Dec 1st, 12:00 AM

Crop weather risk for 2010

Elwynn Taylor
Iowa State University, setaylor@iastate.edu

Crop weather risk for 2010

Elwynn Taylor, professor, Agronomy, Iowa State University

The Midwest has just experienced two harsh winters in a row, a wet Spring, lagging Growing Degree Days, slow development of crops, record high yield in the field, Fall rain (and floods), and record moist grain and soy at harvest. Although there are a few who do remember when everyone helped with harvest AFTER Thanksgiving Dinner, most of us were convinced that it was better equipment that got the crops in. It turns out that weather may have had an impact all along. The curious aspect of this atypical year is that it was accurately anticipated well before the crops were planted. Soil conditions at harvest time in 2008 told us that there would likely be areas with excessive moisture at planting time (but not that ALL areas would have excessive moisture). The developing La Niña in early September 2008 foretold a harsh winter for the Midwest. Fog in February is indeed an indicator of a wet spring (especially when matched with wet conditions in Arkansas during March). The National Weather Service Summer Outlook foretold hot conditions for the Northwestern US (almost always associated with cool conditions in the Corn Belt with large crop yields). Growing Degree Accumulation seemed to be in a summer-long slump, and when the lag exceeded 300 Growing Degrees behind normal delayed maturity (with high moisture at harvest) was almost assured. The USDA October estimate of 2009 harvest, based on harvested samples in selected fields assumes normal weather to the end of the season. The weather was not typical, but there was no reason to question the anticipated large yield. My grandfather said, "The harvest is not late if you get the corn out of the field." There were some years he did not get the full crop out of his fields. A review and outlook relative to this collection of key factors follows.

Soil moisture

Most of the productive soils in Iowa have a capacity of 10 inches of plant available water in the top 5 feet. A few soils have a capacity of 11 plus inches, some a bit less than 10. The average rooting depth of both corn and soy is 5 feet. Under favorable conditions both crops are known to root to a depth of 7 or more feet. During an average year, crop water use in central Iowa is about 22 inches of water and yield is within 2% of the 30-year trend expectation. The potential crop water use is about 24 inches with normal conditions. The difference between the potential water use and the actual water use represents the strain associated with the relationship of the plant condition, available moisture, and atmospheric demand. Strain ultimately impacts the realized crop yield. By "rule-of-thumb," some 25 inches of moisture are required for record crop yield. The actual amount required varies with the temperature, humidity, wind, sunlight and numerous factors associated with plant production and protection. Corn and soy have about the same total moisture requirement but differ in the timing of maximum water expenditure. Iowa corn normally requires more moisture in July than any other month; soy has greatest demand in August.

Soil moisture levels are typically at or near capacity in Eastern Iowa by November and remain at capacity at planting time (Figure 1). The near capacity condition of the soil in spring results in periods of excessive moisture resulting from normal spring rain and often causes delays in planting or results in less than ideal field conditions when planting is accomplished. A slightly below capacity sub-soil moisture total is often favorable for successful crop establishment and is later replenished by normal spring rains. Precipitation is reduced and more erratic in western Iowa. Accordingly, the risk of reduced crop yields when subsoil moisture is initially below capacity is substantial (Figure 2).

Outlook

Abnormally heavy October precipitation in the western Corn Belt resulted in a third consecutive year for Iowa soils to go into winter at near field capacity. As there is little withdrawal of subsoil moisture by overwinter plant activity (at least in fields where crops are produced), subsoil moisture may be assumed to be near capacity at planting time in 2010. Also, it may be assumed that normal spring precipitation will result in some measure of planting disruption.

The contribution to flood risk associated with over-winter soil moisture condition should not be overlooked. The 3 substantial flooding events of the past 20 years at Mason City, IA can serve as an example: Soil moisture was well above capacity (a condition known as saturation) after November. A 2-inch precipitation event and accompanying melting of snow was sufficient to initiate serious flooding in 1993. When rain or extensive snow melt occurs while soils are frozen the infiltration of moisture is negligible and flooding is expected. When the frost is out of the soil, the impact of melt and/or precipitation is buffered by unused moisture holding capacity of the soil.

