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Timing is Key – Describing the Critical Stages of Yield Production

Dr. Dennis Egli, a Professor of Crop Physiology at UK, wrote this article simplifying three key phases of grain crop growth and how they determine yield potential. The effect of management practices or stress on corn and soybean yields often depends on when it happens. It's not just how dry or hot it is, but when. As with most things in life, timing is all-important.

The crop develops the photosynthetic machinery that will ultimately produce yield during Phase I, vegetative growth. Stress during this phase may not affect yield if the plants are healthy and produce enough leaf area to completely cover the ground at the beginning or shortly after the beginning of Phase II, seed development. Sunshine that reaches the soil does not contribute to photosynthesis of the crop, and, to make matters worse, it helps weeds grow. Having complete ground cover to capture almost all the sunshine near the beginning of phase II is a requirement for maximum yield.

The number of seeds per acre is determined during Phase II, making this phase critical for high yield. Phase II in soybean runs from Growth Stage R1, beginning flower, to a little past Growth Stage R5, at least one pod at the top four nodes with $1/8^{th}$ seed in the pod. For corn, Phase II is from 20 days before silking to 20 days after.

Seed number is related to the supply of simple sugars from photosynthesis during Phase II. Lack of these sugars due to stress in this phase may result in corn that doesn't pollinate completely to the ear tip, or single and two-seed soybean pods. Fortunately, soybeans make flower, pod, and develop seeds for up to two months, depending on maturity group and planting date, providing an opportunity for stress-free conditions during Phase II. Any stress that reduces photosynthesis during this period will reduce seed number and probably yield.

I say probably because increases in seed size can compensate for reductions in seed number and limit the effect of stress during Phase II on yield. Soybean seeds are more flexible than corn kernels, but there is a limit to how much they can flex (you can't fit a golf ball into a soybean pod) and how much they can compensate. The bottom line is that reductions in seed number during Phase II will probably reduce yield, so avoiding stress during Phase II is a must for high yields.

Yield is produced during Phase III, which ends at Growth Stage R7, one normal pod on the main stem that has reached its mature pod color in soybean, and at Black Layer in corn. Yield production is complete at the end of Phase III, but the seeds must dry before they can be harvested. Not surprisingly, the length of the seed filling period, which has a genetic and an environmental component, is directly related to yield. The longer the seeds grow, the higher the yield.

Phase III has several interesting characteristics. First, it is short, usually lasting only 30 to 40 days, so all systems must be going good to produce high yields in such a short time. The second interesting characteristic is that early in seed filling, the leaves start to senesce, breaking down the photosynthetic apparatus and shipping the breakdown products to the developing seeds. It seems strange that the crop starts destroying its capacity to produce yield just when it finally starts accumulating yield. Senescence does, however, increase the efficiency of nitrogen use by reducing the amount left in the leaves and stems at maturity.

Stress during phase III will reduce seed size and yield. High temperatures shorten the seed-filling period, as does moisture stress. We found in greenhouse experiments that the acceleration of leaf senesce by moisture stress could not be reversed by rewatering the plants after only 3 days of stress, making yield vulnerable to short periods of water stress.

The simple three-phase model describes the sequential nature of the process and identifies the critical periods for maximizing yield. First, the crop produces the photosynthetic machinery, then the yield container (seed number), and finally, it fills the container. Understanding this model will lead to better management decisions, and that means more money in the bank.