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Reference Strip Series: Applying your Nitrogen-Rich and Ramp Calibration Strips

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A crop's demand for fertilizer nitrogen varies annually, even in long-term plots where the same fertilizer nitrogen (N) rates are applied each year. Long-term soil fertility experiments at Lahoma have revealed that the average N fertilizer requirement by wheat is 2 lb/bu. However, examining individual years reveals a wide range in the response of wheat grain yield to N fertilizer observed. Figure 1 shows the difference in yield between check plots that have not received any N since the trial was established more than 40 years ago and plots that have received 100 lbs of N every year. In 1973, 1979, 1983 and 2001, the non-fertilized plots produced the same yields as the fertilized. In years when no fertilizer response was observed, the yields ranged between 28 and 40 bu/ac. In comparison, nitrogen fertilizer increased yields by more than 35 bu/ac in 1988, 2003, and 2004.

Where did the N come from in the years where the non-fertilized plots did as well as plots that had been fertilized yearly for nearly 40 years? The answer is N mineralization via an extremely wet and warm winter/spring. When winters are wet and warm, sufficient N can be mineralized from soil organic matter to meet the demands for high grain yield. In addition to this mineralization, wet years have more N deposition from rainfall. Our long-term winter wheat data confirm that the demand for N varies from year to year and wheat grain yield response to nitrogen fertilizer is unpredictable at the time when pre-plant N is being applied.

If the optimal nitrogen fertilization rate changes each year, how can a farmer accurately calculate the correct amount of nitrogen fertilizer to apply? Soil testing (NH4-N and NO3-N) works well, but a pre-plant soil test does not give you all the information you need to make the most precise mid-season N rate decision. Soil testing is necessary to check the soil pH and the availability of other macronutrients such as phosphorus and potassium. Basing nitrogen fertilization practices on a

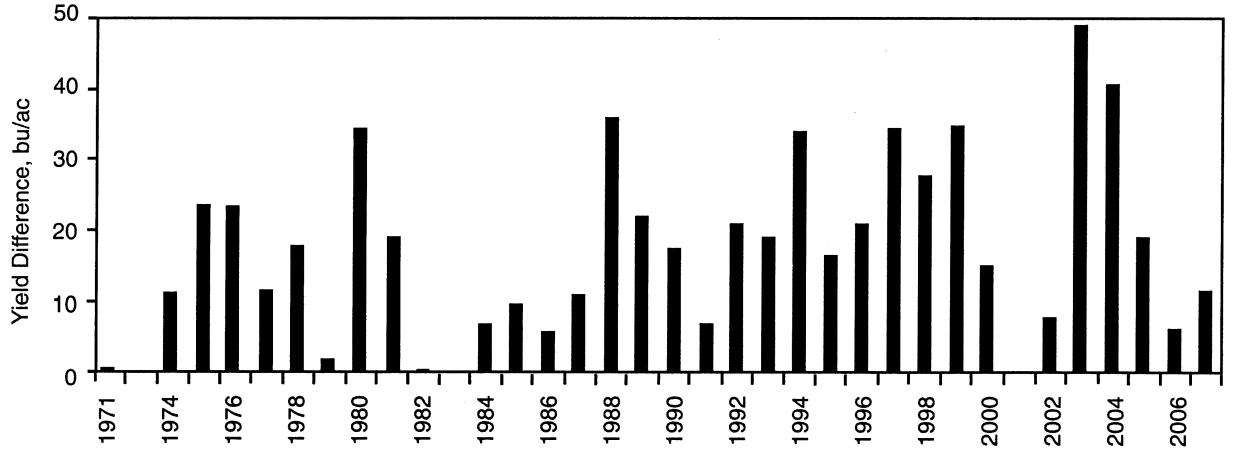

Figure 1. The wheat grain yield difference between plots that receive 100 lbs N per acre every year and check plots that have never received fertilizer N. Data from the 502 long term fertility study, which was established in 1971, located at the North Central Research Station near Lahoma, OK.

pre-plant soil test, however, still requires the producer to make fertility decisions with little knowledge of crop yield potential or N mineralization. For this reason, Oklahoma State University has developed methods that account for the influence of year to year variability for N needs. By using a nitrogen reference strip, better fertilizer N decisions can be made mid-season when the growing crop can tell us precisely how much N was delivered for free and how much more will be needed.

What are Reference Strips?

