

Assessing Effects of Drought on Corn Grain Yield?

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Parts of Indiana remain abnormally dry as we approach the middle of the growing season for corn; especially the southeastern areas of the state. Nearly 64% of Indiana was classified as abnormally dry while 13% of the state was classified as experiencing moderate drought conditions as of 3 July according to the U.S. Drought Monitor Web site (Fig. 1). Rains throughout the state during the past week have actually moderated the drought ratings somewhat compared to recent weeks; which is also reflected by the slight improvement in USDA estimates of Indiana's corn crop condition as of 1 July (Fig. 2).

Estimates of soil moisture deficits by the Midwest Regional Climate Center (5 July 2007) mirror the estimates of drought conditions. As of 5 July, estimates of soil moisture in the upper 72 inches throughout most of the eastern half of Indiana ranged from 5 to 15% below normal (Fig. 3). Estimates of soil moisture in the upper 12 inches indicate that areas of northeast Indiana were as great as 30% below normal as of 5 July (Fig. 4).

Obviously, none of this is any surprise to those growers affected by dry soils this current growing season. The nagging question that continues to be debated at the corner table of the Chat 'n Chew Café is how much yield potential has been or will be lost due to these dry soils and hot temperatures?

Unfortunately, accurately predicting the effects of severe drought stress on corn grain yield is never easy or straightforward. The actual yield for any given field is determined cumulatively throughout the entire season; not at any specific point in time. Like any stress, the effects of drought on corn grain yield depend on the severity of the stress, the duration of the stress, and the timing of the stress with crop developmental stages.

Grain yield can be broken down into several components, each of which is determined or "set" at different periods throughout the growing season (Fig. 5). The potential number of productive plants per acre is determined during the first 30 to 45 days after planting (germination through about leaf stage V6). Severe stress throughout the growing season can continue to affect harvestable plant population until harvest is complete.

The potential size of the ear (number of ovules) is determined over a lengthy period ranging from about leaf stage V5 to maybe as late as V15 (Nielsen, 2007b). The success or failure of pollination determines what percentage of the number of ovules will be fertilized and thus initiate kernel development (Nielsen, 2007a). The actual number of surviving kernels is largely determined during the first week or two following pollination

(Nielsen, 2005). Finally, dry weight per kernel is determined throughout the remainder of the so-called “grain fill” period (Nielsen, 2007c) that terminates with the development of the kernel black layer (aka physiological maturity).

Given the early beginning of drought or near-drought conditions this year in Indiana, essentially every single yield component may be influenced in some fields. Stand establishment in 2007 was erratic or non-existent due to excessively dry seedbeds in some areas of the state (Nielsen, 2007f). Consequently, the productive number of plants per acre was significantly reduced from the “git-go”.

Ear size determination was undoubtedly impeded in some fields due to severe drought stress from V5 to V15. Dryness that caused leaf rolling only in the afternoon hours is probably not severe enough to significantly reduce ear size determination. Leaf rolling that occurred from shortly after sun-up to after dusk probably constitutes severe drought stress. Leaf and/or plant death due to drought obviously constitutes severe drought stress.

The success of pollination and the grain fill period this current season largely remains to be seen as of the date that I’m writing this article. Traditionally, the pollination phase is referenced as THE most important yield-determining period of the growing season relative to the percent of yield potential that can be lost per day of severe stress (Thelen, 2007). When coupled with the importance of the first couple of weeks following pollination that determines “kernel set” (Nielsen, 2004b), there is no question that the next few weeks will be very important in determining the severity of yield loss due to drought this year.

Estimating actual or percent yield loss due to drought is challenging for the reasons I’ve outlined above. Obviously, one can estimate yield potential due to a lower productive plant population by using available references on yield and plant population (Nielsen, 2007f). Assessing ear size potential prior to pollination is difficult to do because of the small size of the developing cobs (Nielsen, 2007b). Assessing the success of pollination can be done shortly after pollination is complete by conducting the so-called “ear shake” test (Nielsen, 2007a).

