N-Rich Reference Zone Case Study: Kings County 2021-22

Nicholas Clark, Joy Hollingsworth, Ruben Chavez, Pahoua Yang, Walter Martinez, Erik Hansen, Taylor Nelsen & Mark Lundy

Three nitrogen (N) rich reference zones were created on a 150-acre triticale seed field in Kings County where average grain yields are approximately 7000-8000 lb/ac.

N-rich reference zone set up:
Prior to planting, the grower applied 5 tons/ac dairy manure (approx. 100 lb/ac N with ~ 25 lb/ac available N) and 70 lb/ac N as NH_3, chiseled to a depth of 18 in. On 12/3/21, pre-plant soil samples of the top 0-12 in. were taken. Soil nitrate quick tests for these samples measured 19 lb/ac nitrate-N fertilizer equivalent in the Gepford clay soil. On the same day, 60 lb/ac N as urea was broadcast applied to create 3 N-rich reference zones. Each of the 3 reference zones were 90ft x 180ft rectangles, with two zones placed within the same check on opposite ends of the field (one near the tail and one near the head of the flood irrigation), and a third near the head of a separate check.

Early season conditions:
The field was planted on 12/3/21 by broadcasting followed by disking so that the seed was incorporated to approximately 2-3 in. depth. The planting event was prior to more than 1.5 in. of rainfall over the subsequent 7-10 days. On 1/18/22, the crop was at the 1-tiller stage (< 1% of total seasonal N uptake) and the plant stand was full. There had been more than 3 in. of rainfall since planting and 4 in. up to that point in the rainfall year, which was around 1.5 in. more than normal.

SITE INFORMATION

Location: Kings County
Soil type: Gepford clay
Previous crop: Cotton
Variety: 158 EP (triticale)
Seeding method: Broadcast and disked
Seeding rate: 130 lb/ac
Planting date: 12/3/21
Bedded: No

Pre-plant N Management

Field rate: ~ 95 lb/ac N
N-rich zones: 60 lb/ac N
N form in zone: Urea, granular

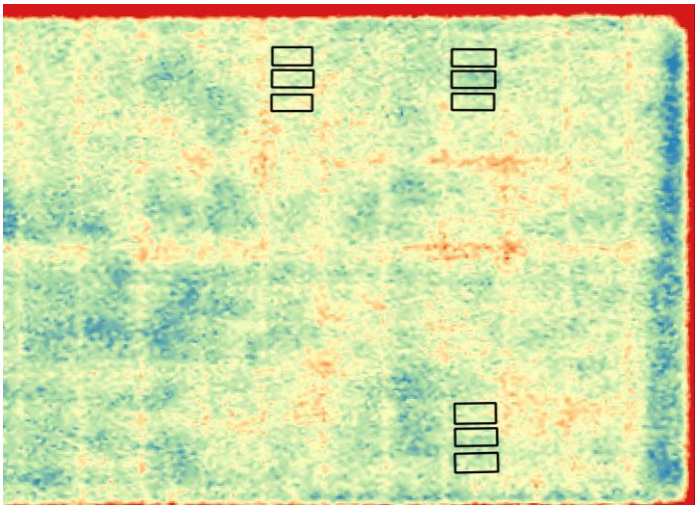

Figure 1 (left). False color representation of NDRE values measured via Planet satellite on 1/30/22. In each group of three boxes, the center box represents the N-rich reference zone and the adjacent boxes represent the grower management.

Plant and soil measurements, fertilizer recommendations, and in-season management actions:
Soil nitrate in the top 1 ft. of soil was measured on 1/21/22. There were some differences between the two areas of the field where samples were taken, but the average N fertilizer equivalent was 60 lb/ac nitrate-N. In addition, canopy reflectance (NDRE and NDVI) was measured on 1/18/22 and 1/30/22 via satellite. These measurements found a sufficiency index (SI) = 0.98. SI is the ratio of the measurements taken from the broader field to the measurements taken in the N-rich zone. SI values less than 0.97 indicate possible crop N deficiency, and values less than 0.93 indicate likely crop N deficiency. Considering the projected yield (7800 lb/ac) and protein (10.5%) at this field, alongside the plant and soil measurements recorded in late-January, The Nitrogen Fertilizer Management Tool for California Wheat recommended an in-season N fertilizer application of 30 lb/ac N. The grower

applied 30lb/ac N as NH3 during a flood irrigation event of 9.8 in. on 2/1/2022.

