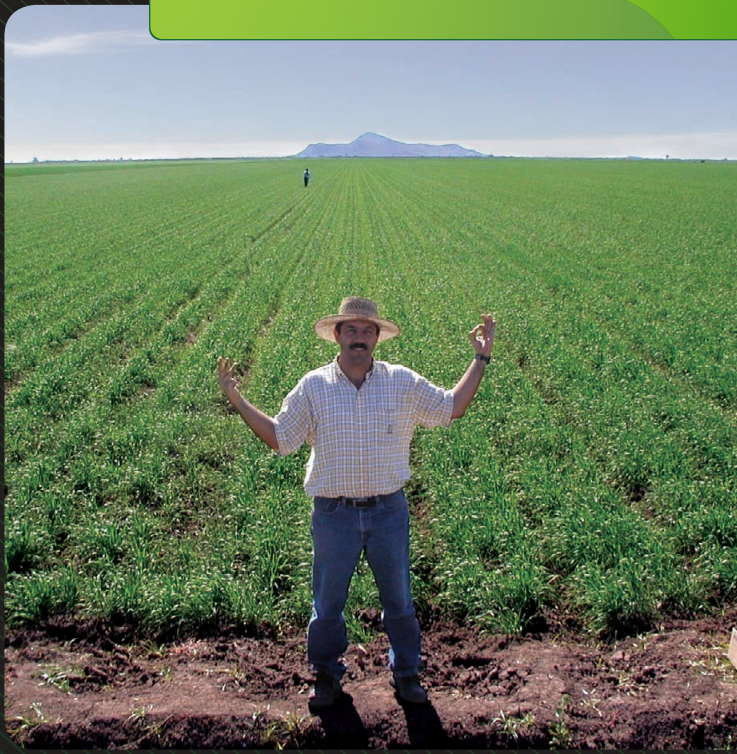
Nitrogen Rich Strips



OKLAHOMA STATE UNIVERSITY
EXTENSION

DIVISION OF AGRICULTURAL SCIENCES AND NATURAL RESOURCES

Nitrogen Rich Strips
for wheat, corn and other crops

[1]Bill Raun, [2]John Solie, [1]Jerry May, [1]Hailin Zhang,
[1]Jonathan Kelly, [2]Randy Taylor, [1]Brian Arnall and
[3]Ivan Ortiz-Monasterio

[1]Department of Plant and Soil Sciences,
[2]Department of Biosystems and Agricultural Engineering
[3]CIMMYT, International Maize and Wheat Improvement Center, Mexico

Summary

The optimum nitrogen (N) rate for cereal crops changes dramatically from year to year. Again, the optimum N rate for cereal crops changes dramatically from year to year. **It bears repeating because many producers continue to apply the same amount of N, year after year.** Farmers are well aware that their yield levels change significantly, but they are not aware that the yield response to additional N changes too (magnitude of response if N is applied). Combined, N responsiveness and yield level dictate precisely how much N should be applied. What farmers have to embrace is that their N use efficiency changes every year too. The GreenSeeker sensor technology, developed at Oklahoma State University, predicts yield potential from NDVI readings measured during the growing season. Using N Rich Strips applied at planting or shortly after, the optimum topdress N rate for maximum yields and economic profitability can be determined. Even if producers don't use the GreenSeeker sensor, the N Rich Strip by itself remains an incredibly valuable tool for deciphering whether or not mid-season N is needed. Applying N Rich Strips, over time and measuring responsiveness with the GreenSeeker sensor, will net producers more than $25.00 per acre.

COVER. Wheat farmer in Ciudad Obregon, Sonora, Mexico, illustrating where he applied 300 kg N/ha (about 270 lb N/ac) preplant on the left, and 0 lbs N preplant on the right. Because there were no visible differences, he decided not to topdress with added N. As it turns out, he did not need any added N as there was no yield difference between the two at harvest.

Why are N Rich Strips needed?

It is hard to detect N deficiencies in actively growing crops without comparing the crop to crops with sufficient N. The easiest way to do that is to create strips with sufficient N, applied at non-limiting but not excessive amounts and a strip of the crop with N applied at the normal rates. The two strips are monitored as the growth cycle progresses. While other nutrients other than N might also be limiting, these 'other' nutrients (P, K, S, Fe, Mg, Ca, Cu, Zn, B) are readily and successfully identified with soil testing (http://www.soiltesting.okstate.edu/pricelist.htm). Soil testing for NH_4-N and NO_3-N (readily available N fractions in soils) is commonly used to detect N deficiencies. However, levels of both these fractions change drastically depending on soil moisture, growing conditions up until the sample was taken, time of year, and depth to which the sample was taken. They don't reflect the N released from organic matter during the growing season either. As such, the utility of the inorganic soil N test is limited. While soil testing remains the most effective, and proven tool to improve nutrient management in all crops, and for virtually all the essential elements (N, P, K, S, Ca, Fe, Mg, B, Mn, Cl, Cu, Zn, and Mo), when it comes to better N management, using N Rich Strips delivers more accurate recommendations.