The first opportunity to integrate most of the yield components into a pre-harvest estimate of grain yield occurs by dough stage of kernel development or later when one can count the likely number of harvestable ears per acre and the average number of kernels per ear (Nielsen, 2004a). This so-called “yield component” method for estimating grain yield will place you in the proverbial “ball park” for accuracy, but can vary plus or minus 20 bushels per acre in my experience. This method for estimating grain yield is not precise because kernel dry weight (the final yield component) cannot be estimated prior to physiological maturity and so the formula uses a proverbial “fudge factor” for kernel weight in order to complete the yield estimate.

Bottom line.....This year’s drought conditions will undoubtedly result in lower than desired corn grain yields for some growers; the magnitude of which is nearly impossible to estimate with any degree of accuracy at this point in time.

Related References

- Midwest Regional Climate Center. 2007. Midwest Climate Watch. [On-Line]. Available at <http://mcc.sws.uiuc.edu/cliwatch/watch.htm>. (URL verified 7/5/07).
- Nafziger, Emerson. 2007. How Soon and How Much Does It Need to Rain? Illinois Pest & Crop Bulletin. Univ. of Illinois. [On-Line]. Available at <http://www.ipm.uiuc.edu/bulletin/article.php?id=782>. (URL verified 7/5/07).
- Nielsen, R.L. (Bob). 2004a. Estimating Corn Grain Yield Prior to Harvest. Corny News Network, Purdue Univ. [On-Line]. Available at <http://www.kingcorn.org/news/articles.04/YieldEst-0718.html>. (URL verified 7/4/07).
- Nielsen, R.L. (Bob). 2004b. Yield Loss Potential During Grain Fill. Corny News Network, Purdue Univ. [On-Line]. Available at <http://www.kingcorn.org/news/articles.04/GrainFillStress-0705.html>. (URL verified 7/4/07).
- Nielsen, R.L. (Bob). 2005. Kernel Set Scuttlebutt. Corny News Network, Purdue Univ. [On-Line]. Available at <http://www.kingcorn.org/news/articles.05/KernelSet-0809.html>. (URL verified 7/4/07).
- Nielsen, R.L. (Bob). 2007a. A Fast & Accurate Pregnancy Test for Corn. Corny News Network, Purdue Univ. [On-Line]. Available at <http://www.kingcorn.org/news/timeless/EarShake.html>. (URL verified 7/2/07).
- Nielsen, R.L. (Bob). 2007b. Ear Size Determination in Corn. Corny News Network, Purdue Univ. [On-Line]. Available at <http://www.kingcorn.org/news/timeless/EarSize.html>. (URL verified 7/5/07).
- Nielsen, R.L. (Bob). 2007c. Grain Fill Stages in Corn. Corny News Network, Purdue Univ. [On-Line]. Available at <http://www.kingcorn.org/news/timeless/GrainFill.html> (URL verified 7/2/07).
- Nielsen, R.L. (Bob). 2007d. Silk Emergence. Corny News Network, Purdue Univ. [On-Line]. Available at <http://www.kingcorn.org/news/timeless/Silks.html> (URL verified 7/2/07).
- Nielsen, R.L. (Bob). 2007e. Tassel Emergence & Pollen Shed. Corny News Network, Purdue Univ. [On-Line]. Available at <http://www.kingcorn.org/news/timeless/Tassels.html> (URL verified 7/2/07).
- Nielsen, R.L. (Bob). 2007f. Variable Emergence Due to Variable Seedbed Moisture. Corny News Network, Purdue Univ. [On-Line]. Available at <http://www.kingcorn.org/news/articles.07/VariableEmergence-0520.html>. (URL verified 7/5/07).
- Thelen, Kurt. 2007. Assessing drought stress effects on corn yield. Field Crop Advisory Team Alert Newsletter. Michigan State Univ. [On-Line]. Available at <http://www.ipm.msu.edu/cat07field/fc06-28-07.htm>. (URL verified 7/5/07).
- Thomison, Peter. 2007. Drought and Heat Stressing Corn. C.O.R.N. Newsletter, Ohio State Univ. [On-Line]. Available at

<http://agcrops.osu.edu/story.php?setissueID=189&storyID=1134>. (URL verified 7/5/07).

