Crops and Manure

By Quirine Ketterings and Karl Czymmek

My 2013 corn silage crop was yellow. What happened to the nitrogen?

2013: corn and nitrogen

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

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.

FYI

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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. ❐

N rate studies of winter cereals

By Shona Ort, Quirine Ketterings and Karl Czymmek

Driven primarily by 2012 weather related forage shortages in NY, and the desire to increase total dry matter production per acre, more dairy farmers are growing winter cereals as a double crop. These farms benefit from reduced soil erosion, nutrient recovery, and other soil health benefits of a living crop growing through the cooler months, as well as added feed inventory and higher total annual dry matter production per acre. Over the past several years we have measured yields of two to four tons of dry matter per acre where the crop was properly managed and weather was cooperative. Some fields in 2012 yielded four to five tons of dry matter of high quality forage from winter cereals planted after corn silage, even with limited growth in the fall after planting. While the mild 2011 to 2012 winter weather may have been a main yield driver, it provides a sense for the upper limit of production in great conditions. With this practice on the increase, producers are asking new questions, including: How much fertilizer N is needed at green-up for optimal economic yield? On-farm replicated trials were implemented in the spring of 2013 to quantify crop response to N addition to begin to answer this question. At green-up, a total of five treatments with four rates of urea plus Agrotain were applied to achieve the following N rates: 0, 30, 60, 90, and 120 lbs N/acre. In total, 44 on-farm trials were established and harvested. The use of five rates and four repetitions ("replications") is critical to develop an N response curve and draw reliable conclusions about optimum N rates and yields. With multiple rates, including zero and low N rates (two rates below what we expect to be the optimum N rate and two rates above our expected response rate), allows us to find a true optimum rate for the site that year. In this case, we estimated the optimum N rate would be between 50 and 75 pounds per acre. Then, with many sites across the state and with multiple years of trials, we can put together sound guidelines. In the spring of 2013, average yield across 44 NY sites was 2.0 tons DM/acre. Optimum N rates ranged from 0 to 120 lbs N/acre, with 30% of the sites showing no yield benefits to N addition (where the optimum N rate was zero), while 44% of the sites had an optimum N rate between 75 and 100 lbs N/acre. Determining conditions that make a field responsive or unresponsive to fertilizer N is an important economic and environmental matter. Forage crude protein (CP) levels responded differently than yields: averaged across sites they increased with fertilizer N addition, independent of yield response, from an average of 12 to 13% CP without N addition to 18 to 20% with the highest N rates. However, CP levels without N addition showed a wide range among sites, from a low of 7.5% to a high of 19% CP, showing that fertilizer N is not necessarily needed to increase CP levels. Additional work is ongoing to determine what drives differences in optimum N rate across sites (manure history and soil types) and the impact of N addition on protein levels and forage quality. More sites will be included in 2014.❐