How do N Rich Strips work?

Nitrogen Rich Strips compared to the farmer practice capitalize on the reality that last year's environment is going to be different from this year's. Figure 1 illustrates this point quite well, where the N fertilized (100-40-60, N-P_2O5-K_2O) plot yields (blue bars) are plotted along with the zero-N check (0-40-60), (yellow bars) from 1972 to 2009, at Lahoma, OK. Note that the harvested yields changed drastically from year to year (both blue and yellow bars), suggesting the yields are unpredictable before planting. Not only do yield levels change unpredictably from year to year, but the response to applied N (difference between the blue (fertilized) and yellow (unfertilized) bars) is equally unpredictable.

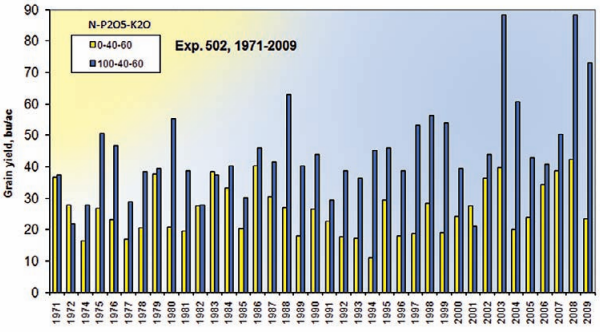


FIGURE 1. Winter wheat grain yields in the N fertilized (100-40-60, N-P_2O_5-K_2O) plot (blue bars) and the zero-N check (0-40-60), (yellow bars) from 1971 to 2009, Lahoma, OK.

The Response Index or RI, was developed as a measure of the response of the crop to additional N (Figure 2). The RI was computed as the ratio of the yield of the N Rich (N sufficient) fertilized plot to the yield of the unfertilized 0-N check. Like yield levels, the RI's varied significantly from year to year and were unpredictable (Figure 2). The response index to N was highly variable ranging from 0.7 to 4.0. In some years such as 1972, additional fertilizer reduced grain yield compared to the unfertilized plots (RI<1). In 1994, applying sufficient N produced grain yields 4.0 times those of the unfertilized plots.

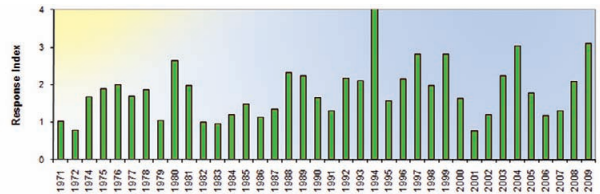


FIGURE 2. Response to applied N calculated by dividing the yield of the N fertilized plot by the 0-N check, long term Experiment 502, Lahoma, OK, 1971-2009.

A critical question from these experiments was whether response to N fertilizer predicted grain yield. For Experiment 502 and all other long-term experiments where this was tested, limited or no

relationship existed between N responsiveness (Response Index) and yield level (Figure 3). So what does this mean? It means that farmers are not going to get good estimates of N fertilizer demand unless they consider both the crops ability to respond to additional N and the potential grain yield without additional N fertilizer. In other words, you cannot arrive at an appropriate mid-season N rate using estimated yield potential alone. Similarly, you cannot arrive at an appropriate mid-season N rate using N response (Response Index) alone. You could have a year where yield potential is high but the crop does not respond to additional N (warm wet winters where sufficient N was mineralized from soil organic matter and N deposited in the rainfall). In this environment, added N would not be expected to increase grain yield even though yields were projected to be high. Conversely in a year when the winter months were cool and dry, but where an excellent plant stand was achieved, N demand would likely be higher, yield potential lower, and the topdress N application rate might be moderate to high.

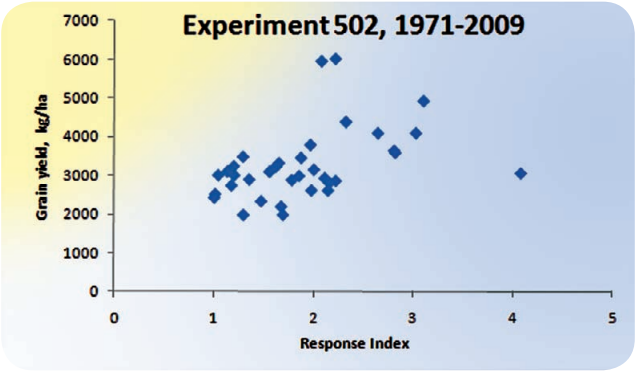


FIGURE 3. Relationship between N fertilized plot grain yields and the Response Index (high N fertilized plot divided by the zero-N check plot), Experiment 502, Lahoma, OK, 1971-2009.

