
In This Issue



## Annoying Swarms of “Bees” and Mystery “Worms” on Corn!

*(John Obermeyer)*, *(Christian Krupke)*, *(Elizabeth Long)*, *(Laura Ingwell)*, *(Larry Bledsoe)* & *(Cliff Sadof)*

Recently there have been numerous reports of swarms of “bee-like” flies around Indiana fields, farmsteads, and rural environments, and wanted to take the opportunity to tell you a bit about this curiosity. Adult hover flies (aka syrphid flies) can sometimes be mistaken for bees or wasps, because they look a lot like them! Some people refer to hover flies as “corn flies” or “sweat bees,” but these insects are actually quite different from bees.

Hover flies belong to the Order Diptera, or the true flies. The most noticeable group at this time of year belong to the genus *Toxomerus*, which feed on pollen. There are many other syrphid flies present throughout the season that are beneficial, as their larvae feed on soft-bodied insects like aphids.

Hover (Syrphid) flies on a corn tassel.

Two hover fly larvae next to corn anthers.

Compared to sweat bees, hover flies have black and yellow markings, are able to fly in place yet dart away quickly, have a characteristic abdomen-bobbing behavior, and are unable to sting – in fact, they are harmless. Sweat bees, on the other hand, are typically dark or metallic in color, smaller than common honey bees and do have stingers. Both hover flies and sweat bees can be a minor nuisance, as they are attracted to us for moisture and salts they get by lapping up our sweat. Sweat bees will sting if accidently squished against our skin while they are feeding.

Hover fly feeding on sweaty skin.

Sweat bee feeding on sweaty skin.

In cornfields and other flowering crops, you will likely find the larval form of this insect, a small, rather plain-looking maggot, feeding in leaf axils and other areas where pollen collects. They look very much like the spent pollen anthers. Be advised that the larvae are not pests, as they do not damage the crop. Rather, they are taking advantage of an abundance of pollen. This holds true for other flowering crops as well. As corn has pollinated at a more staggered rate than usual this year (a result of the wet spring and delayed/sporadic planting), you may continue to see these insects for a couple more weeks. Just remember they are not pests and cannot sting you, they just might be a bit bothersome *hovering* around you in large numbers!

Dead hover fly and live larva feeding in corn leaf axil.

## 2019 Corn Earworm Trap Report

*(Laura Ingwell)*




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# Estimating Corn Grain Yield Prior to Harvest

*(Bob Nielsen)*

Fancy colored yield maps are fine for verifying grain yields at the end of the harvest season, but bragging rights for the highest corn yields are established earlier than that down at the Main Street Cafe, on the corner of 5th and Earl. Some patrons of the cafe begin “eyeballing” their yields as soon as their crops reach “roasting ear” stage. Some of the guys there are pretty good (or just plain lucky) at estimating yields prior to harvest, while the estimates by others are not even close to being within the proverbial ballpark. Interestingly, they all use the same procedure referred to as the **Yield Component Method**.


Largest ear of corn in Nebraska, ca. 1908. Courtesy of the Nebr. Historical Society.

**Yield Component Method**

Other pre-harvest yield prediction methods exist (Lauer, 2002; Lee & Herbek, 2005; Thomison, 2015), but the **Yield Component Method** is probably the most popular because it can be used well ahead of harvest; as early as the so-called “roasting ear” or milk (R3) stage of kernel development. Under “normal” conditions, the kernel milk stage occurs about 18 to 22 days after pollination is complete (Nielsen, 2018b). Estimates made earlier in the kernel development period risk being overly optimistic if subsequent severe stresses cause unforeseen kernel abortion (Nielsen, 2018a).

The Yield Component Method was originally described by the University of Illinois many years ago and is based on the premise that one can estimate grain yield from estimates of the yield components that constitute grain yield. These yield components include number of ears per acre, number of kernel rows per ear, number of kernels per row, and weight per kernel. The first three yield components (ear number, kernel rows, kernels/row) are easily measured in the field.

Final weight per kernel obviously cannot be measured until the grain is mature (kernel black layer) and, technically, at a grain moisture of 15% since that is the typical moisture value used to determine a 56-lb market bushel. Consequently, an average value for kernel weight is used as a proverbial “fudge factor” in the yield estimation equation. As first described many years ago, the equation originally used a “fudge factor” of 90, which represented 90,000 kernels per 56-lb bushel. In terms of how kernel weight is usually measured in research, this would be equal to about 282 grams per 1000 kernels.

Recognize that actual kernel numbers per 56-lb bushel among years or fields within years can vary significantly and are influenced by both growing conditions and hybrid genetics. Kernel weight among hybrids can easily vary from less than 65,000 kernels per 56-lb bushel to more than 100,000 kernels per 56-lb bushel. Kernel weight from year to year for the same hybrid can easily vary by 20,000 kernels per bushel or more simply due to variability in growing conditions during the grain filling period.

Crop uniformity also influences the accuracy of any yield estimation technique. The less uniform the field, the greater the number of samples that should be taken to estimate yield for the field. There is a fine line between fairly sampling disparate areas of the field and sampling randomly within a field so as not to unfairly bias the yield estimates up or down.

1. At each estimation site, measure off a length of a single row equal to 1/1000th acre. For 30-inch (2.5 feet) rows, this equals 17.4 linear feet.

**TIP:** For other row spacings, divide 43,560 by the row spacing (in feet) and then divide that result by 1000 (e.g., [43,560 / 2.5] / 1000 = 17.4 ft).

2. Count and record the number of ears on the plants in the 1/1000th acre of row that you deem to be harvestable.

**TIP:** Do not count dropped ears or those on severely lodged plants unless you are confident that the combine header will be able to retrieve them.

3. For every fifth ear in the sample row, record the number of complete kernel rows per ear and average number of kernels per row. Then multiply each ear’s row number by its number of kernels per row to calculate the total number of kernels for each ear.

**TIPS:** Do not sample nubbins or obviously odd ears, unless they fairly represent the sample area. If row number changes from butt to tip (e.g., pinched ears due to stress), estimate an average row number for the ear. Don’t count the extreme butt or tip kernels, but rather begin and end where you perceive there are complete “rings” of kernels around the cob. Do not count aborted kernels. If kernel numbers per row are uneven among the rows of an ear, estimate an average value for kernel number per row.

