

N-Rich Reference Zone Case Study: Kings County 2020-21

Nicholas Clark, Taylor Nelsen, Mark Lundy

Three nitrogen (N) rich reference zones were set up on a 145-acre triticale seed field in Kings County where average grain yields are approximately 6000-8000 lb/ac.

N-rich reference zone set up:

The grower applied no pre-plant fertilizer. On 11/17/20, pre-plant soil samples of the top 0-12 in. were taken. [Soil nitrate quick tests](#) done on these samples measured 13 and 63 lb/ac nitrate-N fertilizer equivalent in the western and eastern halves of the field, respectively, in the Gepford clay soil. On 11/21/20, 60 lb/ac N as urea was applied to the N-rich reference zones. Each of the three N-rich reference zones were 90ft x 180ft rectangles. The [N-rich reference zones](#) were placed in two separate irrigation checks with two near the tail and one near the head of the flood irrigated field.

Early season conditions:

The field was planted by drilling seed on 11/18/20. The seed was irrigated up on 11/29/20 with 7 in. of water. On 1/21/21, the crop was at the 3-tiller stage (4% of total seasonal N uptake) and the plant population ranged from an average of 13 plants/ft² in the SW corner of the field to an average of 19 plants/ft² in the northern half of the field, much lower than the target population (25-30 plants/ft²) for maximum yields. These assessments were made ahead of the predicted rainstorm on 1/25/21 – 1/29/21. Cumulative rainfall from planting through the rainstorm ending 1/29/21 was 0.82 in. less than historical average. Rainfall remained below average throughout the season.

Plant and Soil Measurements:

Just before the end-of-January rainstorm, normalized difference vegetative index (NDVI) measured on 1/18/21 via satellite showed a sufficiency index (SI) of 0.87. A 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. Shortly after, on 1/21/21, we began using [hand-held devices for measuring plant N status](#). NDVI measured with the hand-held GreenSeeker showed an average SI of 0.85, confirming N deficiency was likely. Soil nitrate quick tests taken on the same day revealed only 13 lb/ac nitrate-N present in the top 0-12 in. of soil across the whole field.



Figure 1. N deficiency visible in fertilizer exclusion zone

On 3/1/21, we used the GreenSeeker and Planet satellite NDVI images to measure plant N status ahead of an irrigation. The two measurements agreed with each other, where the GreenSeeker measured a field SI of 0.93 and the satellite measured a field SI of 0.95. In early April, before the planned last irrigation of the season when the crop was in the boot stage of heading, satellite and drone normalized difference red-edge (NDRE) measurements made on 4/6/21 showed an average SI of 0.96. On the same day, leaf chlorophyll measurements were made using the hand-held atLEAF+ meter which showed an average SI of 0.99.

SITE INFORMATION

Location: Kings County

Soil type: Gepford clay

Previous crop: Cotton

Variety: Swift 77 (triticale)

Seeding method: Drilled

Seeding rate: 130 lb/ac

Planting date: 11/18/20

Irrigated up: 11/29/20

Bedded: No

Pre-plant N Management

Field rate: 0 lb/ac N

N-rich zones: 60 lb/ac N

N Form: Urea, granular

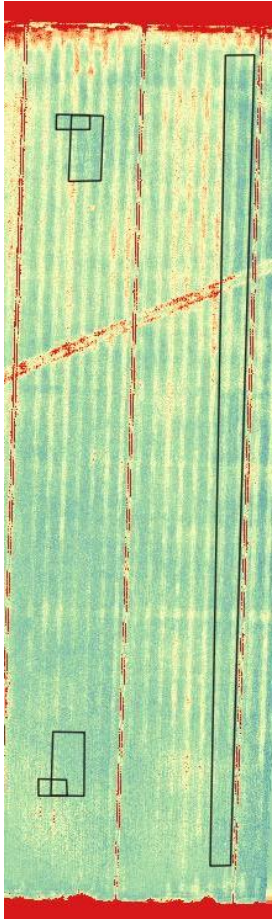


Figure 2. Hand- and aerial-applied N-rich reference zones

Fertilizer recommendations and in-season management actions:

To predict the optimal N application rate at the end of January, SI, soil nitrate-N, the yield goal of 7800 lb/ac grain at 10% protein and remaining N uptake of about 162 lb/ac N were all considered. [The Nitrogen Fertilizer Management Tool for California Wheat](#) predicted a significant increase in yield from an N fertilizer application of 140 lb/ac N. Since the grower typically splits N applications, an application of 90 lb/ac N was recommended at the time for a predicted increase in grain yield of approximately 1300 lb/ac plus or minus 300 lb/ac. On 1/25/21, 90 lb/ac N as urea was applied by plane ahead of a rainstorm. Exclusion zones were established by covering rectangles with tarps ahead of the fertilizer application and removing them shortly afterward. The grower also applied an additional N-rich reference zone by flying a pass of urea along the length of an irrigation check at a rate of 180 lb/ac N. Plants in the N exclusion zones quickly began to show visible signs of N deficiency (Figure 1). Drone NDRE and GreenSeeker NDVI measurements of the exclusion zones and the surrounding farmer managed area on 3/1/21 showed the exclusion zones had an SI of 0.78 indicating severe N deficiency.

After the 3/1/21 field SI measurements with the GreenSeeker and Planet satellite imagery indicated the field was likely N deficient with a SI of 0.93-0.95, [the Nitrogen Fertilizer Management Tool for California Wheat](#) predicted a significant yield increase of 780 lb/ac from an application of 50 lb/ac N. This recommendation concurred with what the grower already planned on applying. On 3/2/21, 50 lb/ac N as ammonia was applied in 5.2 in. of irrigation water. On 4/6/21 with only 32 lb/ac N uptake remaining, late-season measurements of the hand-applied and the grower applied N-rich reference zones were taken ahead of the last irrigation. These measurements resulted in a recommendation to not apply N fertilizer. No more fertilizer was applied for the remainder of the season.

End of season results:

The average grain yield for this field was 7500 lb/ac. This yield is slightly higher than the normal range for the region. We measured 9% grain protein, but the quality is not important because the crop was being grown to produce seed for planting. The fertilizer recommendations based on plant and soil N measurements between the N-rich reference zones and the rest of the field were followed and proved to be accurate. Average grain yield in the N exclusion zones was 6593 lb/ac, approximately 1000 lb/ac less than the grower managed areas. The predictions made by the decision support tools and the field outcomes reflected the normal N fertilization level and expected yield for this grower. The final in-season measurement of plant N status resulted in a recommendation to withhold a fertilizer application of 30 lb/ac N in the irrigation. Assuming the cost of N fertilization is \$0.75/lb N, applied to the whole 145-acre field the grower saved approximately \$3,200 in fertilization costs without sacrificing yield.

The large size of this field, which is typical for the region, made applying and measuring the small plot N-rich reference zones by hand challenging. Drone and satellite imaging of vegetation indices for the triticale crop showed distinct variability within the field. The grower for this site will likely rely on aerial imagery for plant N measurements. As a result, they took the step of implementing their own N-rich reference zone by plane which was visible by available satellite imagery. Exploration of aerial imaging services will be critical moving forward with this site to make the best use of N-rich reference zone-based fertilizer management decisions.

OUTCOMES:

- In-season N fertilizer application recommended:
 - 90 lb/ac N
- In-season N fertilizer applied:
 - 90 lb/ac N
- Yield = 7500 lb/ac
 - Average yield for the area and grower
- Crop N removal
 - 147 lb/ac N
- Total N fertilizer applied
 - Pre-season: 0 lb/ac
 - In-season: 140 lb/ac
 - For this grower and region this N management was typical

The grower saved approximately \$3,200 in fertilization costs without sacrificing yield.