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In This Issue

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Editor: Tammy Luck | Department of Entomology, Purdue University, 901 W. State St., West Lafayette, IN 47907

Highlighter Green Soybeans Marking Our Fields

Author: Shaun Casteel

We are accustom to a sea of dark green soybeans during the month of August, so it is troubling when we see areas in our fields that turn highlighter green (Figure 1). Soybeans have typically reached their final height, developed their last leaf, and peaked in nitrogen (N) fixation during this month (basically, R5 to R6). In other words, soybeans finish the vegetative growth and transition fully to reproductive development and growth (i.e., pod retention and seed fill).

Figure 1. Highlighter green soybeans (N-deficient) showing up in fields across Indiana. (Photo taken Aug. 24, 2018 in Warren County by Jon Charlesworth, Purdue Extension, Benton County ANR).

Unfortunately, many soybeans across the state have been coming up short on N over the past several weeks (Figure 2). This problem has been building at various points across the season, but fully being expressed now due to the N demands the plant requires during seed fill and the field conditions of the past month or so. The root cause of the highlighter green soybeans (i.e., N-deficient) is literally at the roots! Nodulation and N fixation have been hit more this season with frequent and substantial wet feet. The wet conditions push out the oxygen in the pore space for the soil, which can lead to root and nodule death depending on duration.

Figure 2. Highlighter green soybeans (N-deficient) in the foreground vs. healthy, dark green soybeans in the background. (Photo taken Aug. 27, 2018 in Warren County by Kelly Pearson, Purdue Extension, Warren County ANR).

The first step is to dig up the good (i.e., dark green) and the bad (i.e., highlighter green) areas to investigate the root systems in particular the nodule load and activity (Figure 3). As you dig in these areas, please be aware of the ease or difficulty to push the spade into the soil. In other words, you are assessing the degree of compaction that could be limiting root development and the restriction to water flow. An investigation of the soybean roots, should also indicate if they have experienced any sidewall compaction, tire compaction, tillage pan, etc. In most every case, the highlighter soybeans have had a compromised root system, fewer nodules, and limited nodule activity (pink vs. white interior). If you want further confirmation that this is N deficiency, I suggest taking leaf samples of the good and bad areas for nutritional content (look at S level too) (Figure 4).

Figure 3. LEFT – Healthy, dark green soybeans with bigger root system with many active nodules. RIGHT – N-deficient soybeans (highlighter green) with limited nodules. August 23, 2018 near Columbia City.

Figure 4. Taking proper leaf samples (most recent mature leaves are typically the 3rd to 4th trifoliate from the top of the plant) to help diagnose the N deficiency. LEFT – Healthy, soybean leaf. RIGHT – N-deficient soybean leaf due to poor

nodulation and N fixation.

We understand that soybeans need a good root system and nodule load/activity to maximize growth, development, and yield. Many of us have probably experienced compromised root systems and limited N fixation due to compaction and wet feet. The pattern of N deficiency in many fields is causing some confusion since it is not matching up with soil series, clay knobs, sand ridges, or the low lying areas. In fact, the N-deficient soybeans are showing up on the side slopes (please see the following article on “Seep Hydrology and Soybeans”). Other patterns do not match up with side slopes, but I wager that is related to the subsoil (perhaps, more on those situations next week).

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Seep Hydrology and Soybeans

Authors: Jason Ackerson and Shaun Casteel

Seeps most often occur where a permeable soil layer is found above a restrictive or less permeable layer (Fig. 1a). While there are several types of restrictive layers (Table 1), all restrictive layers impede or slow the movement of water. When water infiltrates into the soil after rainfall or irrigation, the water moves rapidly downward through the permeable layer until it reaches the restrictive layer (Fig. 1b). Due to the low permeability of the restrictive layer, only a small amount of water can enter the restrictive layer. The water that does not enter the restrictive layer is then forced to flow laterally along the boundary between the restrictive layer and the permeable layer (Fig. 1c). The lateral flow of water can cause the soil to become saturated (Fig. 1d).

