maturity & Geography). Instead we simply call them "commonly grown" hybrid maturities and their inclusion in the tables are based on the integration

Hybrid Maturity & Geography:

The relationship between availability of seasonal GDD and the definition of "adapted" hybrid maturity varies from north to south, at least in Indiana. Growers in northern and east central Indiana often "push the envelope" by using hybrid maturities that will likely mature within only a week of the average date of the first fall frost (32^{o} F). Growers in west central and central Indiana often plant hybrid maturities that will mature about three weeks before the average first light frost in the fall. Growers in southern Indiana, especially southwest Indiana, often use hybrids that are 5 to 10 CRM earlier than what would be theoretically "adapted" for the expected seasonal GDD in that portion of the state and which mature more than three weeks before the average first fall frost.

[3] Reference to commercial brand names does not constitute an endorsement by Purdue University or The Ohio State University.

of the following criteria:

- The availability of GDDs during a "normal" growing season,
- Our belief that one should aim for grain maturation to occur about three weeks prior to a typical (50% probability) fall frost (32^{o} F), and
- Our knowledge of the typical hybrid maturities grown in each area of these two states.

Given the commonly grown maturities listed in Tables 1 & 2 for normal late April to early May plantings, when should earlier maturities be substituted as planting is delayed? That decision is not clear-cut because hybrid GDD values from planting to maturity vary somewhat from year to year as climatic conditions change. Several years ago, we collaborated on field research that investigated the effects of delayed planting on the GDD needs of different hybrid maturities (Nielsen et al., 2002).

That research, conducted by former graduate students Greg Brown and Tony Halter, indicated that delayed planting decreases hybrid GDD requirements from planting to maturity. In fact, as planting is delayed beyond about May 1, the number of GDDs from planting to kernel black layer (physiological maturity) decreases by about 6.8 GDDs per day of delayed planting. The consequence of this research is that adapted "fuller season" maturities can be planted much later than previously thought and still mature safely prior to the average date of a fall frost (see text box: GDD Decrease With Delayed Planting).

Based on that research, we can more accurately determine when to "pull the trigger" for switching from fuller season to earlier season hybrid maturities with delayed plantings. The good news is that hybrid maturities commonly grown throughout Indiana and Ohio (Tables 1 & 2) will mature safely when planted throughout most of the month of May. Once planting is delayed further, the ever-shortening growing season (measured by estimated available GDD) finally exceeds the fuller-season hybrids' abilities to adjust their developmental GDD needs.

GDD Decrease With Delayed Planting:

A hybrid that normally requires 2700 GDDs from planting to maturity would require slightly less than 2500 GDDs if planted on May 31 rather than May 1 (30 days delay in planting multiplied by 6.8 fewer GDDs per day of delayed planting, then subtracted from the hybrid's normal rating of 2700 GDDs). Using historical GDD data from the National Weather Service and typical dates for the first fall frost event (32^{o} F), such a hybrid planted in central Indiana on May 31 would likely encounter at least 2500 GDDs prior to the average date (October 13) of a first fall frost (32^{o} F), enough to safely mature the grain.

Tables 3 and 4 list the relative hybrid maturity values that should safely mature prior to a fall frost (32^{o} F) when planted from late May through early June in Indiana and Ohio. These "safe" hybrid maturities were estimated for the various geographic areas of the states according to the available length of growing season (GDDs) following the planting period, the average date of the first fall frost (32^{o} F), and adjustments based on hybrid GDD response to delayed planting.

BEAR IN MIND that these estimates of safe hybrid maturities are aimed at achieving grain maturity before the average (50% probability) date of the first "light" fall frost (32^{o} F) in the fall. Such frost events normally injure corn leaves, but do not kill the whole corn plant. The first fall frost dates generally range from the first through the third weeks of October from northern to southern Indiana and Ohio.

Our choice to use the first occurrence of a "light" fall frost (32^{o} F) rather than a true killing frost (28^{o} F) adds a bit of a "safeguard" to our estimates of safe hybrid maturities. Also recognize that northern Indiana and Ohio grain producers who already "push the envelope" by planting 113-day CRM maturities or greater should begin switching to more adapted maturities of about 109-day CRM maturities by about May 20.

Grain of full season maturities will be wetter on any given day in the fall than that of an earlier maturity hybrid planted on the same day regardless of planting date. The good news is the relative grain moisture differences among hybrid maturities become somewhat less with delayed planting (Figure 2.) Nonetheless, growers may opt to plant hybrids of earlier maturity than listed in Tables 3 & 4 to facilitate the fall harvest and to minimize the cost of drying (time and energy) the grain to safe and storable moisture levels. Silage growers should recognize that they can continue to plant adapted hybrid maturities for silage purposes until mid-June or beyond because silage harvest typically occurs several weeks before physiological maturity.