4. Calculate the average number of kernels per ear by summing the values for all the sampled ears and dividing by the number of ears.

**EXAMPLE:** For five sample ears with 480, 500, 450, 600, and 525 kernels per ear, the average number of kernels per ear would equal: (480 + 500 + 450 + 600 + 525) divided by 5 = 511.

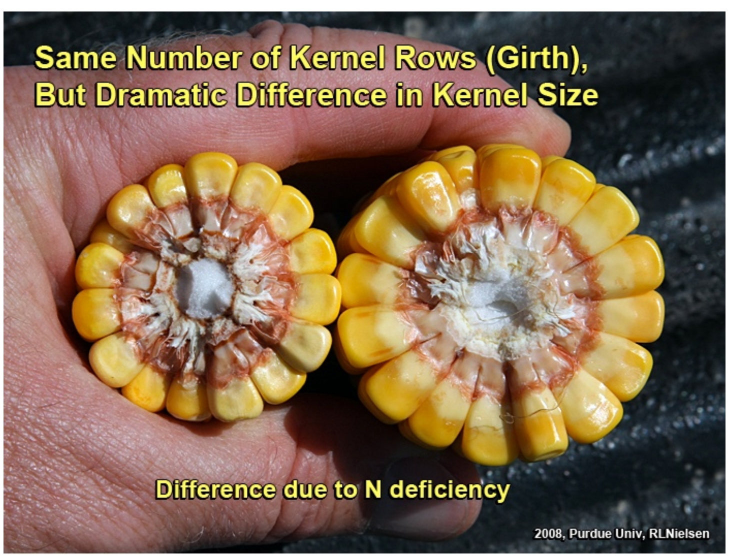
5. Estimate the yield for each site by multiplying the ear number (Step 2) by the average number of kernels per ear (Step 4) and then dividing that result by a kernel weight “fudge factor”. Unless your seed company can provide some insight into kernel weight values for their hybrids, I suggest simply performing separate calculations using “fudge factor” kernel weight values equal to 75, 85, and 95. This range of values probably represents that most commonly experienced in the central Corn Belt.

**EXAMPLE:** Let’s say you counted 30 harvestable ears at the first thousandth-acre sampling site. Let’s also assume that the average number of kernels per ear, based on sampling every 5th ear in the sampling row, was 511. Using “fudge factor” values of 75, 85, and 95; the estimated range in yield for that sampled site would (30 x 511) divided by 75 = 204, or divided by 85 = 180, or divided by 95 = 161 bushels per acre.

Repeat the procedure throughout field as many times as you deem representative. Tally and average the results separately for each “fudge factor” used for the calculations.


Random sample of ears.


Poor tip fill due to N deficiency.




Kernel size differences due to N deficiency.

Remember that this method for estimating pre-harvest grain yield in corn indeed provides only an estimate. Since kernel size and weight will vary depending on hybrid and environment, this yield estimator should only be used to determine "ballpark" grain yields. Yield can easily be overestimated in a year with poor grain fill conditions (e.g., low kernel size and weight from a drought year) and underestimated in a year with excellent grain fill conditions (e.g., larger kernel size and weight from non-stress grain fill periods). The closer to kernel black layer stage you sample, the more accurately you can "guesstimate" whether kernel weight will be above or below average for this year. Recognize that the **Yield Component Method** for estimating corn grain yield is probably only accurate within plus or minus 20 bushels of the actual yield. Obviously, the more ears you sample within a field, the more accurately you will "capture" the variability of yield throughout the field. Use the yield estimates obtained by this method for general planning purposes only.

### Smart Phone and Mobile Tablet Apps

There are a number of apps available for download to your smart phone or mobile tablet that can be used to simplify the calculations of the Yield Component Method. Some crop scouting apps include grain yield estimators as one of their features. Be sure to thoroughly test the calculations of any app you choose to use on your phone to ensure that the math is correct. Some offer multiple kernel "fudge factors", but do not literally specify what kernel numbers per 56-lb bushel they use. Some only allow you to sample 3 ears at a time. Most do not allow you to sample AND save the results of multiple sites within a field or multiple fields in an operation. As the old adage says… "Buyer beware!"

This curmudgeon prefers to do the math the old-fashioned way… with my smart phone calculator and a note pad.

### The Pro Farmer Midwest Crop Tour Method

The Pro Farmer division of Farm Journal Media sponsors an annual Midwest Crop Tour that sends out teams of "scouts" to visit corn fields throughout the Midwest to estimate yields. The method used in that effort is a variation of one described years ago by University of Minnesota agronomist Dale Hicks (now Professor Emeritus) that combines the use of several yield components (ears per acre and kernel rows per ear) with a measurement of ear length (a proxy for kernel number per row).

The focus of the crop tour is not to necessarily estimate the yields of specific fields, but rather to more broadly estimate the yield potential within regions of the Midwest, so one probably should exercise caution in using this method for estimating yields within an individual field. Nevertheless, folks who have heard about the Pro Farmer Tour may be interested in trying the method themselves, so here are the steps involved with the Pro Farmer method (Flory, 2010; Micik, 2013). I would certainly suggest that these steps be repeated in several areas of an individual field because of natural spatial variability for yield.

1. Measure and record the row spacing (inches) used in the field.

**EXAMPLE:** 30 inches

2. Walk through the end rows into the bulk of the field, then walk about 35 paces down the rows to the first sampling area.

**TIP:** For subsequent yield estimates within the field, I would suggest walking even further into the field and crossing over multiple planter passes to sample different areas of the field.

3. Measure or step off 30 feet down the row, then count all ears in the two adjacent rows. Divide that number by two and record it.

**EXAMPLE:** (42 ears in one row + 45 ears in other row) divided by 2 = 43.5

4.Pull the 5th, 8th and 11th ears from plants in one row of the sampling area.

**TIP**: Frankly, I would suggest harvesting up to 5 ears from each of the two adjacent rows to better sample the area and minimize the effect that one oddball ear could have on the calculated average ear lengths and kernel row numbers.

