# WHEN DO LATE-SEASON MANAGEMENT DECISIONS NO LONGER INFLUENCE CORN YIELD?

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Numerous in-season management decisions need to be made growing corn. Some inputs are relatively easy decisions to make and must be legally followed, i.e. pesticide applications. Other decisions are more difficult with no clear guidelines due to the unpredictability of environmental influences. For example, irrigating for the last time during a growing season is influenced by the growth stage, the amount of plant green leaf area, the yield potential of the crop, the amount of rainfall predicted, the amount of stored water in the soil profile and the air temperature and humidity which will drive the evapotransporation process to cool the plant if needed. Some things can be measured like green leaf area, yield potential, and stored water, but other things are vague yet need to be considered in the decision.

Not only is the environment fickle, but the plant must be able to respond to the management input decision. A grower must ask the question, "Can I affect yield with this decision?" Or will they end up throwing "good money after bad" and increase their cost of production. Can inputs add to yield or are we just preventing further yield decreases from occurring. Examples of decisions that need to be made include:

1) Cultivation
2) Planting date and plant density
3) Last irrigation
4) Last split-application of nitrogen and micronutrients
5) Pest management and economic thresholds
    a. Insect control (most common)
    b. Foliar fungicides
    c. Rescue weed control treatments
6) Management after an abiotic stress like frost, hail, drought and/or flooding
7) Potential lodging problems due to stalk quality

These decisions affect yield by preventing further losses, but can some decisions increase yield? A good understanding of what corn yield consists of is important to understanding the decision process. Grain yield in corn is comprised of the yield components: ears per unit area, kernel number per ear consisting of kernel rows and kernels per row, and kernel weight (Figure 1).

Each of these yield components is determined at different stages in the lifecycle of the plant. Yield components develop by initial cell division near the growing point and formation of numerous primordial tissues that eventually become ears or kernels. Often the number of these early structures is greater than what the plant is later capable of supporting. The plant "adjusts" yield components according to environmental and management influences that take place during the growing season.

The plant has the "potential" to produce more ears and kernels than what is "actually" harvested. For example, the corn plant typically produces 6 to 10 ear shoots, but only one ear (at most two) actually develops. In some years, hybrids may produce 20 rows of kernels on an ear, but most of the time only 12 to 16 rows of kernels develop on the hybrids used in Wisconsin. If you were to examine the ear shoot at the V18 stage (just prior to tasseling) using a microscope, you could count 50 to 60 kernel ovules in a kernel row. Multiplying the number of kernel ovules by the number of kernel rows indicates that 600 to 1200 kernels could potentially grow on an ear. Usually only 300 to 600 kernels develop on the ears of Wisconsin hybrids. Likewise, test weight (an indirect measure of kernel weight) is affected by environmental stresses. In the Wisconsin Corn Hybrid Performance

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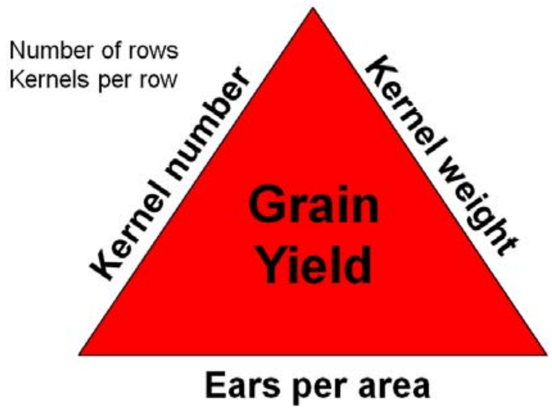
Trials, test weight has ranged between 45 and 62 pounds per bushel. Usually we consider 56 pounds per bushel an average for corn.

Figure 1. Yield components of corn.