When corn planting is delayed beyond mid-June, grain producers should consider switching to crops other than corn in most areas of Indiana and Ohio, except in the far southern counties. The reason for this is that very early hybrid maturities suitable for such late plantings may not be acceptable in terms of their disease and other stress tolerance traits, as well as grain and stalk quality characteristics. The yield potential for such unusually early maturities may also be too low to warrant their production costs.

Reference Citations:

Nielsen, Robert L., Peter R. Thomison, Gregory A. Brown, Anthony L. Halter, Jason Wells, and Kirby L. Wuethrich. 2002. Delayed Planting Effects on Flowering and Grain Maturation of Dent Corn. Agron. J. 94:549–558.

Pioneer Hi-Bred Int'l, Inc. 2001. "Pioneer Brand Products for 2000-2001". [Sales literature]

This publication is available online at:

http://www.agry.purdue.edu/ext/pubs/AY-312-W.pdf

For more information about corn,
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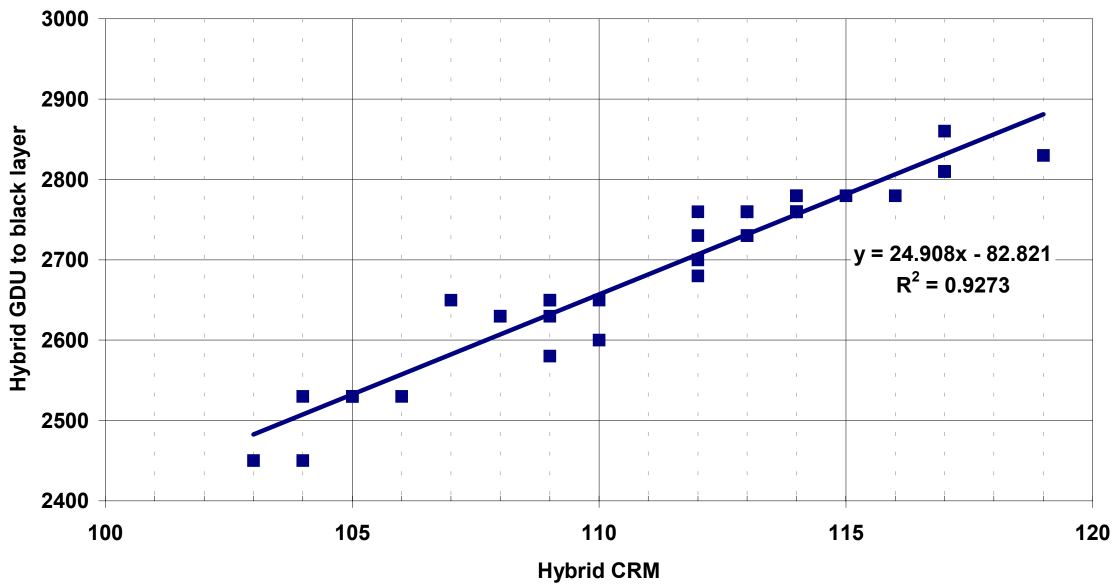
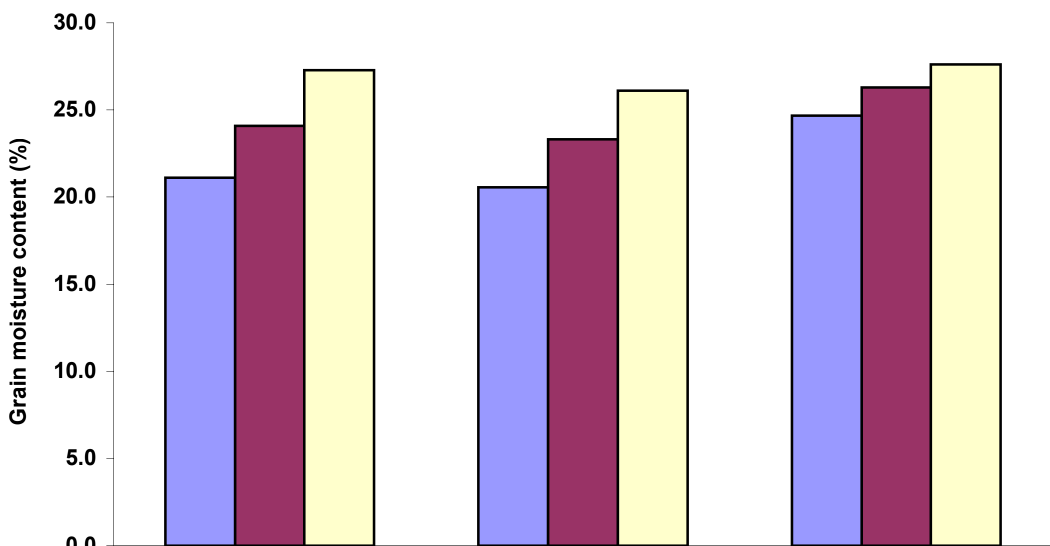