5. Measure length of the portion of each ear that successfully developed kernels. Calculate the average ear length of the three ears and record it. Because cob length increases during the grain filling process, it is important that fields not be sampled any earlier than kernel dough stage or even kernel dent stage.

**EXAMPLE:** (6 inches + 7 inches + 5 inches) divided by 3 = 6

6. Count the number of kernel rows on each ear. Calculate the average kernel row number and record it.

**EXAMPLE:** (16 rows + 14 rows + 16 rows) divided by 3 = 15.3

7. Grain yield for the sampling area is calculated by multiplying the average ear count by the average ear length by the average kernel row number, then dividing by the row spacing.

**EXAMPLE:** (43.5 ears x 6 inches x 15.3 rows) divided by 30-inch rows = 133 bu/ac yield estimate

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# Grain Fill Stages in Corn

*(Bob Nielsen)*

The grain fill period begins with successful pollination and initiation of kernel development, and ends approximately 60 days later when the kernels are physiologically mature. During grain fill, the developing kernels are the primary sink for concurrent photosynthate produced by the corn plant. What this means is that the photosynthate demands of the developing kernels will take precedence over that of much of the rest of the plant. In essence, the plant will do all it can to “pump” dry matter into the kernels, sometimes at the expense of the health and maintenance of other plant parts including the roots and lower stalk.

A stress-free grain fill period can maximize the yield potential of a crop, while severe stress during grain fill can cause kernel abortion or lightweight grain and encourage the development of stalk rot. The health of the upper leaf canopy is particularly important for achieving maximum grain filling capacity. Some research indicates that the upper leaf canopy, from the ear leaf to the uppermost leaf, is responsible for no less than 60% of the photosynthate necessary for filling the grain.

Kernel development proceeds through several distinct stages that were originally described by Hanway (1971) and most recently by Abendroth et al. (2011). As with leaf staging protocols, the kernel growth stage for an entire field is defined when at least 50% of the plants in a field have reached that stage.

**Silking Stage (Growth Stage R1)**

Silk emergence is technically the first recognized stage of the reproductive period. Every ovule (potential kernel) on the ear develops its own silk (the functional stigma of the female flower). Silks begin to elongate soon after the V12 leaf stage (12 leaves with visible leaf collars), beginning with the ovules near the base of the cob and then sequentially up the cob, with the tip ovules silking last. Consequently, the silks from the base half of the ear are typically the first to emerge from the husk leaves. Turgor pressure “fuels” the elongation of the silks and so severe drought stress often delays silk elongation and emergence from the husk leaves. Silks elongate about 1.5 inches per day during the first few days after they emerge from the husk leaves. Silks continue to elongate until pollen grains are captured and germinate or until they simply deteriorate with age.

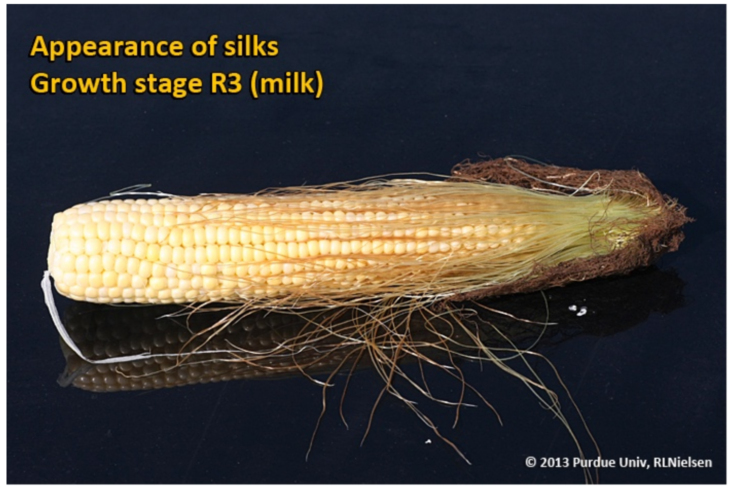
Silks remain receptive to pollen grain germination for up to 10 days after silk emergence (Nielsen, 2016b), but deteriorate quickly after about the first 5 days of emergence. Natural senescence of silk tissue over time results in collapsed tissue that restricts continued growth of the pollen tube. Silk emergence usually occurs in close synchrony with pollen shed (Nielsen, 2016c), so that duration of silk receptivity is normally not a concern. Failure of silks to emerge in the first place (for example, in response to silkballing or severe drought stress) does not bode well for successful pollination.

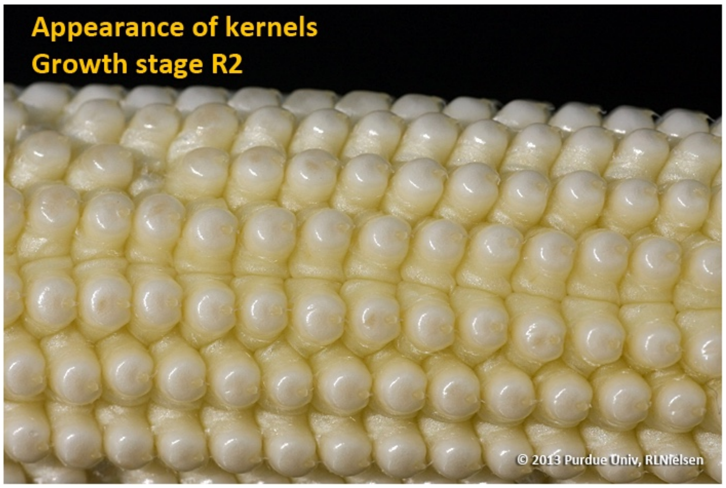
Pollen grains “captured” by silks quickly germinate and develop pollen tubes that penetrate the silk tissue and elongate to the ovule within about 24 hours. The pollen tubes contain the male gametes that eventually fertilize the ovules. Within about 24 hours or so after successfully fertilizing an ovule, the attached silk deteriorates at the base, collapses, and drops away. This fact can be used to determine fertilization success before visible kernel development occurs (Nielsen, 2016a).