The N Rich Strip represents wheat growth under non-N limiting conditions. By comparing this to the farmer practice where partial N was applied preplant, farmers can visually see if there is a difference, mid-season before they decide whether or not to apply more N.

We commonly recommend that farmers apply ½ of the anticipated total N needed at planting and wait to make the decision on added N until the middle of the season. In general for winter wheat, if no differences can be visually detected prior to jointing (Feekes 6, Figure 4), it is unlikely that added N will result in increased yields. Alternatively if differences are large, there is a high demand for added N. When no differences exist between the N Rich Strip and the farmer practice it means one of two things.

Enough N had been mineralized from soil organic matter or that deposited in the rainfall to meet all of the plant N needs;

Growth was possibly restricted by some other variable and that masked the ability to detect N deficiencies.

The N Rich Strip provides an estimate of how much N was delivered to the crop for free (N mineralization, and atmospheric deposition), from planting to sensing. Even if applied late, the N Rich Strip will still provide visual information concerning whether or not you should apply additional N mid-season.

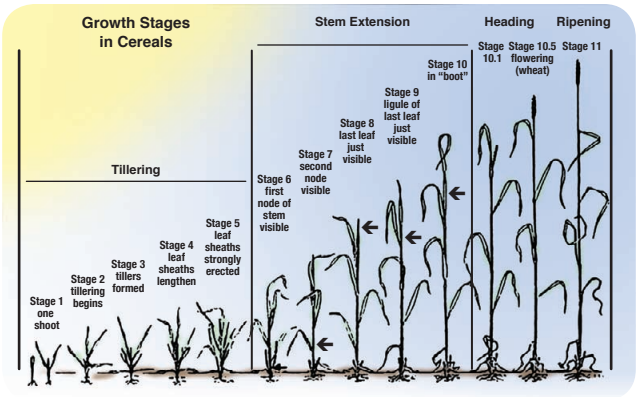


FIGURE 4. Feekes growth stages for wheat.

FIGURE 5. N Rich Strip on the left and the farmer practice on the right (Jason Lawles holding the Greenseeker sensor), winter wheat, Hennessey, OK.

FIGURE 6. N Rich Strip down the center and the farmer practice (*left and right*), corn, Stillwater, OK.

When should N Rich Strips be applied?

For winter wheat the N Rich Strip should be applied at or before planting. If this is not possible, as soon after planting is best. For corn, N Rich Strips should be applied before or at planting. After planting is not ideal for several reasons. First, N fertilizer applied needs to have time to enter the soil solution, and depending on moisture availability/irrigation this could be a while. Second, the growth cycle for corn is relatively short compared to winter wheat (100-110 versus 200-230 days, respectively). Time is needed to assimilate the available N, thus for corn, the window of opportunity to make a decision when evaluating the N Rich Strip versus the farmer practice is narrow (see Figures 5 and 6). Applying and incorporating the fertilizer if possible prior to planting is preferred for establishing an effective N-Rich Strip.

What if I don't get my N Rich Strip out at planting?

The N Rich Strip will provide you with more information if established at or before planting. If this is not possible, and farmers choose to apply the N Rich Strip within the growing season, the later you go, the less useful it will be. But as the saying goes, "better late than never." For winter wheat N Rich Strips are applied at planting in early October, but can be applied as late as December for use in making topdress N decisions in late February and March. Why? Because in most years, there will still be growth that takes place over the winter, and the environment from November to March can be conducive for active growth and soil N mineralization. If N Rich Strips are to be applied late, using UAN, it is best to use streamer nozzles to minimize any damage to new growth.

Where should I put my N Rich Strip?

The best place to put your N Rich Strip is across a portion of the field that you believe is representative of the entire area. Don't put them along the fence line where turning, overlap, and other issues arise that could influence N response. You may have areas in your 40-160 acre field that are distinctly different (e.g., alluvial lowland, vs. eroded backslope), and where you have noticed distinct differences in production. In this case, putting out an N Rich Strip in each area would be advised. You have to remember that the N Rich Strip is a visual guide, and as such needs to represent those areas where you believe final N management might be different.

Why do N Rich Strips work so well?