USDA-NASS. 2 July 2007. Indiana Crop & Weather Report. USDA-Nat'l Ag Statistics Service. Vol. 57, No. 26. [On-Line]. Available at http://www.nass.usda.gov/Statistics_by_State/Indiana/Publications/Crop_Progress_&Condition/2007/we2607.pdf. (URL verified 7/2/07).

U.S. Drought Monitor. 2007. [On-Line]. Available at <http://www.drought.unl.edu/dm/monitor.html>. (URL verified 7/3/07).

Figures Referenced in Text

U.S. Drought Monitor Indiana

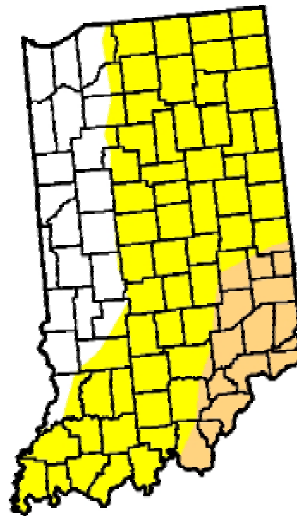
July 3, 2007
Valid 7 a.m. EST

Drought Conditions (Percent Area)

| | None | D0-D4 | D1-D4 | D2-D4 | D3-D4 | D4 |
|---|-------|-------|-------|-------|-------|-----|
| Current | 23.5 | 76.5 | 12.7 | 0.0 | 0.0 | 0.0 |
| Last Week (06/26/2007 map) | 14.3 | 85.7 | 21.4 | 2.0 | 0.0 | 0.0 |
| 3 Months Ago (04/10/2007 map) | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Start of Calendar Year (01/02/2007 map) | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Start of Water Year (10/03/2006 map) | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| One Year Ago (07/04/2006 map) | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements



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Author: Douglas Le Comte, GPC/NOAA

<http://drought.unl.edu/dm>

Fig. 1. Estimates of drought conditions throughout Indiana as of 3 July 2007.