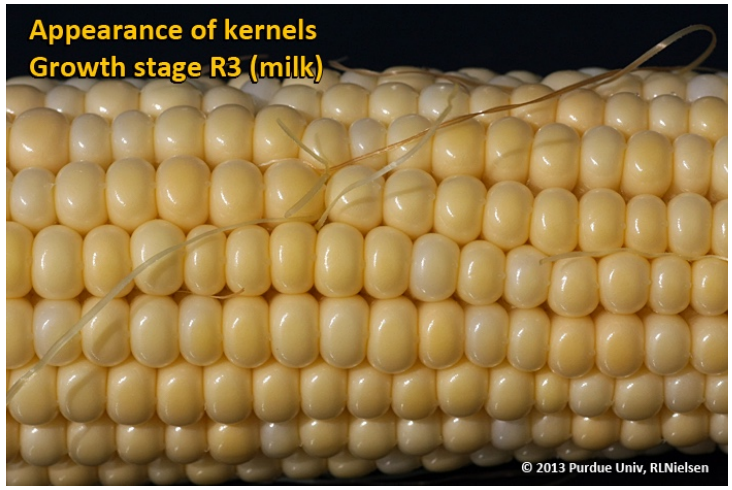


## Kernel Blister Stage (Growth Stage R2)

About 10 to 12 days after silking, the developing kernels are whitish “blisters” on the cob and contain abundant clear fluid. The ear silks are mostly brown and drying rapidly. Some starch is beginning to accumulate in the endosperm. The radicle root, coleoptile, and first embryonic leaf have formed in the embryo by the blister stage. Severe stress can easily abort kernels at pre-blister and blister stages. Kernel moisture content at the beginning of R2 is approximately 85 percent. For late April to early May plantings in Indiana, the thermal time from blister stage to physiological maturity is approximately 960 GDDs (Brown, 1999).

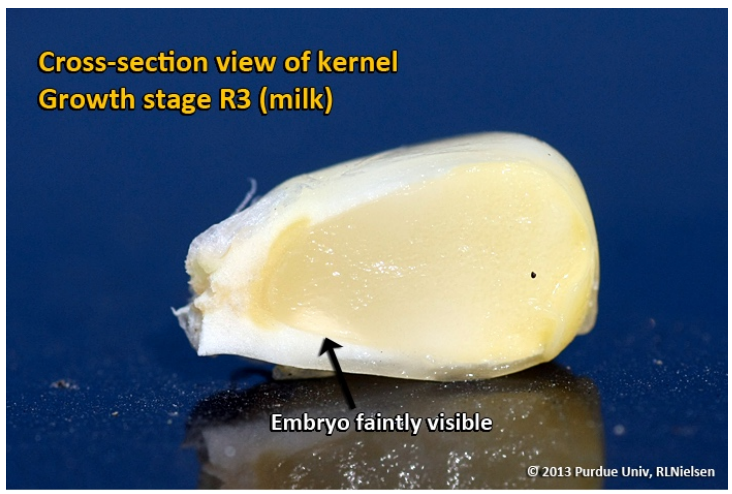



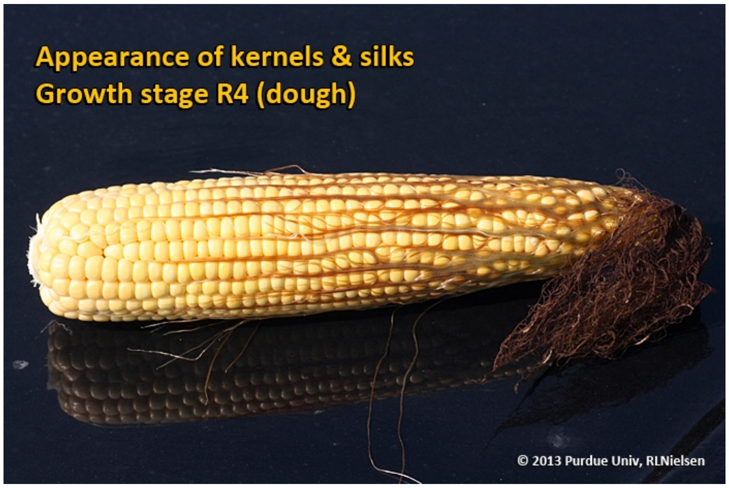

## Kernel Milk Stage (R3)

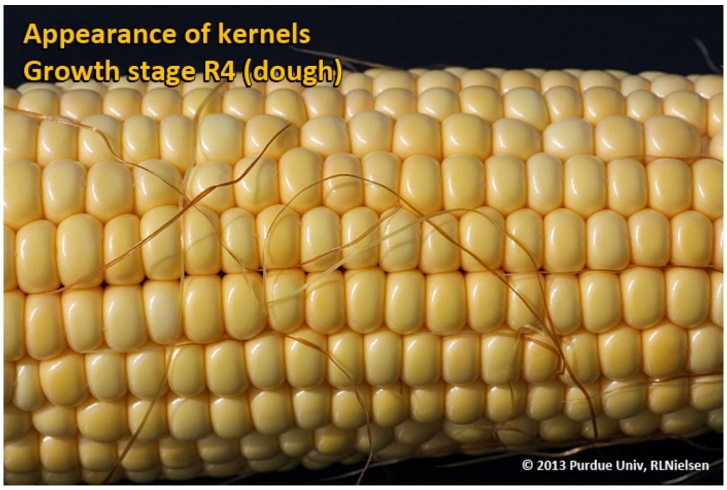
About 18 to 20 days after silking, the kernels are mostly yellow and contain “milky” white fluid. The milk stage of development is the infamous “roasting ear” stage, when you will find die-hard corn aficionados standing out in their field nibbling on these delectable morsels. Starch continues to accumulate in the endosperm. Endosperm cell division is nearly complete and continued growth is mostly due to cell expansion and starch accumulation. Severe stress can still abort kernels, although not as easily as at the blister stage. **Kernel moisture content at the beginning of R3 is approximately 80 percent**. For late April to early May plantings in Indiana, the thermal time from milk stage to physiological maturity is approximately 880 GDDs (Brown, 1999).