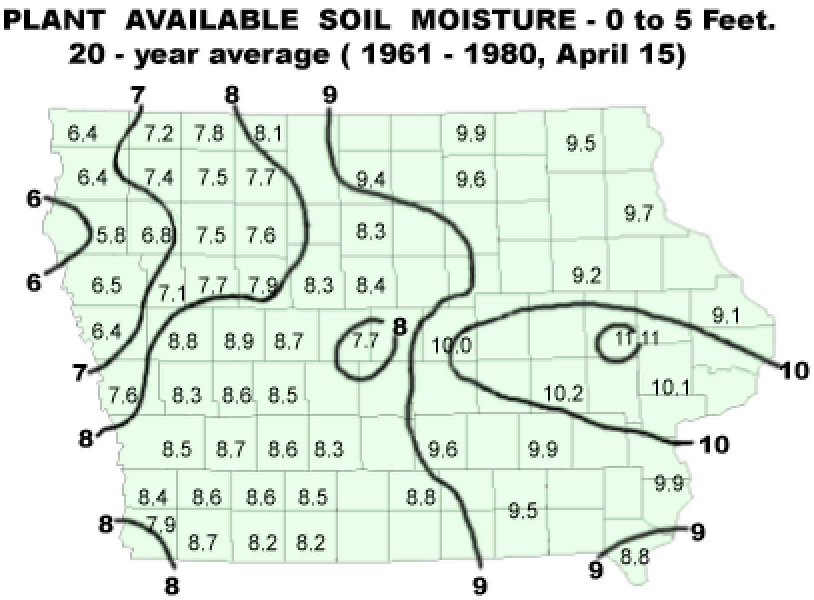

Figure 1. Subsoil moisture is normally at capacity in east central Iowa at planting time. During the winters of 2007-2008 and 2008-2009 soils statewide were at capacity. Although problems associated with excessive moisture were expected at planting, the full measure of moisture was considered desirable in the western third of the state. It appears that moisture will approach capacity over the 2009-2010 winter (third consecutive year).

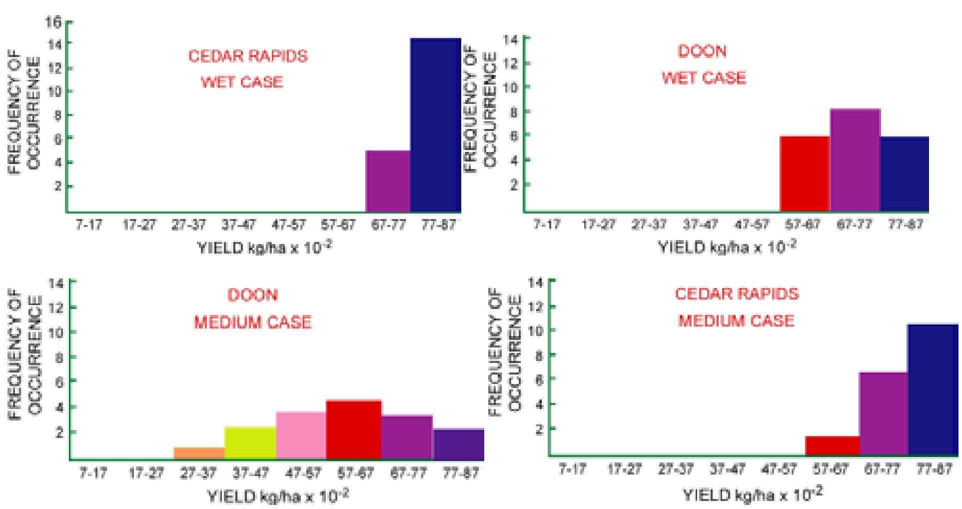

Figure 2. The chance of a "full" yield is greatest in both western Iowa (Doon) and eastern Iowa (Cedar Rapids) when soil moisture is at field capacity at planting time. Reduced soil moisture, near 60% of capacity, results in a much increased risk of reduced yield in western Iowa because of limited mid-season precipitation.