The N-Rich Strip and Ramp Calibration Strip are two types of nitrogen reference strips. The N-Rich Strip is an area in the field that has received enough fertilizer N so that no matter what the environmental conditions may be, N will not be deficient during the growing season. The rest of the field that receives the standard pre-plant rate is called the Farmers Practice. The N-rich strip is used in conjunction with the GreenSeeker™ hand held sensor to determine mid-season N rates. The Ramp Calibration Strip has multiple N rates placed in sequence from a high to a low rate. Ramps are in essence small N-rate studies that can be easily placed in fields. Sensors can be used with the Ramp to determine mid-season N rates or a visual determination of the best rate can be made. Reference strips have great value in any field crop.

How are Reference Strips Used?

The most basic use of the N-Rich strip is as a 'Yes' or 'No' indicator. Which is just how it sounds, when you look at a reference strip if you can see the strip it means 'YES,' the field needs N fertilizer, if however the reference strip is not visible it mean's 'NO,' this field does not need extra N fertilizer. Using the N-Rich strip in this way though, does not give you an N rate recommendation, just whether or not N is needed. To get an N rate recommendation from an N-Rich Strip, a GreenSeeker™ sensor must be used.

The Ramp Calibration Strip does not require the use of a sensor to get an N rate recommendation. By simply walking to the point within the ramp where the crop is the greenest, an N rate can be determined. For example, a Ramp Calibration Strip is created with a 10lb N/ac rate change every 10 feet (Figure 2). When it came time for mid-season nitrogen application, 45 ft from the edge of the first 10lb rate and the crop did not appear "greener" past that point. Forty five feet from the end would be the middle of the 50 lb rate, therefore, this is the N rate recommendation.

To get the most accurate rate from any reference strip a sensor is needed. The GreenSeeker™ sensor measures normalized difference vegetative index (NDVI) which is calculated from the reflected light collected by the sensor. NDVI is a value that provides a highly accurate estimate of plant biomass; as a result yield potential can be predicted mid-season using both sensor and some known climatic data from planting to sensing. By knowing the yield potential of the reference strip and the yield potential of the rest of a field, the N rate can be calculated. For example, if a reference strip is sensed and yield potential is estimated at 50 bu/ac and the rest of the field has an estimated yield potential of 30 bu/ac, then enough N needs to be added to make up the 20 bushel difference. Using the rule of thumb of 2 lbs N / ac/bu the recommended N rate would be 40 lbs of N/ac. This is all done by an algorithm that has been developed for each specific crop. The algorithm is a series of calculations used to mathematically predict yield potential and determine N rate. For a more in-depth discussion of the algorithms read the "Optical Sensor Based Algorithm" article at http://nue.okstate.edu/Index_NFOA.htm.

Why Apply Reference Strips?

A perfect example of why everyone should apply N reference strips was the 2006-07 wheat production year. Many acres were abandoned because of wet weather that prevented the harvesting of what promised to be a bumper crop. The question then presented itself: *How much N is going to be supplied by residue incorporated back into the soil?* Dependent upon yield of the last year's crop and concurrent environmental conditions this value could vary substantially. A soil test gives a very accurate determination of the amount of N available at the exact moment of sampling. However, if fertilizer decisions are made from a pre-plant soil test there is no accurate way to estimate the amount of N that is either mineralized or immobilized over the winter period. The only way to know how much N was made available between planting and time of top-dress would be use of a reference strip.

Other situations where reference strips offer an even greater benefit is in the adoption of no-till and when rotating after a legume. The reference strips provide information on the amount of N that the environment (mineralized from soil organic matter and/or deposited in the rainfall) provides. Nitrogen reference strips also say a lot about the environment; as in years of high production, the reference strips will likely indicate the need for more N and indicate the need for less N in those years where growing conditions are poor.

Applying Reference Strips:

How

The N-Rich strip is the easiest reference strip to apply. It can simply be made by a double or triple pass of the applicator when pre-plant N is being applied.

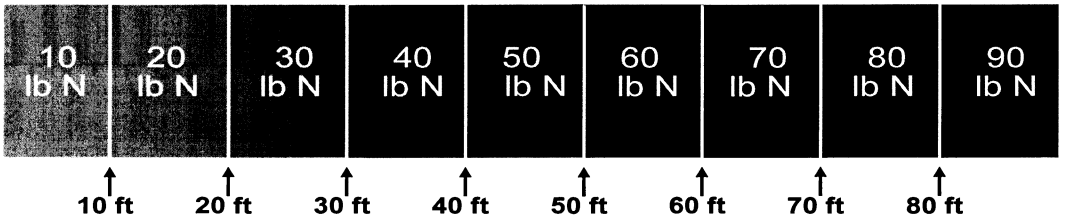

Figure 2. An example of a Ramp Calibration Strip where the N-rate changes 10 lbs/ac every 10ft. In this case the optimum rate is 50 lb N/ac.