Monitoring of the field continued via satellite. Measurements on 2/20/22, 2/25/22, 3/2/22, and 3/7/22 indicated that the field SI was between 0.99 and 1 throughout this period. This conclusion was also confirmed by handheld canopy reflectance measured via Greenseeker NDVI meter on 3/11/22. At this date, the plants were at the early stem elongation stage of growth with approximately 60% of seasonal N uptake remaining. The grower planned to irrigate again in mid-to-late March with the intention to apply fertilizer during this second irrigation event. Using the recent SI measurements combined with the yield and protein goals, the web-tool recommended an application rate of 60 lb/ac N. However, the recommended fertilizer rate decreased if we estimated more N had become plant available from the 5 ton/ac pre-plant manure application. This is important to consider when an organic fertilizer like manure is used since nutrient availability can be highly variable compared to synthetic fertilizers. A soil nitrate test in early-March would have been informative to us. Unfortunately, an additional soil nitrate sample was not taken at this time. When we input the January soil nitrate-N values into the webtool, we noticed the rate recommendation for maximum yield was also substantially reduced. This information, combined with the knowledge an organic N fertilizer had been applied pre-plant, suggested that a lower than recommended rate might have been appropriate in this circumstance.

On 3/17/22, the grower applied 30lb/ac N as NH3 and 20lb/ac N as UAN-32 injected into the irrigation water of an irrigation event totaling 11.7 in. of water. Further monitoring of the field via satellite on 4/13/22 resulted in an SI = 1. This indicated no sign of deficiency from the plants at a time when less than 10% of the seasonal N uptake remained. The grower applied 6.6 in of water during the final irrigation on 4/16/22, and no additional N fertilizer during this irrigation event.

OUTCOMES:

- In-season N fertilizer application recommended:
  - 50 – 100 lb/ac N
- In-season N fertilizer applied:
  - 80 lb/ac N
- Yield = 6000 lb/ac
  - Below average yield for the area and grower
- Crop N removal
  - 166 lb/ac N
- Total N fertilizer applied
  - Pre-season (manure): ~ 100lb/ac (with ~ 25 lb/ac available)
  - Pre-season (mineral): 70 lb/ac
  - In-season: 80 lb/ac
  - Total: 250 lb/ac
  - For this grower and region this N management was typical

End of season results:
The average grain yield for this field was 6000 lb/ac. This yield is on the lower end of the normal range for this grower. Grain protein content was 12%, but the quality was less important because it was a triticale crop not intended for milling. Yield and protein estimates were taken both from the N rich reference zone area and from adjacent areas of the field representing the grower's management. No differences in yield or protein were measured between these two areas of the field, indicating that the crop was probably not N-limited.

Total N uptake from the crop was estimated to be 166 lb/ac N, while total N applied in the form of manure and mineral fertilizer applications was estimated to be 250 lb/ac N. This indicates a moderate balance between N application and removal, which is an important objective of sustainable nutrient management. In general, the grower's standard management plans and actions at this field matched the recommendations produced by the decision support web-tool using the in-season measurement information gathered on the ground and via satellite.

The impact that the soil nitrate-N estimate made on the web-tool recommendation produced mid-March is notable. The N-rich reference zone acts as a positive control. Therefore, when deficiency is detected, the interpretation is clear. However, when deficiency is not detected from monitoring the plants, as was the case at this site, the importance of the soil nitrate estimate increases. Although SI values indicate sufficiency up to the moment of measurement, deficiency may still occur later in the season. Because of this, the information provided by soil nitrate about near-future soil N supply greatly improves the accuracy of the prediction when SI values indicate no deficiency. Therefore, the combination of these two measurements is able to deliver the most precise prediction of crop N need, particularly in a site where soil N supply via fertilizer applications remained high throughout the season.

Preplant addition of an organic fertilizer source complicated our ability to predict the availability of N to the crop, emphasizing the importance of the soil nitrate quick test in situations when plants N deficiency is not detected.