Figure 1. Relationship between hybrid comparative relative maturity (CRM) and hybrid growing degree units (GDU) from planting to kernel black layer for a group of Pioneer™ brand corn hybrids. (Adapted from: Pioneer Hi-Bred Int'l, Inc. 2001.)



	Early	Mid	Late
106	21.1	20.6	24.7
111	24.1	23.3	26.3
115	27.3	26.1	27.6

Relative planting dates

Figure 2. Grain moisture contents of three hybrid maturities (106, 111, and 115 CRM) planted the first week of May (Early), third week of May (Mid), and the first week of June (Late). The sampling dates for the moisture values averaged 23 Sept (Early), 8 Oct (Mid), and 5 Nov (Late), and represent dates when the grain moisture content of the mid-maturity hybrid (111 CRM) had reached 25% or less. Data represent averages over three replicates and four years (1991-94) at the Purdue Agronomy Research Center in west central Indiana.

Table 1. Commonly grown hybrid maturities for geographic areas of **Indiana** and their corresponding approximate GDD ratings from planting to kernel black layer.

Area of **Indiana**	Commonly grown CRM	Approximate GDDs to black layer
NW	105-112	2550-2700
NC	105-112	2550-2700
NE	105-112	2550-2700
WC	108-115	2600-2800
C	108-115	2600-2800
EC	105-112	2550-2700
SW	112-118+	2700-2850+
SC	108-115+	2600-2800+
SE	108-115+	2600-2800+

Hybrid CRM (comparative relative maturity) values and GDD ratings correspond closely with those used by Pioneer Hi-Bred International, Inc.

Table 2. Commonly grown hybrid maturities for geographic areas of **Ohio** and their corresponding approximate GDD ratings from planting to kernel black layer.

Area of **Ohio**	Commonly grown CRM	Approximate GDDs to black layer
NW	105-112	2530-2700
NC	107-112	2580-2700
NE	105-112	2530-2700
WC	107-114	2580-2760
C	109-114	2620-2760
EC	109-114	2620-2760
SW	109-114+	2620-2780+
SC	109-114+	2620-2780+
SE	109-114+	2620-2780+

Hybrid CRM (comparative relative maturity) values and GDD ratings correspond closely with those used by Pioneer Hi-Bred International, Inc.

Table 3. Approximate "safe" relative hybrid maturities for delayed plantings throughout **Indiana**. **Bolded values** indicate hybrid maturities that are earlier than what is commonly grown in that area of the state (Table 1), otherwise the listed hybrid maturities are within the commonly grown range in each area Indiana.

	Latest "safe" hybrid maturity for planting no later than…		
Area of Indiana	May 31	June 7	June 14
		CRM values	
NW	108	**104**	**101**
NC	105	**102**	**99**
NE	105	**102**	**99**
WC	115	112	109
C	114	110	**106**
EC	106	**103**	**99**
SW	118+	118+	118+
SC	115+	115+	113
SE	115+	115+	113

Hybrid CRM (comparative relative maturity) values correspond closely with those used by Pioneer Hi-Bred International, Inc.

Table 4. Approximate "safe" relative hybrid maturities for delayed plantings throughout **Ohio**. **Bolded values** indicate hybrid maturities that are earlier than what is commonly grown in that area of the state (Table 2), otherwise the listed hybrid maturities are within the commonly grown range in each area of Ohio.

	Latest "safe" hybrid maturity for planting no later than…		
Area of Ohio	May 31	June 7	June 14
		CRM values	
NW	105	**103**	**100**
NC	107	**105**	**100**
NE	107	105	**95**
WC	107	**105**	**103**
C	110	**107**	**103**
EC	110	**105**	**103**
SW	114	114	112
SC	114+	114	114
SE	114	112	110

Hybrid CRM (comparative relative maturity) values correspond closely with those used by Pioneer Hi-Bred International, Inc.

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