NO-TILL FARMER
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Soils, Rainfall Influence Payoff of Spoon-Feeding Nitrogen in Corn

Contents

By Laura Barrera, Contributing Editor

Growers with sandy or heavy textured, poorly drained soils that experience nitrogen leaching or denitrification are most likely to benefit from split nitrogen applications.

When it comes to designing and implementing a nitrogen (N) application plan for no-tilled or strip-tilled corn, the options seem limitless.

Between the various tools, N sources and technology available, growers have a lot to consider when deciding when and how they'll apply N fertilizer to produce the most bushels for the least amount of N.

One approach is to split N up into several applications based on when the corn plant will need it — also known as spoon feeding. But determining how many N applications to make and when to apply them all depends on the unique environmental factors a grower is dealing with.

"What we have observed is that N is very mobile in the soil environment," says Mark Alley, crop consultant and retired Virginia Tech University Extension soil scientist. "And so for any given field, in any specific season, those reactions that affect my N availability are going to differ."

Soil, Rain Impact Timing

For growers trying to manage their N program for profitability, as well as environmental sensitivity, Alley says they have to think through all the factors that can affect N applications. One major influencer is the soil and how it holds water.

Retired Kansas State University Extension soil fertility specialist Dave Mengel says sandy or heavy textured, poorly drained soils can experience N loss through leaching and denitrification, respectively.

Most farmers are in tune with their soils and whether they leach or denitrify, but Alley notes they can also use the NRCS's web soil survey tool to look within the background tabular data of their soils and see the hydraulic conductivity of the most limiting layer.

"In other words, how fast does the water run through this soil profile?" he says. "Some of profiles moves water very, very slowly. Some of them it move it very, very fast."

Where water moves very slow N will denitrify, and where it moves quickly it will leach. Once growers understand if they're dealing with one of these, they can ask themselves what system is most appropriate for applying N on their farm.

On sandy soils, Mengel says, timely applications are easier because those soils dry out more quickly and can be trafficked sooner. But timing can be more difficult on heavy soils that stay wetter longer, and may even require hiring an airplane to apply fertilizer. Instead, a nitrification inhibitor or slow-release

fertilizer may be a better option.

"You have to look at your situation and how that really fits," he says.

The number of N applications a grower may need really boils down to whether they're in a low-loss soil environment or a high-loss environment. The higher the potential loss, the more a grower will benefit from several applications.

"If you're one of those lucky people that have a good, deep, silt-loam soil and you've got tile drainage out in all the wet spots, some sort of application at planting time — whether it's starter followed by a sidedress, or spring pre-plant anhydrous work relatively well. You may not be able to improve on that by just spoon-feeding," Mengel says. "Because you may not have that much loss going on."

Because a soil's water-holding capacity plays such a big role in N availability and loss, rainfall is another factor that influences N application timing. For example, no-tillers in high-rainfall areas may benefit from multiple N applications throughout the season to avoid N loss from leaching.

In 2009, Mengel and graduate student Andrew Tucker did a study at the Kansas State University Agronomy Farm in Manhattan, Kan., on late sidedress N application in corn.

Mengel says it was in a high-residue, no-till field where they compared three total N application rates —

Table 1 Late Sidedress N Application on Corn

Treatment	N Rate lb/ac	Grain Yield bu/ac
Pre-plant N	60	133 e
Pre-plant N + 30 at V-8	90	158 d
Pre-plant N + 60 at V-8	120	173 c
Pre-plant N + 90 at V-8	150	185 bc
Pre-plant N + 30 at V-16	90	166 cd
Pre-plant N + 60 at V-16	120	192 b
Pre-plant N + 90 at V-16	150	206 a

Tucker and Mengel, KSU Agronomy North Farm, 2009

DELAYED APPLICATION PAYS OFF. In this Kansas State University study conducted in 2009, researchers found sidedressing nitrogen (N) at V16 saw greater yields than sidedressing at V8. Retired soil fertility specialist Dave Mengel says that between V8 and V16 the no-tilled field experienced high rainfall and delaying N application until V16 allowed them to avoid some of the N losses that would have occurred.