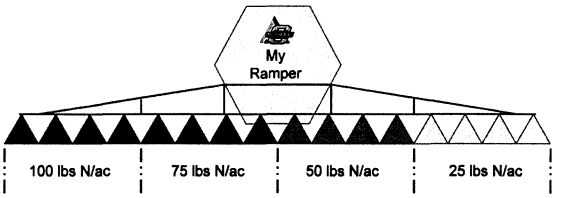

Figure 3. An example of a spray boom nozzled to apply a ramp calibration strip.

The application of the Ramp Calibration Strip can be a bit more complicated. There are commercially-available applicators that, with a single push of a button, automatically apply the series of N rates. Several producers have made their own applicators through many different methods, but most require a manual activation or change of rate. Examples are available online at http://nue.okstate.edu/Index_RI.htm. The simplest version of the Ramp Calibration Strip is produced when a sprayer is nozzled so that a different rate is applied every x number of nozzles (Figure 3). Creating this type of Ramp applicator is as simple as equipping a spray boom with different size nozzles. When setting up the spray boom, it is suggested to have at least 10 ft of boom for each rate.

When

The application of the reference strips should take place at the time of pre-plant fertilizer application, planting, or soon thereafter. For summer crops, is it very critical to create reference strips at this time. For winter wheat, the placement of the strips can be delayed for up to one month after sowing. Also, when creating a Ramp Calibration Strip it is important that the ground is not worked after application. The movement of the soil will blur the edges of each rate and make determination of the optimum rate more challenging. Most N-rich strips can take a light tillage pass because of their larger size.

Where

Two strips are recommended in every field, every year. And it is best when using the Ramp Calibration Strip, to change the location every year. The best case scenario is placing strips in each management or yield zone of the field. This way an N rate can be prescribed for each zone.

How Much N

A pre-plant N application is recommended, and at least 33 percent of the total N needed for the yield goal should be available at planting, so this is the total of both soil test N and pre-plant N (Table 1). The N-Rich strip should be no less than 125 percent of the total N recommended from the yield goal. This 125 percent value is including the pre-plant N, not in addition to the pre-plant N. For the Ramp Calibration Strip, the high rate would be the same as an N-Rich Strip. The N-source used is dependent upon the situation. Use the source that is the most efficient and economical.

Other Sources

PT 2005-3; Get your Nitrogen-Rich Strips out Early
PT 2003-12; "2 lb. Nitrogen/Bushel of Wheat" May Be Wrong
PT 2003-7; Developing and Using Nitrogen-Rich Strips
PT 2003-7; Managing Nitrogen Fertilizer for Spatial Variability in Wheat Fields
PT 2002-21; Managing Nitrogen Fertilizer Using a Nitrogen Rich Strip: Projected Profitability

Oklahoma Soil Fertility Handbook 2006:
Chapter 4. Determining Fertilizer Needs
Chapter 12. The New Nitrogen Recommendation Strategy

Table 1. Nitrogen rate recommendation for the pre-plant and N rich strip nitrogen applications in winter wheat, grain sorghum, corn, and cotton, based on the yield goal (5 year yield average plus 20%).

Winter Wheat	Yield Goal bu/ac	Preplant N lb/ac	N-Rich N lb/ac	Total N in N-Rich
	20	13	37	50
	30	20	55	75
	40	26	74	100
	50	33	92	125
	60	41	109	150
	70	51	124	175
	80	61	139	200
	100	79	171	250

Grain Sorghum	Yield Goal lb/ac	Preplant N lb/ac	N-Rich N lb/ac	Total N in N-Rich
	2000	10	28	38
	2500	13	37	50
	3000	17	46	63
	4000	23	64	88
	4500	28	78	106
	5000	33	92	125
	7000	53	147	200
	8000	64	179	244
	9000	76	212	288

Corn	Yield Goal bu/ac	Preplant N lb/ac	N-Rich N lb/ac	Total N in N-Rich
	40	13	37	50
	50	17	46	63
	60	20	55	75
	85	28	78	106
	100	36	101	138
	120	43	120	163
	160	63	175	238
	180	71	198	269
	200	79	221	300

Cotton	Yield Goal bale/ac	Preplant N lb/ac	N-Rich N lb/ac	Total N in N-Rich
	0.5	10	28	38
	0.75	15	41	56
	1	20	55	75
	1.25	25	69	94
	1.5	30	83	113
	1.75	35	97	131
	2	40	110	150
	2.25	45	124	169
	2.5	50	138	188

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