Most years some places in the Eastern US get more early-season rainfall than crops prefer. The spring of 2013 was no exception. Some areas in the Northeast received excess rain early in the growing season and corn plants really suffered. The corn stands in high rainfall areas tended to be very uneven in height and color, with some areas where corn was tall and green, and other areas in the same field where corn plants were stunted and yellow. The yellow and stunted color must mean that more manure or fertilizer nitrogen should have been applied, right? Not so fast. Let’s analyze this closer.

Everyone knows that yellow corn leaves mid-season most likely reflect a nitrogen (N) deficiency. But whether adding more N the next year is the right solution has to do with why the crop was expressing N deficiency symptoms. There are three main, sometimes related, possibilities for this yellow coloring: 1) not enough N was applied independent of the weather; 2) enough N was applied for normal growing seasons and converted to plant-available nitrate but due to excessive rainfall a portion of this nitrate was leached (well-drained soil) or denitrified (lost as N gas in waterlogged, less well-drained soil) before the crop could take it up; or 3) N was applied in organic form (manure, compost) or as ammonium fertilizer and has not mineralized yet due to wet and cold soil conditions (loss of nitrate through leaching or denitrification requires that nitrate is present in the soil when excess rainfall occurs).

A delay in the conversion of organic N or ammonium to nitrate can occur when soils are cold. The conversions require that microbes are active. During a typical spring warm-up period this conversion happens quickly, but what happens when rain is excessive like some regions experienced in spring 2013?

Heavy rains create waterlogged soil conditions and when this persists for 48 hours or more, saturated soil conditions cause an oxygen deficiency in the soil. Lack of oxygen really stresses young corn plants. Young corn is more susceptible to such saturated conditions because the growing point is below the soil surface until the V6 growth stage (about six leaves with visible collars). Soil wetness, sealing, and compression of soil from excess rain prevent good root development and even if plants survive they often never fully recover. Upon inspection, root systems from these plants tend to have an unhealthy appearance: stunted, yellow and brown. Often such conditions are reflected in the above ground portion of plants too, with stunted and yellow corn plants throughout the season. But do these visual symptoms mean that not enough N was applied, that too much N was lost after application, or that addition of extra N later in the season would have increased yield? Maybe. However, it is entirely possible that in uneven looking fields the plants were unable to take up nutrients that were present and that later N additions would not benefit the crop.

The situation in manured fields can even be more challenging to diagnose. Urea and ammonium forms of N from manure (or fertilizer) are stable until converted to nitrate by soil microbes. So, when wet conditions occur early and ammonium-based forms of N or organic N (manure, compost) are applied, at least some of this N is not prone to loss initially. It must first be converted to nitrate. Transformation occurs as soils warm up and usually tracks well with

**FYI**

- **Quirine Ketterings** is a professor in the Cornell Department of Animal Science. Email her at qmk2@cornell.edu.
- **Karl Czymmek** is a Senior Extension Associate. Email him at kjc12@cornell.edu.
- **Shona Ort** is a technician in Quirine Ketterings’ program. Email her at sbo6@cornell.edu.

Corn that is under water for 48 hours or more suffers from a lack of oxygen, causing stunted and yellow corn plants in saturated areas of the field, surrounded by taller and green corn where lack of oxygen was not as much of an issue. Although denitrification will occur if nitrate is present in saturated soil, trying to recover a crop with N fertilizer application may not result in a healthy crop if root systems were damaged by a lack of oxygen.
Green and tall corn over the tile lines shows that sufficient N was applied while in the yellow areas, saturated soil condition and lack of oxygen prevented plants from developing the root systems to take up N.

the N need of corn plants. When soil is warm and moist, N transformation rates are highest. That often coincides with the time when corn plants are rapidly growing and have the highest N uptake.

So, with a wet and often cold spring, it is entirely possible to get stunted and yellow corn even if adequate N from manure and fertilizer was applied. This N will become available as soon as soils warm up and dry as oxygen returns. What is the best way to know if enough manure was applied in conditions such as described above and as seen in the picture? Look at the better drained areas of a field, including places over tile lines. If those areas look relatively green and are not N deficient, while other parts of the field look poor, and assuming manure was applied fairly evenly, the answer is more likely related to poor root development preventing nutrient uptake, not insufficient N application. Each of these areas received the same amount of rain. If N was in nitrate form when it started raining, wouldn’t it have been lost through tile drainage and resulted in yellow and stunted corn over the tile lines as well? In the same way, the N was not prone to denitrification and oxygen limited conditions prevented plant uptake.

Yes, yellow corn leaves may mean that not enough N was applied. But this is not likely the case on fields with regular manure application and where rates were calculated, and properly applied, to meet crop demand. Fields that regularly receive manure tend to have an ability to supply adequate N when conditions necessitate, a phenomenon known as soil biological buffering capacity. If parts of fields show N deficiency, take a second look, dig up some plants and look at the roots. Do not automatically assume it is based on inadequate N supply. Fertilizing areas that were impacted by saturated soil conditions, resulting in stunted root systems, will be a waste of time and money.