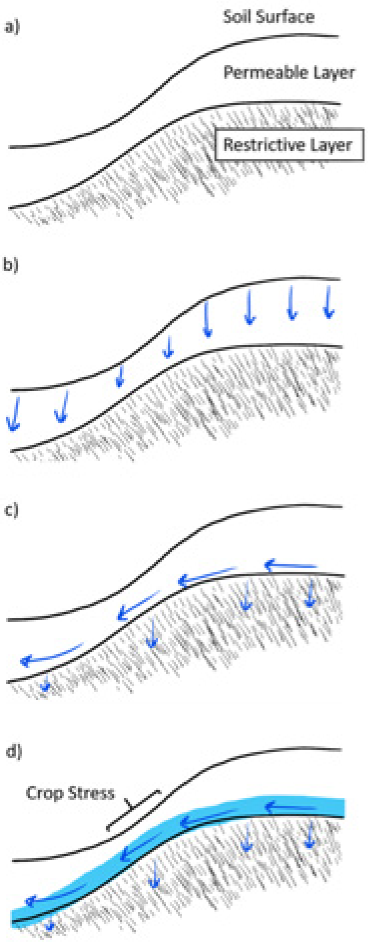


Figure 1. A cross section of a hillslope showing seep hydrology (Fig. 1a). During rainfall, water (blue arrows) moves vertically through the permeable layer (Fig. 1b). Only a small amount of water enters the restrictive layer and must flow laterally (Fig. 1c). With sufficient water movement, a saturated zone (blue shaded region) can form above the restrictive layer (Fig. 1d) and lead to crop stress.

Table 1. Examples of common restrictive layers found in Indiana.		
Restrictive Layer	**Origin**	**Location**
Dense till	Dense glacial deposits, often high in clay	Northern Indiana
Fragipan	Cemented subsurface layers	Southern Indiana
Bedrock	Hard, impermeable rock	Statewide, most common in Southern Indiana
Compacted soils	Compaction due to vehicle traffic and/or tillage	Statewide

On slopes the permeable layer is often thin and the zone of saturated soil is can be found near the soil surface. In extreme cases, where the permeable layer is very thin or there has been recent heavy rainfall, water can be seen "seeping" or flowing from the sides of hillslopes. Even if water is not seen at the soil surface, down-slope water movement at seeps can cause saturation of rooting zone. Saturation in the rooting zone can lead to crop stress like those described in the previous article ("Highlighter Green Soybeans Marking Our Fields") and Figures 2 through 6.

Figure 2. Soybean chlorosis and N deficiency pattern near Columbia City on Aug. 23, 2018.

Figure 3. Transition of dark green to highlighter green soybeans on the top of the hill down the slope near Columbia City on Aug. 23, 2018.

Figure 4. Close-up of healthy dark green soybeans on top of the hill near Columbia City on Aug. 23, 2018.

Figure 5. Close-up of highlighter green soybeans on the side slope that are N-deficient due to poor nodulation and N fixation (i.e., saturated conditions). Aug. 23, 2018 near Columbia City.

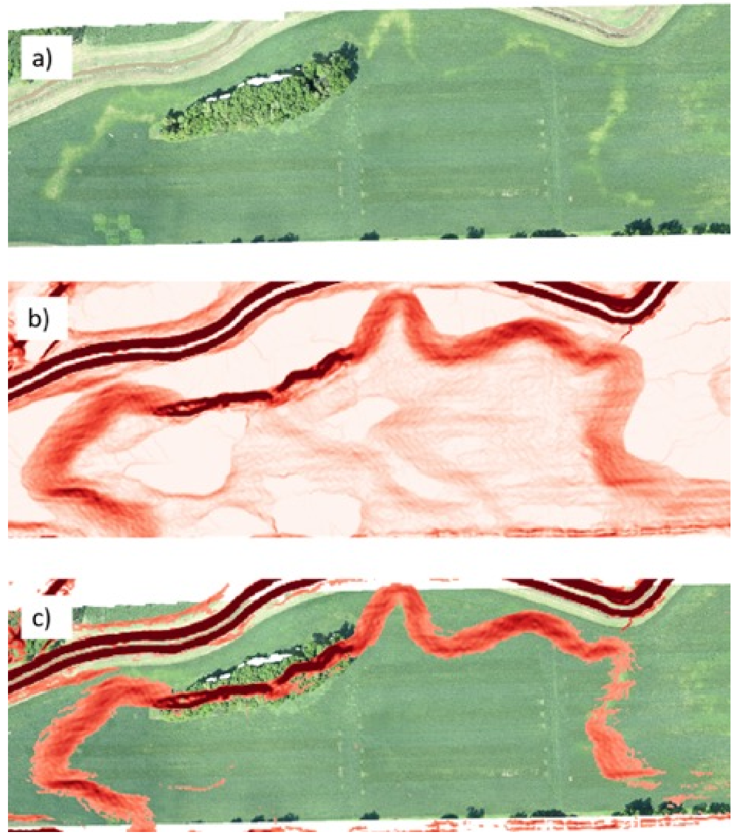


Figure 6. Aerial photo showing chlorosis and N deficiency stress in soybean (Fig. 3a). Slope of the soil surface visualized in red (Fig. 3b) show the likely location of seep hydrology where slope is greatest (i.e. areas of dark red). Areas of high slope (dark red from 6b) overlayered on the soybean aerial image (6a) correlate well with regions of crop stress (Fig. 6c).