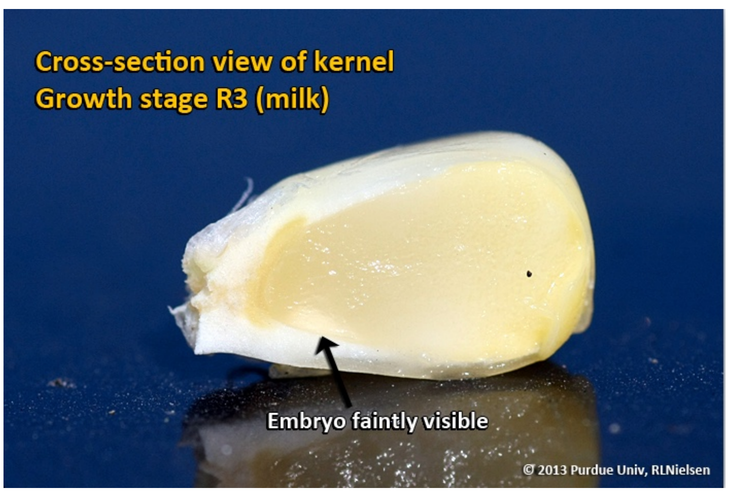



## Kernel Dough Stage (R4)

About 24 to 26 days after silking, the kernel’s milky inner fluid begins changing to a “doughy” consistency as starch accumulation continues in the endosperm. The shelled cob is now light red or pink. By dough stage, four embryonic leaves have formed and the kernels have reached about **50 percent of their mature dry weight**. **Kernel moisture content is approximately 70 percent at the beginning of R4**. Near the end of R4, some kernels will typically be starting to dent. Kernel abortion is much less likely to occur once kernels have reached early dough stage, but severe stress can continue to affect eventual yield by reducing kernel weight. For late April to early May plantings in Indiana, the thermal time from dough stage to physiological maturity is approximately 670 GDDs (Brown, 1999).



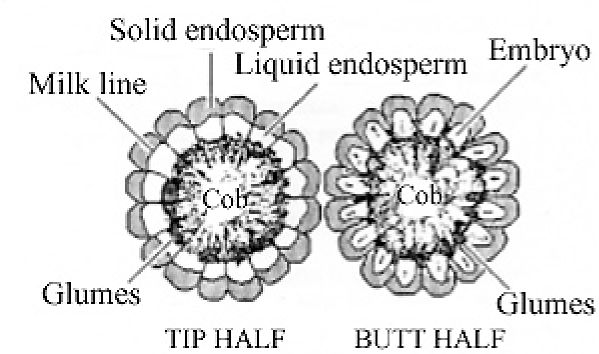




## Kernel Dent Stage (R5)

About 31 to 33 days after silking, all or nearly all of the kernels are denting near their crowns. The fifth (and last) embryonic leaf and lateral seminal roots form just prior to the dent stage. **Kernel moisture content at the beginning of R5 is approximately 60 percent**.

More importantly, **kernel dry matter content at the beginning of R5 is only about 45% of the eventual final** accumulation and there **remains approximately more 30 days before physiological maturity** occurs. This is sobering considering that farmers and agronomists alike often breathe a sigh of relief when the crop reaches R5 because of a mistaken and, frankly, emotional belief that the "crop is made" by this grain fill stage.



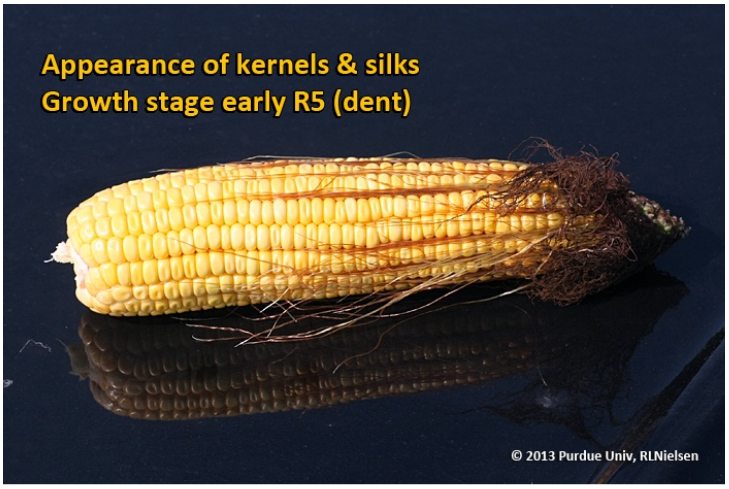
Description of the corn ear.

***Interesting Exercise:***
You can get a sense of the importance of the final 30 days of grain filling by calculating a number of "what-if" grain filling scenarios using the traditional pre-harvest yield estimation formula for corn with a range of kernel weight "fudge factors" from about 65 to 105 (representing kernel weights equivalent to 65,000 to 105,000 kernels per 56-lb bushel.)

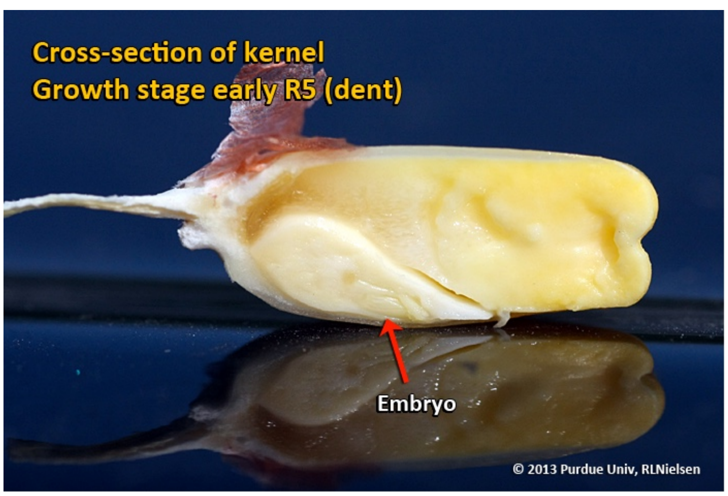
Within about a week after the beginning of R5, a distinct horizontal line appears near the dent end of a split kernel and slowly progresses to the tip end of the kernel over the next 3 weeks or so. This line is called the "**milk line**" and marks the boundary between the liquid (milky) and solid (starchy) areas of the maturing kernels.