There is really no mystery as to why they work. When the environment changes (hot-cold, wet-dry), everything else changes too. Soil biology, soil temperature, soil moisture, and ultimately crop growth, all change as the environment changes. No two years are the same. As a result, N demand, and potential N response change too. The N Rich Strip compared to the Farmer Practice is a tool that integrates environmental change into one, clearly defined variable, that being demand for N. Do you really want to make a mid-season fertilizer N rate decision without an N Rich Strip? Not putting out N Rich Strips will only add to the uncertainty and risk that farmers have to take.

Will my N Rich Strip still be good for next year if I don't apply any more N?

No. N Rich Strips should be applied each year at a rate where N will not be limiting. Be careful not to apply too-much or too-little N. See Table 1 below for some basic recommendations. Preferably, your N Rich Strip should be placed in a **different** location each year, being careful not to overlap where you applied N-Rich Strips for at least the last two years.

	Yield level, bu/ac				
	30	40	50	60	70
Winter Wheat					
Grain only, lbs N/ac	90	120	150	180	210
Grain and forage, lbs N/ac	120	150	180	210	240
	Yield level, bu/ac				
	50	100	150	200	250
Corn, lbs N/ac	75	150	225	300	375
Sorghum, lbs N/ac	70	140	210		
	Yield level, bales/ac				
	1	2	3	4	
Cotton, lbs N/ac	80	160	200	200	

TABLE 1. N Rate suggestions for the N Rich Strip

Why aren't N Rich Strips required?

For anyone applying fertilizer N for crop production they should be required. But, they are not. Legislating fertilizer N use is a hot topic in many states where non-point source contamination of key watersheds has been documented. In some states, fertilizer use is regulated, especially in fragile ecosystems where some damage has already been encountered. For these areas, N Rich Strips will go a long way towards minimizing damage from excess N applications.

My neighbor is using N Rich Strips, but why should I?

If you are anything like your neighbor and you are interested in increasing your bottom line, you need to adopt this practice as soon as possible. Averaged over many sites, over many years, farmers can net at least $25/ac using OSU's N recommendations that require the N Rich Strip.

Are N Rich Strips a Best Management Practice?

NRCS provides cost shares for implementing better N management strategies in some states and some counties in Oklahoma (many other states as well). Check with your local conservation district office to find out if it is available in your area. If they aren't on the list, they should be. No other agricultural practice used today is as simple, affordable, and as cost effective as N Rich Strips in cereal production. Yet, we still have farmers that won't take the time to put out this visual tool each year, knowing full well that this practice will put money in their pockets. Using N Rich Strips and the OSU mid-season fertilizer N recommendations that employ GreenSeeker sensor NDVI data, is money in the bank.

http://www.soiltesting.okstate.edu/SBNRC/SBNRC.php
www.nue.okstate.edu

What about N Rich Strips for crops other than corn and winter wheat?

For virtually any non-legume crop, N rich strips applied at or near planting are going to be useful. Especially in those crops where mid-season N is applied (sorghum, canola, and other cereal and/or oil seed crops). If the crop demands added N to realize near maximum yields, an N Rich Strip will be a useful, diagnostic tool.

N Rich Strip/GreenSeeker N Recommendation Checklist

1. Apply N-rich strips before planting or right after planting.

2. Wait until early February or March to sense yield potential and apply top-dress N for winter wheat. Wait until the 8 or 10 leaf stage in corn to sense and apply fertilizer.

3. For winter wheat, from February to March (topdress season, depending on plant stand, the environment, etc.) if **YOU DO SEE** the N-Rich Strip that means there was **NOT** enough N in the soil at your regular preplant rate and you need to fertilize. Similarly for corn, at the 8 to 10 leaf stage, if you do see the N-Rich Strip, there is obviously a demand for added N.

4. Sense the N-Rich Strip and your farmer practice with the GreenSeekerTM sensor and enter these NDVI values on the NUE web site to determine your topdress N rate (corn, winter wheat, spring wheat, sorghum, rice, and cotton):

   http://www.soiltesting.okstate.edu/SBNRC/SBNRC.php

5. From February to March in winter wheat, if **YOU DO NOT SEE** the N-Rich Strip that means the field likely has enough available N to meet the maximum yield potential for that field for that year, and you may not need additional N. However, if as a producer you sense that the potential for yield is high, applying a modest amount of topdress N is still considered prudent. This is especially the case for corn.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Robert E. Whitson, Director of Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Vice President, Dean, and Director of the Division of Agricultural Sciences and Natural Resources and has been prepared and distributed at a cost of 190 cents per copy. Printed by University Marketing, University Printing Services #3343 July/10.

http://www.soiltesting.okstate.edu/SBNRC/SBNRC.php
www.nue.okstate.edu


Lake Carl Blackwell
OSU Research

Woodward, OK
Toellner Farms


Hollis, OK
Heath Beanland


Stillwater, OK
OSU Research


Tipton, OK
OSU Research