Short Husks & Exposed Ears

Author: Bob Nielsen

Periods of severe stress can do all sorts of strange things to crops. One oddity that has been reported by a number of folks this year is often described as “ears outgrowing their husks.” The phenomenon is the result of stunted husk leaf development combined with fairly normal ear (cob) elongation.

The primary symptom is that the ears elongate beyond the end of the stunted husk leaves, resulting in exposed kernels that are subject to insects, birds, and weathering effects. Kernels damaged by these factors are vulnerable to fungal infection and the development of ear molds. Consequently, overall grain quality can be compromised to the point that grain buyers may discount or “dock” their prices accordingly.

The development of stunted husk leaves and exposed ears seems to be related to combination of severe stress before or during pollination that is then relieved in the initial weeks following pollination. The most common combination of conditions that results in this oddity is severe heat and drought stress that is then relieved by cooler temperatures and rainfall.

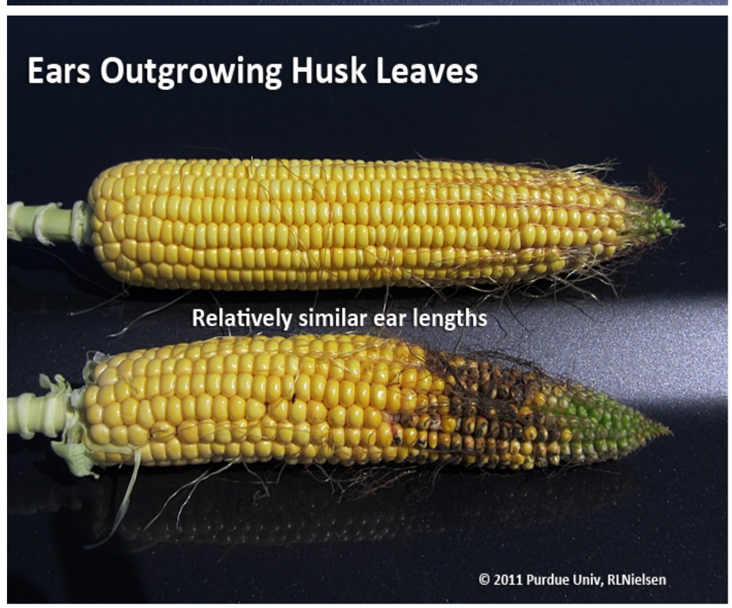
The stunting of the husk leaves is similar to what happens to the whole plant when it is subjected to lengthy periods of heat and drought stress. The potential for husk leaf expansion and elongation seems to be permanently restricted while the ear (cob) is able to continue elongation upon relief of the stress.

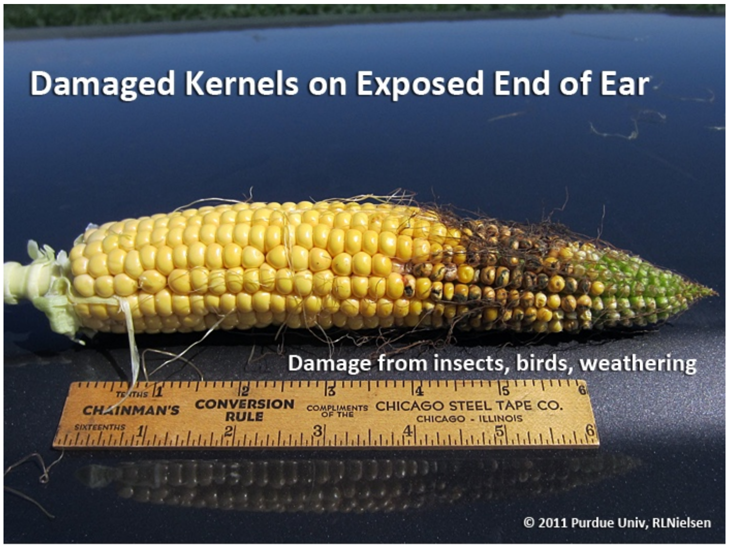
While the combination of excessive heat and drought stress followed by relief due to cooler temperatures or rainfall seems to be the common thread among reports of ears outgrowing their husk leaves, other combinations of severe pre-tassel stress followed by relief of the stress by pollination time may also result in the stunting of husk leaves without stunting of cob length. If not drought stress, it can be difficult identifying the nature of the pre-tassel stress.