For late April to early May plantings in Indiana, the thermal time from full dent (kernel milk line barely visible) to physiological maturity is approximately 350 GDDs (Brown, 1999). Thermal time from the half-milkline stage to physiological maturity for similar planting dates is approximately 280 GDDs. One of the consequences of delayed planting is that thermal time from the dent stage to physiological maturity is shortened, though this may simply reflect a premature maturation of the grain caused by the cumulative effects of shorter daylengths and cooler days in early fall or by outright death of the plants by a killing fall freeze.

Severe stress can continue to limit kernel dry weight accumulation between the dent stage and physiological maturity. Estimated yield loss due to total plant death at full dent is about 40%, while total plant death at half-milkline would decrease yield by about 12% (Carter & Hesterman, 1990).

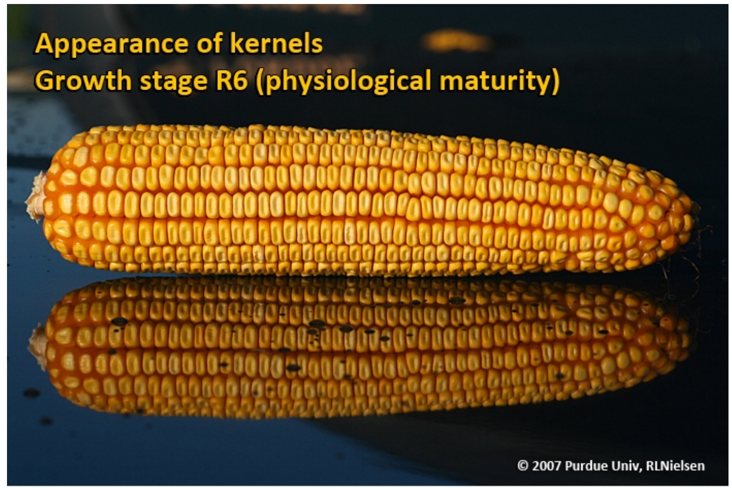


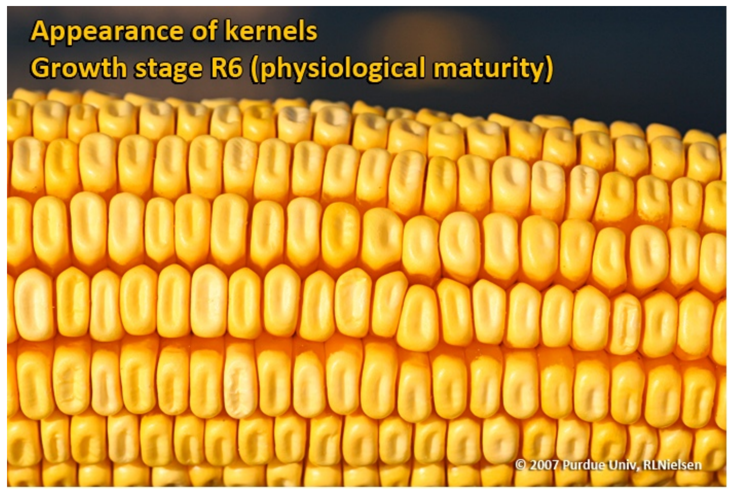


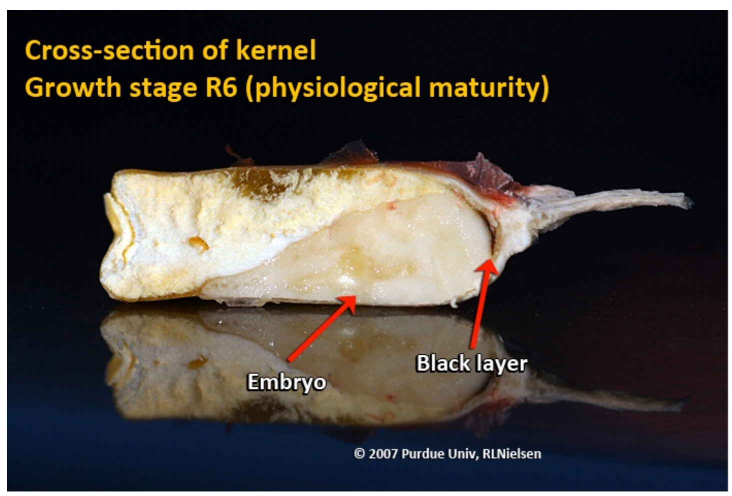



## Physiological Maturity (R6)

About 55 to 65 days after silking, kernel dry weight usually reaches its maximum and kernels are said to be physiologically mature and safe from frost. Physiological maturity occurs shortly after the kernel milk line disappears and just before the kernel black layer forms at the tip of the kernels. Severe stress after physiological maturity has little effect on grain yield, unless the integrity of the stalk or ear is compromised (e.g., damage from European corn borer or stalk rots). **Kernel moisture content at physiological maturity averages 30 percent**, but can vary from 25 to 40 percent grain moisture depending on hybrid and growing conditions.




## Harvest Maturity

While not strictly a stage of grain development, harvest maturity is often defined as that grain moisture content where harvest can occur with minimal kernel damage and mechanical harvest loss. Harvest maturity is usually considered to be near 25 percent grain moisture.

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# Effects of Severe Stress During Grain Filling in Corn

*(Bob Nielsen)*

Yield potential in corn is influenced at several stages of growth and development. Ear size potential (number of potential kernels) is determined quite early, from about leaf stage V6 to V15 (knee-high to about shoulder-high). The next influential period for the corn crop is pollination. The period following successful pollination and finishing at kernel black layer is defined as the grain filling period in corn and represents the final important yield determination period. Grain fill stages in corn are described in an accompanying article.

Perfect conditions for ear size determination and pollination can be negated if severe stress occurs during the grain fill period. Yield loss during grain fill can occur from 1) stand loss, 2) incomplete kernel set, 3) decreased kernel weight, and 4) premature plant death.

## Stand Loss During Grain Fill

Yield loss due to stand loss during grain fill is usually greater than that due to stand loss occurring earlier during the vegetative phase. When stand loss occurs prior to pollination, ear size (number of kernels) on surviving plants may compensate in response to the lesser competition of a thinner stand. Additional compensation may occur during grain fill in terms of greater kernel weight. When stand loss occurs during grain fill, kernel number has already been set. Only kernel weight can compensate in response to the lesser competition of a thinner stand.