The tasseling, silking, and pollination stages of corn development are extremely critical because the yield components of ear and kernel number can no longer be increased by the plant and the potential size of the kernel is being determined. Table 1 describes when yield components are at their greatest potential and when under normal conditions are actually determined and are not further affected under typical conditions. For example, the potential number of ears per unit area is largely determined by number of seeds planted, how many germinate, and eventually emerge. Attrition of plants through disease, unfurling underground, insects, mammal and bird damage, chemical damage, mechanical damage, and lodging all will decrease the actual number of ears that can be produced. The plant often can compensate for early losses by producing a second or third ear, but the capacity to compensate ear number is largely lost by R1 and from then on no new ears can be formed.

Table 1. Corn growth and development stages when yield components are at maximum potential and actually determined (105 day hybrid).

| Iowa State University Growth Stage | GDU required to reach growth stage | Yield components Potential | Actual |
|---|---|---|---|
| VE (Emergence) | 125 | Ears/area | ----- |
| V6 (six leaf collars) | 470 | Kernel rows/ear | "Factory" |
| V12 | 815 | ----- | Kernel rows/ear |
| V18 | 1160 | Kernels/row | ----- |
| R1 (Silking) | 1250 | Kernel weight | Kernel number Ears/area |
| R6 (Black layer) | 2350 | ----- | Kernel weight |

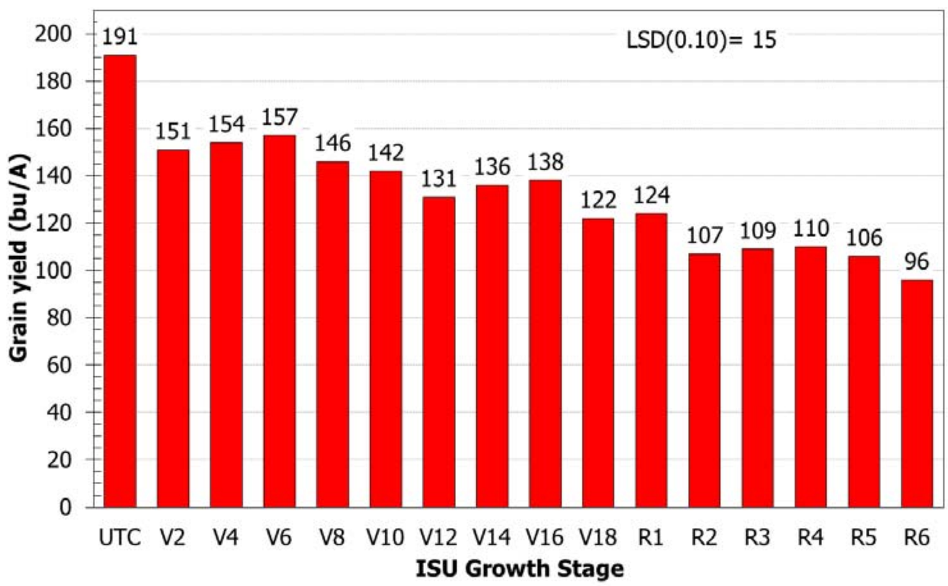
Likewise, kernel number is at its greatest potential slightly before R1, the actual number of kernels formed is determined by pollination of the kernel ovule. The yield component of kernel number is actually set by pollination and fertilization of the kernel ovule. If the ovule is not pollinated, the kernel cannot continue development and eventually dies. No new kernels form after the pollination phase is past.

The only yield component remaining with some flexibility is kernel weight. For the first 7 to 10 days after pollination of an individual kernel, cell division occurs in the endosperm. The potential number of cells that can accumulate starch is determined. At black layer formation (R6) no more material can be transported into the kernel and yield is determined.

One approach to studying the impact of whether management decisions can still impact yield is to do thinning studies at various growth stages. Plants are removed (thinned) thereby increasing the resources available to remaining un-thinned plants. When every other plant is removed, remaining plants have twice the resources that remain for the season that could eventually contribute to yield.