The flood of late May 2004 was the result of 14 inches of spring precipitation. Although the soils were not initially saturated, the single storm event of near 8 inches would have been sufficient for significant flooding. The extraordinary water year comprised of fall 2007 – summer 2008 resulted in very wet soils over the winter followed by June rainfall in and of itself sufficient to cause major flooding. The combined impact set record high flood levels in several Iowa locations. The moist soil condition not only reduces the risk of serious agricultural drought but increases the risks of extensive flooding, a risk that must be considered significant for 2010.

Winter temperature

Bitterly cold outbreaks of Arctic air are not unusual during winters in the Midwest. The "cold waves" interleafing with unusually warm interludes are more common when the La Niña is in place. The past 2 winters were not atypical of "La Niña winters." El Niño conditions are in many respects the opposite of La Niña; accordingly, the months of January through March of 2010 may be expected to have less extreme temperature than the past 2 winters, less precipitation in the valley of the Ohio, and a slight increase of winter precipitation in the High Plains.

Summer temperature

Winter conditions are not, in and of themselves, indicative of summer weather. However, by mid-February 2009 the forecast summer pattern was favorable for a repeat of the record high corn yield years of 1992 and 2004. In all 3 cases the summer temperature averaged well above normal west of the Continental Divide and resulted in cooler than usual temperatures in the Midwest (Figure 3). Cool summer temperature has a complex effect on crop production. Stressfully hot days are likely to be absent or reduced in number and severity. Also crop development may proceed at a reduced rate while development is disproportionately retarded (allowing more dry weight to be accumulated before the crop reaches maturity). On occasion the temperature can be too cool for effective weight gain resulting in reduced yield. However in the 3 years noted above record yields of "record wet" corn were obtained.

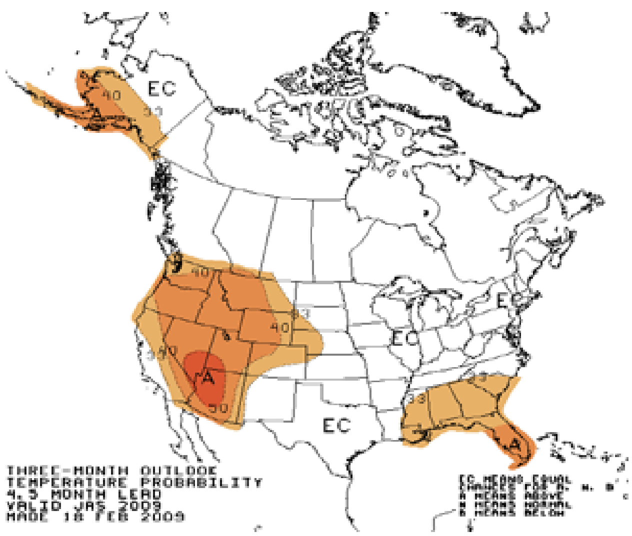

Figure 3. The mid-winter forecast for the summer of 2009 indicated that warm conditions were likely west of the Continental Divide. This was taken as a favorable forecast for the Corn Belt as Midwest temperatures have historically not been excessive when this pattern has been dominant.

The Outlook for 2010 may be dominated by El Niño conditions, but it will likely be February or March before the continuance of El Niño conditions into summer can be established. Although the El Niño does signal a slightly favorable summer precipitation pattern for the Midwest, the absence of oppressively hot temperatures is the primary factor resulting in favorable harvests in the majority of El Niño years.

Spring rain

The 2008 growing season began with warm but moist conditions that lasted almost until planting time. The moisture in March and April exceeded the average in much of Iowa and in the central US in general. Spring rains were a disruption to timely planting for a second consecutive year. With the soils at harvest time saturated across Iowa and in some neighboring states for the 3rd consecutive year, the possibility of delayed planting in 2010 is a distinct possibility.