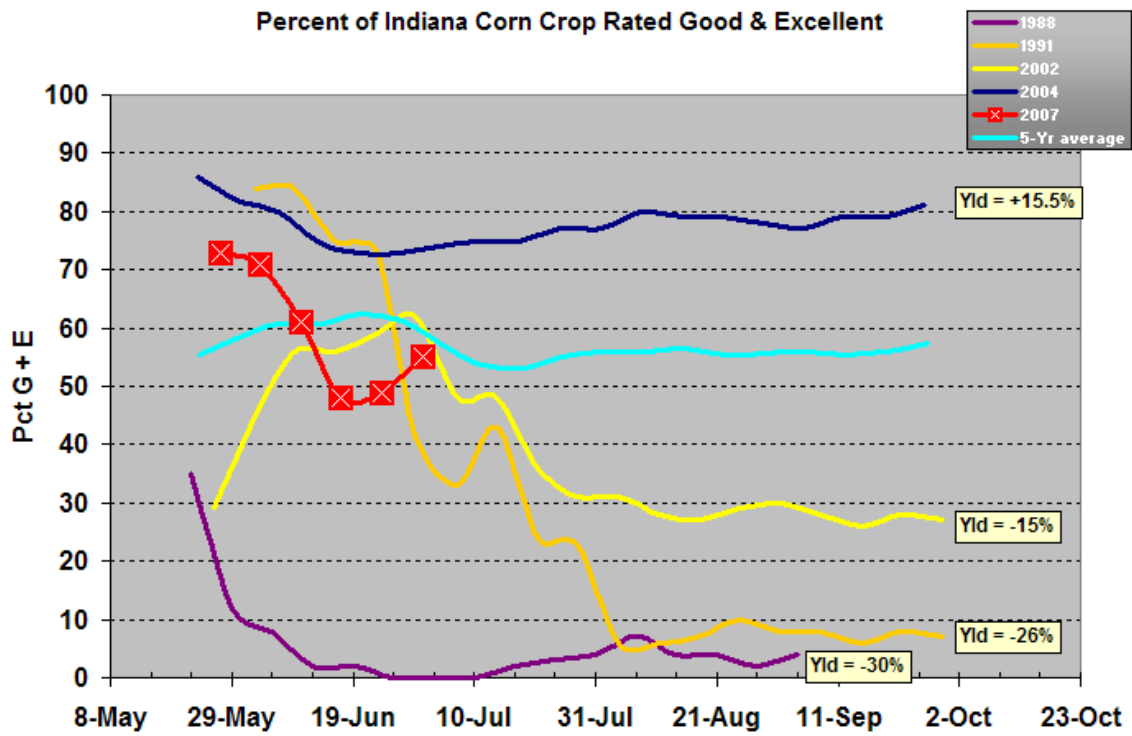
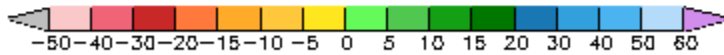
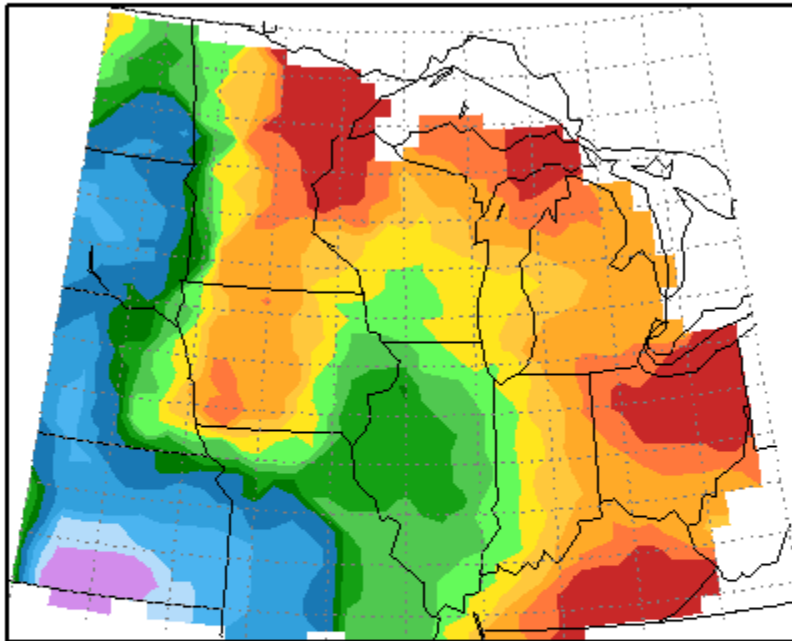


Fig. 2. Percent of Indiana corn crop rated good & excellent from late May through early July for 2007 versus several other years and the 5-year average. The yield values shown in the yellow boxes indicate the percent above or below Indiana corn trend yield for each indicated year. Source: USDA-NASS, 2007.