90, 120 and 150 pounds per acre — which was split into 60 pounds pre-plant and the remaining applied as a sidedressing at either V8 or V16. A single treatment of 60 pounds N pre-planted served as the control. (*See Table 1.*)

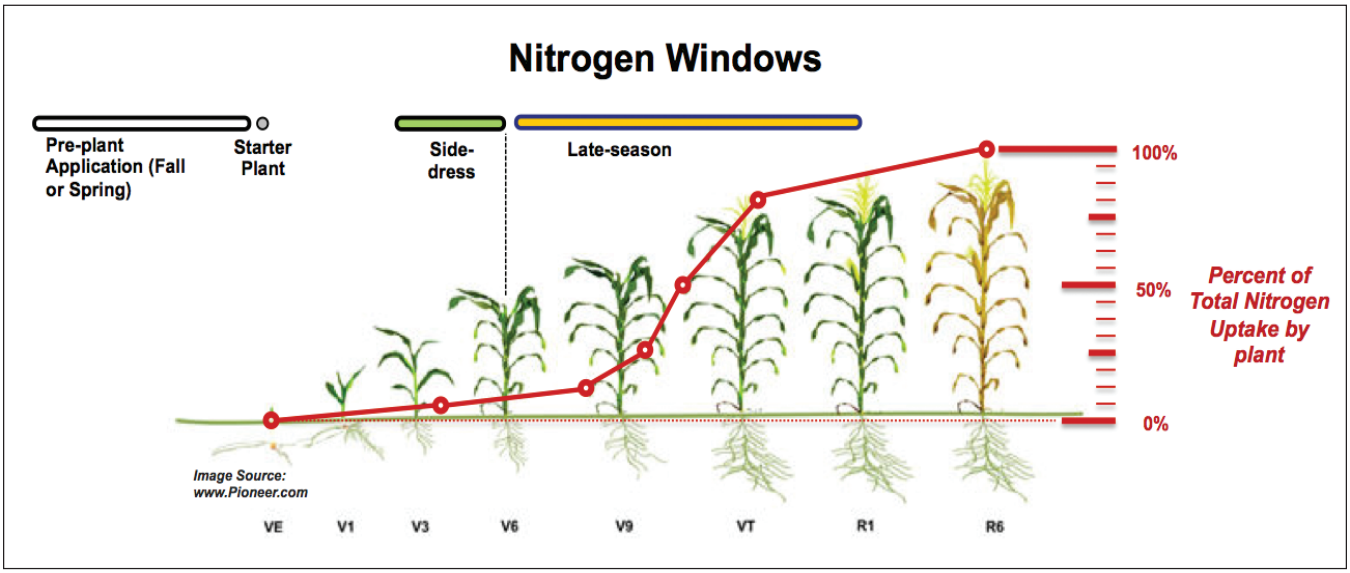
They found in the 120-pound treatment that when 60 pounds was sidedressed at the V16 stage it yielded 192 bushels per acre — 19 bushels more than the same amount sidedressed at V8. And with the 150-pound treatment, corn yielded 206 bushels per acre when the 90-pound sidedressing occurred at V16, vs. 185 bushels when it was sidedressed at V8. Mengel points out that both of these differences are statistically significant.

"It all had to do with when we plant and when does the rain come," Mengel explains. "By the time we got between that V8 and V16, we're talking about the month of June and we're getting high rainfall. By delaying some of that N a little bit later, we avoided some of the losses that would've occurred."

Early vs. Late

Another factor growers should take into consideration is that newer corn hybrids are taking up N later in the growing season.

For that reason, Purdue University agronomist Tony Vyn recommends growers might realize more benefit now to applying 25% of their total intended N after V10 than they would have 30 years ago. Growers with continuous corn or sandy soils using low-moderate total N rates are more likely to see a yield gain. However, true yield increases with late-split N applications have been infrequent in Indiana on-farm or research station studies conducted by PhD student Sarah Mueller and Vyn.



SAVE SOME FOR LATER. This graph created by Ohio State University Extension ag engineer John Fulton shows the majority of nitrogen (N) uptake in corn occurs later in the season, after sidedressing. Because of this, Purdue University agronomist Tony Vyn recommends applying 25% of the total intended N after V10. It may or may not result in a yield increase, but it may reduce N application rates without sacrificing yield.