In 2009, plots were thinned with every other plant removed at different growth stages (Figure 2). Yield of the un-thinned plots was 191 bu/A. The lowest yield was corn thinned at R6 (physiological maturity) that was exactly half (96 bu/A) of the yield in the un-thinned plots. Three step changes seemed to occur during the corn life cycle. Grain yield was greater for plants thinned between V2 and V10, which was greater than plants thinned between V12 and R1, and which was greater than plants thinned between R2 and R6.

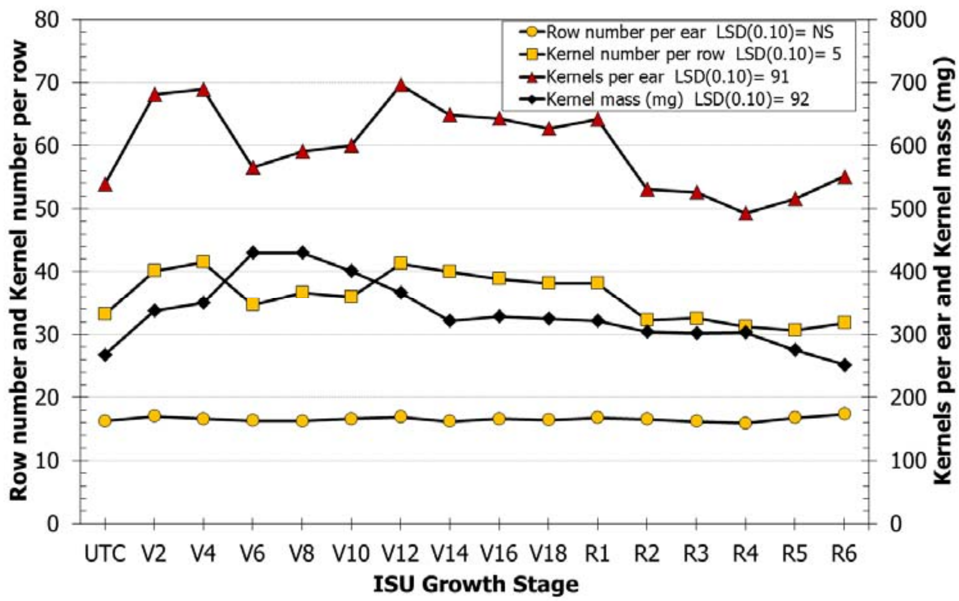
Figure 2. Grain yield of corn when every other plant is removed at various growth stages. Data were collected at Arlington during 2009 in plots with an initial plant density of 30,900 plants/A.




The effect of thinning on yield components is shown in Figure 3. Ears per plant and row number per ear were not affected by thinning at any time during the life cycle of this hybrid. Kernel number (kernels per row and kernels per ear) were at a maximum between V2 – V4 and V12 – R1. Kernel mass was at a maximum between V4 – V12. Most yield component adjustments occurred prior to R1. During grain-filling (R2 – R6) yield components were set and increasing resources to the plant by thinning every other plant did not affect grain yield.

Thus, most management decisions that could increase yield need to occur before the R2 (blister) stage. After this stage yield components are largely set and only yield attrition will occur through smaller kernel size. Numerous sources describe the results of management decisions and environmental influences that can affect kernel size. Afuwaka and Crookston (1984) described the impact of defoliation (simulating early frost) on grain yield between R4 and R6. Corn response to hail events have been simulated (Baldridge, 1976; Hicks and Peterson, 1976; Johnson, 1978; Shapiro et al., 1986; Vorst, 1990; Lauer et al., 2004). Guidelines for irrigation management have been described by many (Claassen and Shaw, 1970; Jama and Ottman, 1993; Howell et al., 1998; Irmak et al., 2000).

Figure 3. Grain yield components of corn when every other plant is removed at various growth stages. Data were collected at Arlington during 2009 in plots with an initial plant density of 30,900 plants/A.

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