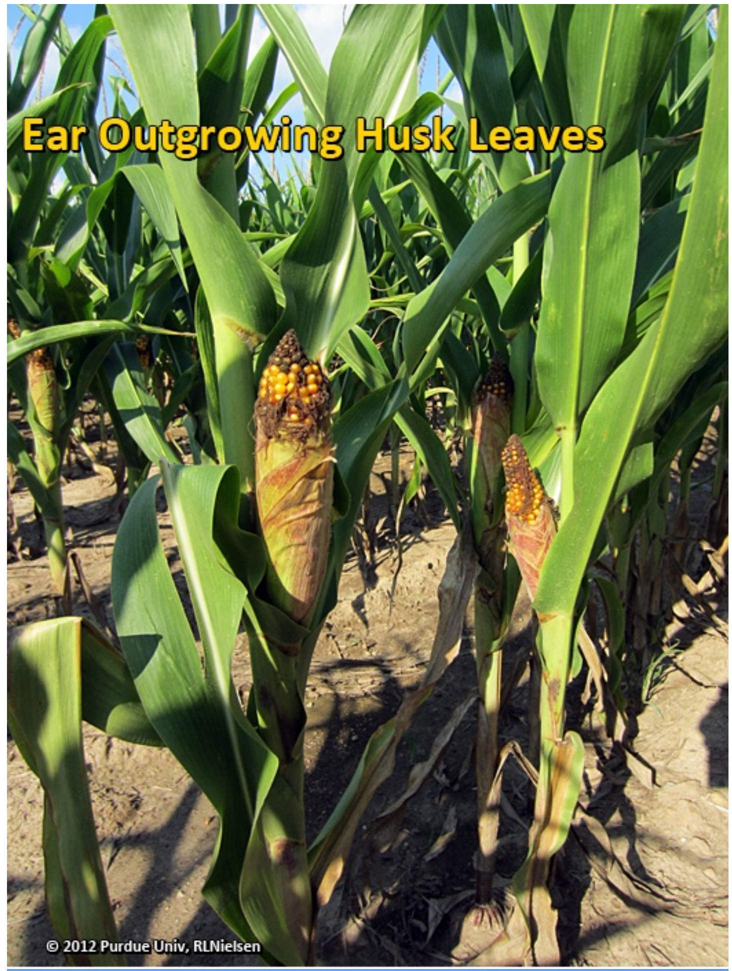
The photos at the bottom illustrate an example of stunted husk leaves from an area of a field in eastern Indiana in 2011 that was particularly drought-stricken compared to other, less stressed areas of the field. This field had also experienced severe root lodging about 10 days prior to pollination, which likely added additional stress on the developing ears for a period of time. Husk leaves of affected plants were about 2/3 the length of the ear itself and about half that of the husk leaves of the “normal” ears. Ear (cob) lengths of the “normal” and “stressed” ears were relatively similar; though kernel number and size were smaller on the “stressed” ears.

The ears (the last 2 photos) are from a field in northeast Indiana that experienced severe drought in 2012 that stunted husk leaves and cob length, but late rains were sufficient to allow the stunted ears to still elongate beyond the even more stunted husk leaves. In that situation, the drought stress was so prolonged and severe during the vegetative period that the height and overall size of the entire plant was significantly stunted.

In 2018, there have been a few reports of short husks and exposed ears with no identifiable severe pre-tassel stress. Additionally, the plants with the affected ears are reportedly otherwise normal in appearance. This is indeed curious and I cannot come up with a good explanation. Nutrient deficiency or toxicity are not known to cause these symptoms. I am not aware of any herbicide injury that results in these symptoms.







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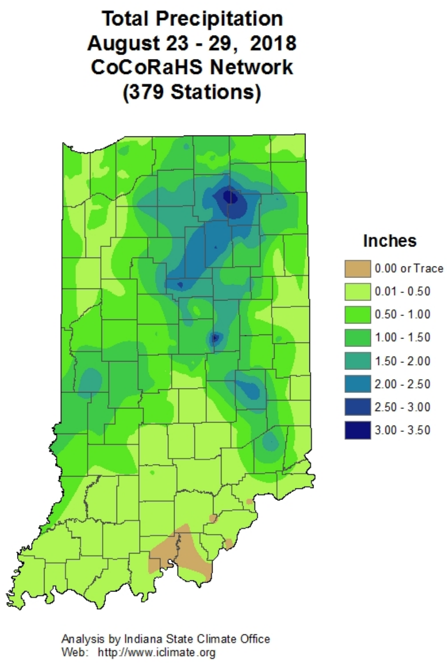
Total Precipitation August 23-29, 2018



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Average Temperature Departure from Mean August 22-28, 2018