"The healthier the leaves are, the longer corn plants can continue to take up N," Vyn says.

But just because corn is taking up more N later doesn't mean that N in the early stages isn't still important.

"The rule here is the corn plant, once it emerges, should never be under N stress," says Alley. "There should always be adequate N available. When we go from the V6 to tasseling growth stages, that corn plant needs a lot of N every day."

The way to ensure that happens will differ, he adds. For example, a grower may decide that his risk of early N loss isn't very high, so instead of planning a sidedressing application he may pre-plant what's needed to achieve the corn yield he expects. Then if the season is shaping up well, he could come back at tasseling with another application.

"It's not a right or wrong thing," Alley says. "It's what's most likely to minimize your risk and optimize your yield for that field in that year."

Growers who don't plan on applying a lot of N before or at planting may want to move their sidedress application up to V3-V4. Vyn has found an advantage to applying N at those two stages when the total prior N application was only 10-25 pounds per acre.

"There's no benefit in doing this if you've already put on, let's say, 60 pounds at plant," he says. "But the early sidedress becomes more important when very little N was applied previously."

For growers who have put the majority of their N down before or at planting there's more to be gained from doing an application at V12 in terms of both yield gain and total N recovery, Vyn says.

"The earlier you apply, the more likelihood there is of losses in a typical rain-fed system," he explains. "Once you're in a normal sidedress situation, or an early sidedress situation — meaning any time after V4 — there is less to be gained by coming back again at V12."

Mengel says Kansas State University research shows that 60-70% of the time higher yields are achieved with lower N rates when the bulk of the N was applied sometime after the plant was up and growing — anywhere from V2-V6.

If corn is planted in a soil that's particularly prone to N loss, Mengel recommends splitting it into a starter, early sidedress and later application.

Tests, Technology

Reduce N Amounts

Vyn warns that applying 25% of the intended total N after V10 in corn doesn't guarantee a yield increase. But it can reduce the amount of total N fertilizer applied.

"We think that the biggest gain from reserving some of your N until later is the opportunity to reduce rates and still achieve the same yield, as long as we can reduce those rates reliably," he says.

Determining how much N can be reduced requires using a "plant-based indicator," Vyn says, such as a nutrient-sensing tool like GreenSeeker or OptRx.

Mengel agrees these tools, or field imagery taken by drones or satellites, can help growers become more efficient in their N applications.

From 2007-09, Mengel and Tucker conducted a study on a no-tilled field in Rossville, Kan., that examined 120-, 160- and 200-pound total N rates which were applied either all in a pre-plant application or split between pre-plant and sidedressing.

The study also looked at 120 pounds applied pre-plant and then using a GreenSeeker, Crop Circle sensor or SPAD meter to determine the remaining amount of N to apply later in the season. (*See Table 2.*)

The treatments that used a GreenSeeker or Crop Circle sensor had the highest yields in the study, along with some of the lowest N rates. In this 3-year study the GreenSeeker unit recommended an average 25 pounds of N for 145 pounds total per season, which yielded an average 228 bushels per acre.

The Crop Circle recommended an average of 33 pounds for a total of 153 pounds N per season, which yielded an average 226 bushels per acre.

Table 2

Rossville Results 2007-2009

Treatment	Mean N Rate over three years, lb/a	Mean Grain Yield over Three years bu/ac
Starter Only	20	102 c
120 pre	120	214 b
160 pre	160	223 ab
200 pre	200	231 a
120 split	120	209 b
160 split	160	223 ab
200 split	200	224 ab
120 + GS	145	228 ab
120 + CC	153	226 ab
120 + Spad	141	214 b

Tucker and Mengel, Kansas River Valley Exp Field

TECHNOLOGY SAVES NITROGEN. This 3-year Kansas State University research found that using a GreenSeeker (GS) or Crop Circle (CC) to determine the amount of nitrogen (N) to apply at sidedressing provided the highest yields for the least amount of N.

The 200-pound split treatment followed with a yield average of 224 bushels, and both the 160-pound pre-plant and split treatments yielded an average 223 bushels.