## Incomplete Kernel Set in Corn

The term “kernel set” refers to the degree to which kernels have developed up and down the cob. Incomplete kernel set is not always apparent from “windshield” surveys of a corn field. Husks and cob will continue to lengthen even if kernel set is incomplete. A wonderfully long, robust-looking, healthy green ear of corn can completely mask even a 100 percent failure of pollination or severe kernel abortion.

**TECHNICAL TRIVIA:**
**Pollination** is the movement of pollen from the tassels to the silks.
**Fertilization** is the actual union of the male and female gametes once the pollen tube reaches the ovule.

One of the causes of incomplete kernel set is **unsuccessful fertilization of the ovules during pollination**. Unsuccessful fertilization results in ovules that never develop into kernels and, subsequently, ears with varying degrees and patterns of incomplete kernel set. Many factors can cause incomplete pollination and distinguishing between them can be very difficult.

- Certain insects like corn rootworm beetles and Japanese beetles can interfere with pollination and fertilization by their silk clipping activities. These insects inadvertently clip silks as they feed on pollen captured by the silks. Unusually early or late pollinating fields are often particularly attractive to these insects.
- Drought stress may delay silk emergence until pollen shed is nearly or completely finished. During periods of high temperatures, low relative humidities, and inadequate soil moisture levels, exposed silks may also desiccate rapidly and become non-receptive to pollen germination.
- Conversely, silk emergence of some drought tolerant hybrids may occur several days prior to the availability of pollen from the tassels when soil moisture levels are favorable for crop growth. Although silks remain receptive to pollen germination for up to 10 days after emergence, they begin to slowly deteriorate (age, desiccation) after 4 to 5 days. Because the first silks to emerge are from ovules near the base of the cob, kernel set near the base of the cob may fail under these conditions. See my related article for more information.
- Unusually favorable conditions prior to pollination that favor ear size determination can result in ears with an unusually high number of potential kernels per row. Remember that silk elongation begins near the butt of the ear and progresses up toward the tip. The tip silks are typically the last to emerge from the husk leaves. If ears are unusually long (many kernels per row), the final silks from the tip of the ear may emerge after all the pollen has been shed.

Another cause of incomplete kernel set is **abortion of fertilized ovules**. Aborted kernels will be shrunken, mostly white, often with the yellow embryo visible; compared to normal plump yellow kernels. Unfertilized ovules, on the other hand, will result in visibly blank areas on the cob.




Kernels are most susceptible to abortion during the first 2 weeks following pollination, particularly kernels near the tip of the ear. Tip kernels are generally last to be fertilized, less vigorous than the rest, and are most susceptible to abortion. Once kernels have reached the dough (R3) stage of development, further yield losses will occur mainly from reductions in kernel dry weight accumulation.

**Kernel abortion can be caused by any stress that greatly limits photosynthetic rates and, thus, photosynthate availability during or shortly following pollination…**

- Severe drought stress.
- Excessive heat stress.
- Severe nutrient deficiencies (especially nitrogen).
- Extensive loss of green leaf tissue by foliar diseases like gray leaf spot (*Cercospora zeae-maydis*).
- Extensive loss of green leaf tissue from severe hail damage.
- Consecutive days of heavily overcast, cloudy conditions.

## Decreased Kernel Weight

Severe photosynthetic stress during dough (R4) and dent (R5) stages of grain fill reduces kernel weight and can cause premature kernel black layer formation. Decreased kernel weight can result from severe drought and heat stress during grain fill; extensive European corn borer tunneling (especially in the ear shanks); loss of photosynthetic leaf area by nutrient deficiency, hail, insects, or disease during grain fill; and killing fall frosts prior to normal black layer development.

Once grain has reached physiological maturity (R6), severe stress will have no further physiological effect on final grain yield per se. However, severe stress prior to R6 can weaken stalk tissue and predispose the plants to the development of stalk rots (see my related article). Weakened or rotted stalks combined with post-maturity damaging wind storms can easily result in significant mechanical harvest losses and, thus, less grain in the bin.

## Premature Plant Death

A killing fall frost prior to physiological maturity can cause premature leaf death or whole plant death. Premature death of leaves results in yield losses because the photosynthetic “factory” output is greatly reduced. The plant may remobilize stored carbohydrates from the leaves or stalk tissue to the developing ears, but yield potential will still be lost. Approximate yield losses due to premature death of leaves, but not stalks, range from 36, 31, and 7% when the leaf death occurs at R4 (dough), R5 (full dent), and half-milkline stages of kernel development, respectively (Afuakwa & Crookston, 1984).

Premature death of whole plants results in greater yield losses than if only leaves are killed. Death of all plant tissue prevents any further remobilization of stored carbohydrates to the developing ear. Whole plant death that occurs before normal black layer formation will cause *premature* black layer development, resulting in incomplete grain fill and lightweight, chaffy grain. Grain moisture will be greater than 35%, requiring substantial field drydown before harvest. Approximate yield losses due to premature whole plant death range from 50, 39, and 12% when the whole plant death occurs at R4 (dough), R5 (full dent), and half-milkline stages of kernel development, respectively (Afuakwa & Crookston, 1984).

A common misconception is that kernel black layer formation sometimes fails to occur following a frost or other late-season severe stress. Not true. FAKE NEWS! The kernel black layer always develops. Any severe stress that occurs during the grain fill period will cause premature kernel black layer formation and is related to the reduction in or termination of sucrose (photosynthate) availability to the developing kernels (Afuakwa et al., 1984).

## Related References

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# Indiana Climate and Weather Report – 8/22/2019

*(Beth Hall)*

Sporadic rain events are barely bringing relief to sections of Indiana (last 7 days pcpn accumulation Figure 1). Warmer temperatures have encouraged evapotranspiration, leading to higher humidity and heat indexes. Therefore, many locations across the state are experiencing abnormally dry conditions coupled with a muggy environment. The climate outlooks for the next 2-3 weeks are showing confidence that precipitation should be above normal with temperatures below normal. For climatological perspective on what this might mean, from 1981-2010, accumulated precipitation for August 22 – September 5th ranges between 1.5” to 2” (Figure 2) and average daily temperatures range from 70°F-80°F (Figure 3).