Growing degree days

Temperature is often the factor that determines crop success. The growth rate of plants is temperature dependent. Corn can initiate growth when the temperature exceeds 50F. The temperature for optimal growth, when other factors are near normal, is 86F. If the low temperature were 60F and the high 80F for a day, the Growing Degree Day contribution for the day would be 20, as the daily Growing Degree Day contribution is the average temperature less 50. For computational purposes, temperature is not allowed to fall below 50 or exceed 86. The computation is useful because the growth stage of most plants is more consistently near a given number of accumulated Growing Degree Days than a given number of accumulated calendar days. For example, a variety of Corn planted May 1 is expected to reach Silking on July 10. If the growing degree days are 50 to 60 ahead of usual since May 1 the corn may be expected to silk on July 7. The system is not a perfect model of corn development, but it is a better model than calendar days. Monthly records of historical Growing Degree Days for Iowa are found at mesonet.agron.iastate.edu under Climatology Climodat.

The 2009 season was on the cold side of normal most weeks. All months from April through October averaged below usual gdd (Growing Degree Days) accumulation in central Iowa, surpassing the June through October record of 1992, a year that was noted for record high yield of record wet corn. Lag from normal accumulation of Growing Degree Days during the spring is not considered as significant aside from the relationship it has to moist soils and less than ideal drying conditions. A lag of 200 gdd between silking and dent stages of corn is considered beneficial to crop yield in that the grain filling period is increased without significant reduction in the filling rate. When the lag exceeds 300gdd the filling rate is usually reduced as well and the overall effect is delayed maturity of the crop.

It is seldom possible to make a meaningful forecast of summer gdd accumulation before February. However, during El Niño years the accumulation tends to be near the norm.

El Niño

The past 2 winters were dominated by La Niña conditions that typically have greater deviation of daily temperature around the norm than does an El Niño year or even a neutral year. Overall, the El Niño winter (in most of Iowa) may average slightly warmer than other years (Figure 5) and may not have temperatures as extreme as other years. Precipitation (in western Iowa and eastern Nebraska) may exceed the average (Figure 6) but winter precipitation amount is not so much the concern as is the type of precipitation (ice, snow, rain). The Ohio River valley is typically on the dry side of usual during El Niño winters.

El Niño was named because of the major impact on weather occurring during the Christmas season. It appears that a substantial El Niño event will be in place by that time in 2009. As such events tend to persist for about 14 months, the risk of adverse planting conditions and of heat/drought stress for the summer of 2010 is much reduced.

