THREE ALTERNATIVE NITROGEN MANAGEMENT STRATEGIES FOR CEREAL GRAIN PRODUCTION

D.B.Arnall[1*], W.R. Raun[1], B. Tubana[1] and O. Walsh[1]

[1]Oklahoma State University, 048 Ag Hall, Stillwater, OK 74078
[*]Corresponding author's e-mail address: b.arnall@okstate.edu

ABSTRACT

The rising cost of oil has increased the awareness of agricultural producers to nitrogen (N) inputs. The challenge of making a correct fertilizer recommendation is complicated by the dependence on unpredictable temporal variability. High N rates are wasted in years of drought while crops may become more N deficient in years of ample rain. Researchers at Oklahoma State University have developed multiple strategies to precisely prescribe N rates in-season. The strategies range from simple mid-season visual evaluation to a sensor based N rate recommendation. The N-Rich Strip is a strip through a field where N has been applied pre-plant at a level so that no N deficiency can develop during the growing season. When no differences exist mid-season between the N Rich Strip and the farmer practice, the added need for fertilizer N is unlikely. Alternatively, the need for added N can be determined using these same 2 strips and a computed response index. The Ramp Strip consists of 16 different N rates from 0 up to an N Rich rate. This allows producers to walk the Ramp Strip and locate the optimum rate, or the point at which there is no increase in biomass or greenness. The Sensor Based Nitrogen Rate Calculator employees the N-Rich Strip and the GreenSeeker™ hand held optical sensor measurements to determine an exact N rate based on predicted yield.

SUMMARY

Knowing that the world nitrogen use efficiency hovers near 33% in cereal crops, the scientific community has been exploring methods to improve fertilization practices for agricultural crops. However, with the continued increasing cost of petroleum the desire to improve N management has moved beyond academia.

With the benefit of multiple long term fertility trials across the state OSU researchers have studied many interactions between N fertilizer and grain yield. One such interaction was the relationship between the yield of the plot with the highest yield level and the check plot, which never receives fertilizer N. The analysis of over 60 site-years showed that the response to fertilizer N, in terms of grain yield, has ranged from 0 to 4 times the average amount over all years. This large range in yield difference and the wide range in the demand for fertilizer N indicates that some years the crop will not respond to fertilizer N (those years where yields were equal), and other years where fertilizer N is in great demand (those years in which the high N plots are 2 to 4 more times greater in yield). From this data the concept of the response index (RI) was proposed. The RI is simply the ratio between the yield levels of an area with high N levels and an area with low N levels. The RI represents the percentage increase in yield that resulted from additional N.

The N-Rich Strip (NRS) was developed to better account for temporal variability and its influence on the demand for mid-season N. The NRS is an area in a field with a pre-plant N rate

that can ensure N deficiencies will not develop at any point in the growing cycle of the crop. The remainder of the field receives a low pre-plant N rate. The NRS serves as an indicator of how the crop will respond to additional fertilizer N mid-season. Through a simple "yes the strip is visible" or "no the strip is not visible" evaluation a producer can determine if top-dress N is needed (yes/no). A visible strip indicates that the crop is taking advantage of the additional N fertilizer applied in the strip. However, it should be noted that the NRS alone can not give the producer any recommendation for the top-dress N rate.

An improvement on the NRS concept is the Ramp Strip (RS). The RS is similar to the NRS in that it is applied in addition to the pre-plant rate. The RS however is not just a single N rate, but a series of 16 N rates. The RS applicator begins fertilization at the highest rate and changes N-rate every 10 ft along the path of the applicator until it reaches 0 and rates start increasing until the initial rate is reached. The total length of the RS is 320 ft. By walking through the area of the RS and visually identifying the point at which the size and color of the crop no longer improves, a producer can make a mid-season top-dress N rate recommendation. This is a very hands-on visual approach that enables the producer to determine the top-dress rate for each field in which the RS is applied.

Through the use of a hand held Green Seeker™ Optical Sensor and the NRS or RS, producers can make a very accurate top-dress N application that is tailored to the field, while accounting for the conditions between planting and top-dress. Oklahoma State University researchers have shown that the potential yield of winter wheat can be estimated with the use of a ground based optical sensor. A large library of sensor and yield data has been compiled to form a yield prediction curve. This curve is updated annually and is available for the public to view at http://nue.okstate.edu/Index_Predicting_Yield.htm. The ability to predict yield allows for mid-season fertilizer N rate determination, tailored to an individual field requirement. The prescribed rate is calculated by the nitrogen fertilization optimization algorithm (NFOA). The NFOA utilizes sensor readings from the N-rich strip and from an area in the field representing the farmer's practice. With these sensor readings, the yield of the two areas is predicted using the yield prediction curve. From the difference in the two yields, an N rate is determined, using the assumption that the difference yield potential is only created by the additional N present in the NRS. A sensor based nitrogen rate calculator (SBNRC) is located at http://www.soiltesting.okstate.edu/SBNRC/SBNRC.php.