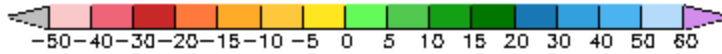
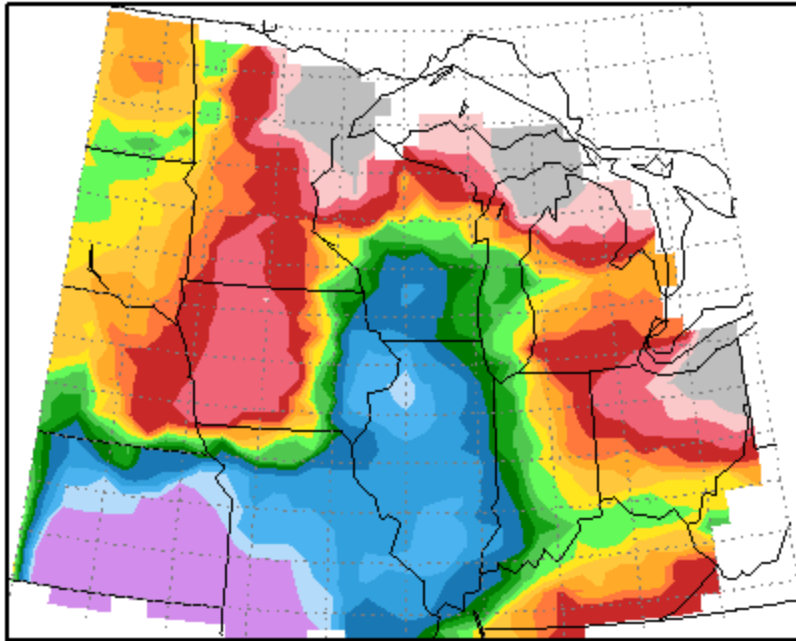
**Current Soil Moisture Deviation (%), Depth = 0-72
July-5-2007**



**Midwestern Regional Climate Center
Illinois State Water Survey
Champaign, Illinois**
<http://mcc.sws.uiuc.edu/cliwatch/watch.htm>

Fig. 3. Estimate of soil moisture deficits throughout the U.S. Midwest in the upper 72 inches as of 5 July 2007. Source of image: Midwestern Regional Climate Center, <http://mcc.sws.uiuc.edu/cliwatch/watch.htm>.

**Current Soil Moisture Deviation (%), Depth = 0-12
July-5-2007**



**Midwestern Regional Climate Center
Illinois State Water Survey
Champaign, Illinois**
<http://mcc.sws.uiuc.edu/cliwatch/watch.htm>

Fig. 4. Estimate of soil moisture deficits throughout the U.S. Midwest in the upper 12 inches as of 5 July 2007. Source of image: Midwestern Regional Climate Center, <http://mcc.sws.uiuc.edu/cliwatch/watch.htm>.

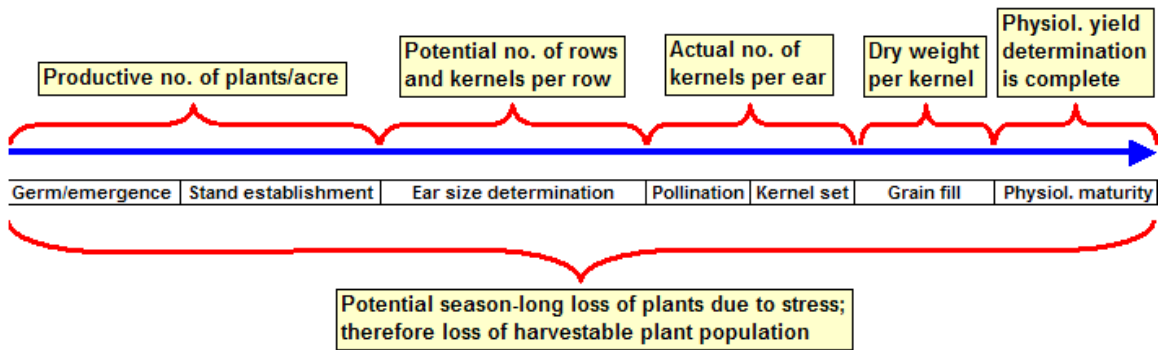


Fig. 5. An illustration of the timing of yield component determination in corn.

Don't forget, this and other timely information about corn can be viewed at the Chat 'n Chew Café on the Web at <http://www.kingcorn.org/cafe>. For other information about corn, take a look at the Corn Growers' Guidebook on the Web at <http://www.kingcorn.org>.

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