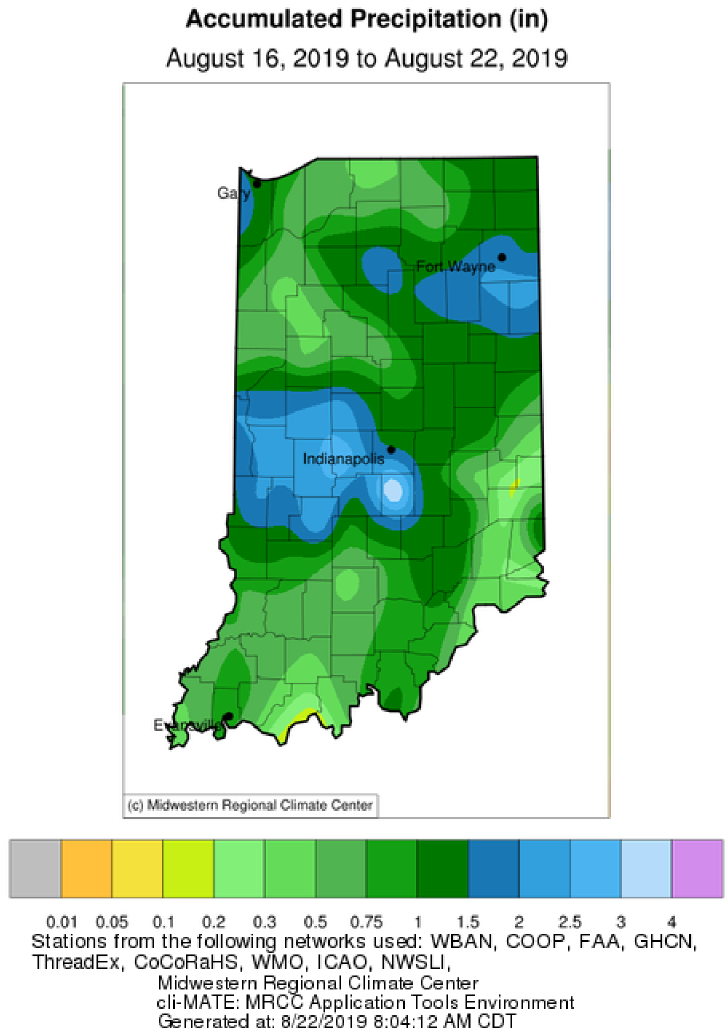

Figure 1.

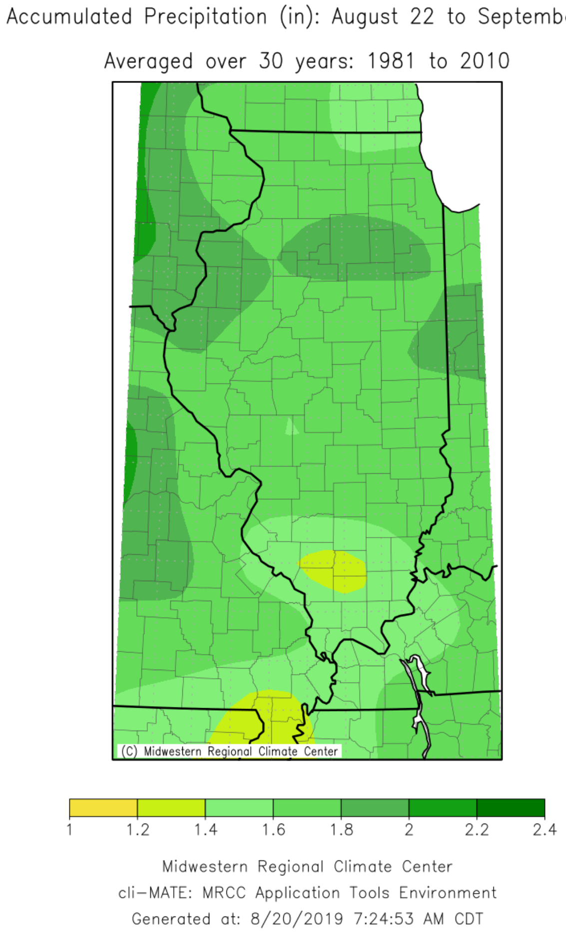


Figure 2.

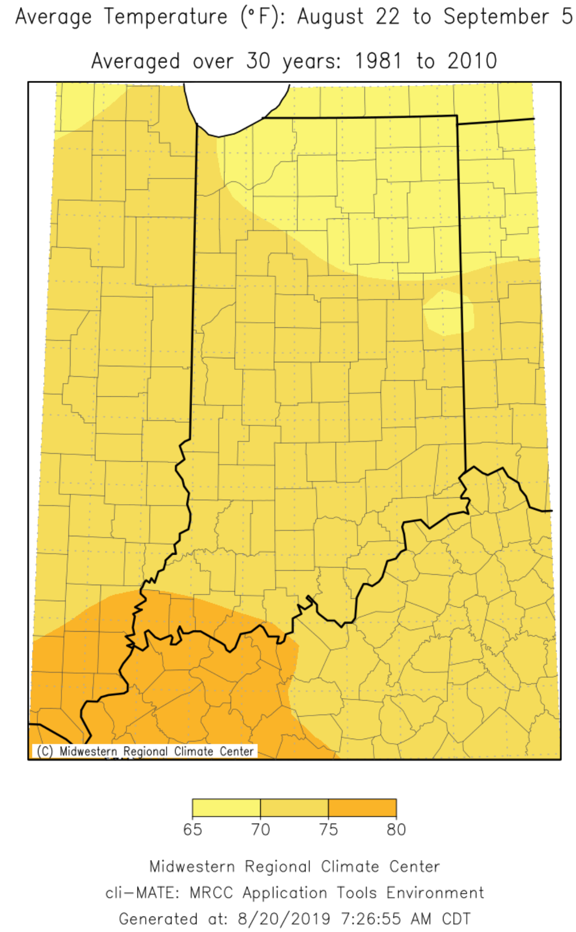


Fig. 3.