"The key point here is we may not increase yield using these sensors, or we may, depending on the situation," Mengel says. "But we can become more efficient. If somebody's out there with a 160 split, we didn't really save much N or increase the yield a whole lot, but we definitely did over someone using 200 pounds. Trying to use some of these newer technologies could be very advantageous. It could save you money and it could protect the environment."

Tissue testing when silks emerge is another option but the problem with that test, Vyn says, is by the time growers get results back from the lab the corn may be past the R1 stage, which is too late to apply more N. Growers without irrigation should apply more N around the V12-V14 stage, which is 2 weeks before silking.

"So if I want to use a tissue-test approach I would like to figure out-in future research-what is a sufficient leaf N concentration for a fully-expanded leaf position before ear shoots are visible. If you sample that leaf position and send those leaves away for a tissue analysis, then you might get an indication that 'Yes, this is in the right range' or 'No, it's not in the right range.'"

One test Vyn doesn't recommend, if a grower has made any banded N applications, is the pre-sidedress soil nitrate test (PSNT), although some other agronomists do recommend it.

"Once you've done a band application of nitrogen, we've found it's almost impossible to gauge how much N is still available if you're trying to decide whether you need that last 30, 40 or 50 pounds," Vyn says.

Alley says the PSNT is most useful for determining when the N in an organic fertilizer, such as manure, has become available — although getting enough samples can be difficult. Growers should sample at least 20 cores mixed very well from 20-acre areas, and to sample separately soils that have differences in management, such as manure applied or cover crops, and texture.

"It's like any laboratory test," Alley says. "We have to put it in the context of what's happening in our field, and with our experience, to see if the numbers that we're getting are reasonable."

Residue Impacts Placement

In addition to weather, soil types and N uptake periods, no-tillers and strip-tillers also have to consider the presence of residue when it comes to their N program.

The biggest concern is with residue that has a high carbon-to-N ratio, such as corn, wheat or a cover crop like cereal rye, as the soil microbes require more N to decompose the residue.

"Where that residue is decomposing, the microbes will get any N that's there," Alley says.

This means that having enough N available early is more important in no-tilled fields that have residue with a high carbon-to-N ratio.

"We've put a lot of emphasis on getting some of your N applied at least pre-plant or at planting, because we're concerned about getting those young plants off with a start of N to begin with," Vyn says. "So that's where we have historically said you've got to have at least 30 pounds on, preferably in a banded form. And if you're going to broadcast in a high-residue situation you'll probably need from 50-100 pounds of N per acre."

Placement is also important in preventing the N from getting tied up in the residue. Alley recommends injecting it 3-4 inches below the soil surface to keep it accessible to the plant and away from the residue.

Whether residue has a low or high carbon-to-N ratio, if there's a lot of residue on the surface it's likely to cause cooler soil temperatures, which can also inhibit N uptake.

Mengel says one option is to broadcast about 50 pounds of N early, which a lot of growers will do by mixing 28% liquid N solution with their herbicide burndown application. This not only provides N to the plant but may help speed up residue decomposition.

But if a grower knifes in anhydrous ammonia, then a starter application should be included because it may take 3 weeks to a month before the corn plant's roots reach that ammonia band.

"Everything is interactions. The residue can be extremely valuable. But it also can create some minor problems if you don't adjust some of the other things, like N timing and placement, to account for that," Mengel says.

"It won't be as big of a problem in soybean stubble, because you don't have much residue and it's a high N, low carbon ratio residue, and it breaks down quickly."

Create a Flexible System

Given the various factors that play into planning an N program, growers must understand the N cycle and how it may play out in their fields, Alley says.

He recommends creating a plan of potential rates and timings based on each field's history and designing a system that can respond to changes throughout the season.

For example, he says the Corn Belt has had very wet springs the last couple years, and then it dried up.

"How do we manage for that?" he asks. "Well, we know we have to have some N early, so we're going to put some down — either in a broadcast or 2-by-2-inch. Then we're going to come back after that rainy spell, but I need enough down at planting to get me through that potentially wet weather.

"Now if I don't have wet weather, well my N's down early and I'll adjust my sidedress rate accordingly, as opposed to if it's been really wet and I'm concerned I've lost some N. And we just keep working our way through these various factors and what's going on this year in this field."

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