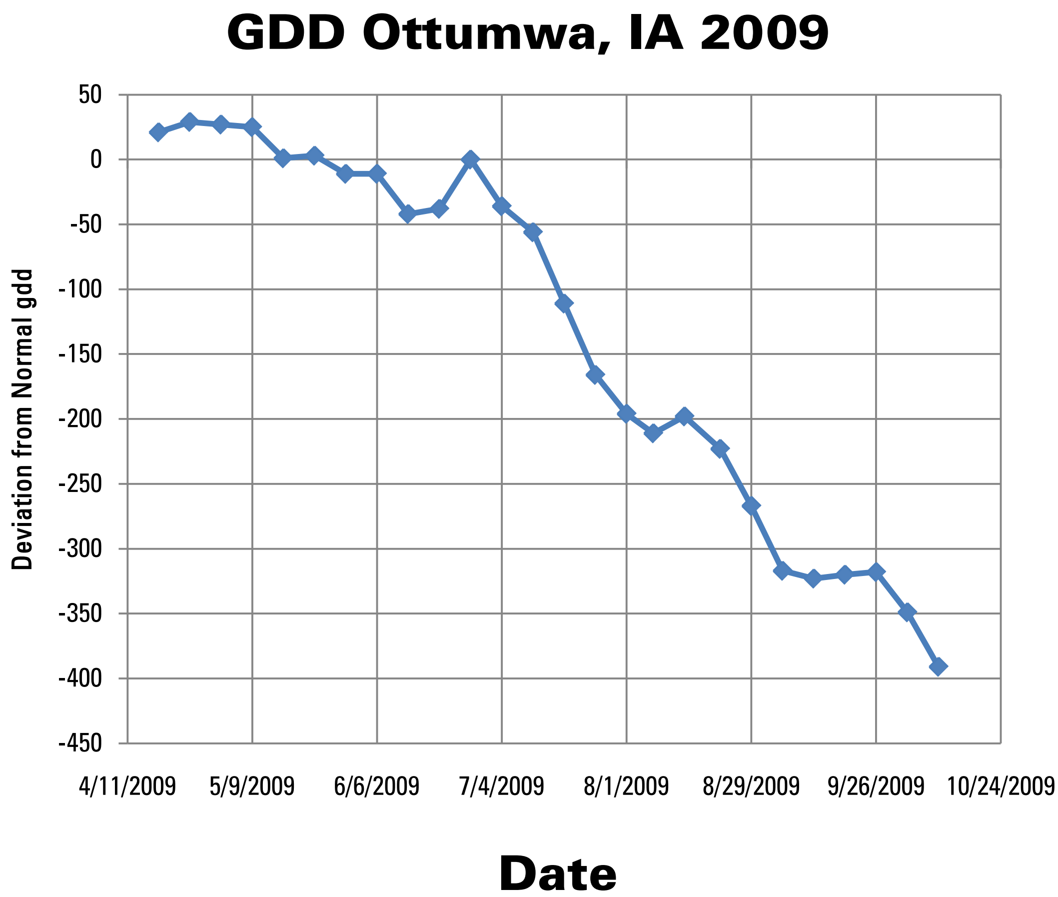

Figure 4. Growing Degree Days (gdd) in South Central Iowa did not depart significantly from normal during spring of 2009. Consistent lag beginning in July slowed crop maturity. When lag exceeds 300 gdd the excess is considered to have a detrimental impact on crop condition and yield.

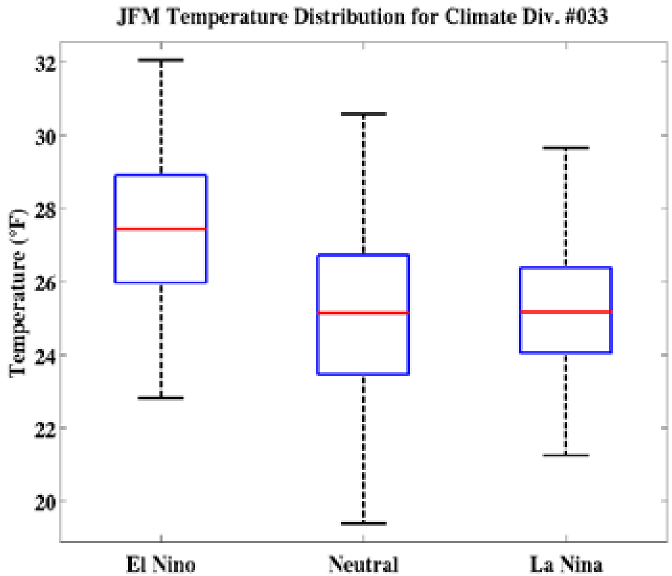

Figure 5. El Niño conditions tend to result in warmer winter (Jan-Mar) temperatures in much of Iowa. Data taken from: www.cpc.ncep.noaa.gov/products/precip/CWlink/ENSO/box_whiskers/index.php

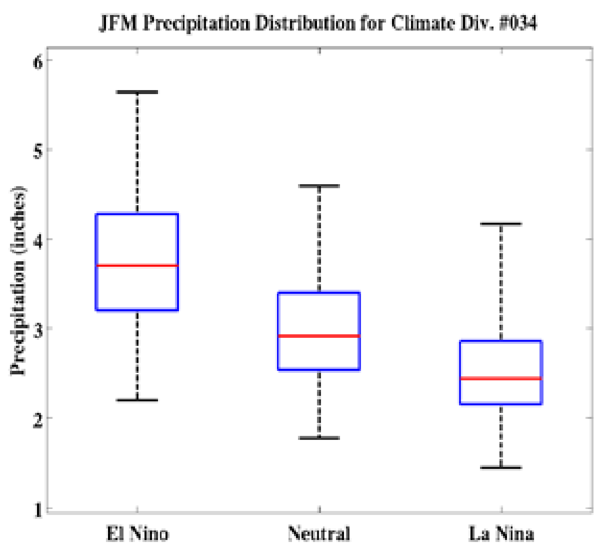

Figure 6. Winter precipitation during El Niño tends to exceed the norm in western Iowa and eastern Nebraska. Moving toward the east, the pattern reverses resulting in relatively dry winters in Ohio.