

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

Michelle Leinfelder-Miles, Taylor Nelsen, Mark Lundy

We implemented nitrogen-rich (N-rich) reference zones on a 40-acre wheat field in the Sacramento County Delta where the seasonal ranch average grain yield and protein were approximately 6800 lb/ac and 11%, respectively. The ranch average yield was approximately 1000 lb higher than the historical average and about 300 lb higher than last year. The 2020-21 season has been characterized as one of the driest winters on record, and this ranch tends to yield higher in dry years. The cumulative rainfall at this site was approximately 6.2 in, compared to a 14-in historical average.

N-rich reference zone creation:

The soil at this field is characterized as a Rindge mucky silt loam. The Rindge series ranges from 10 to 65% organic matter down to the 60-in depth. The grower's pre-plant UN-32 application provided approximately 60 lb/ac N, and the wheat was planted on 11/13/20. The grower usually applies aqua ammonia instead of UN-32, but UN-32 was cheaper this year. We soil sampled from the top 0-12 in on 11/20/20, and performed a [soil nitrate quick test](#) (SNQT). The soil contained approximately 67 lb/ac nitrate-N (± 27 lb/ac nitrate-N). We flagged off three N-rich reference zones. Each zone was 90 ft by 180 ft. On 12/11/20, we broadcasted urea to the N-rich zones at a rate of approximately 60 lb/ac N. We timed our application ahead of a storm that resulted in 1 in of rainfall.

Early season conditions:

On 1/25/21 (2-4 tillers), we took soil and [canopy measurements](#). Prior to this sampling, a canal had backed up and flooded the bottom end of the field, including one of the three N-rich zones. Consequently, the soil nitrate-N was lower at the bottom end of the field, but there were no differences in canopy reflectance between the N-rich zones and field rate for any replicate.

Plant and soil measurements:

On 2/16/21 (tillering to one node), variability down the field was evident in canopy reflectance (Figure 1), but the grower indicated that he would not make

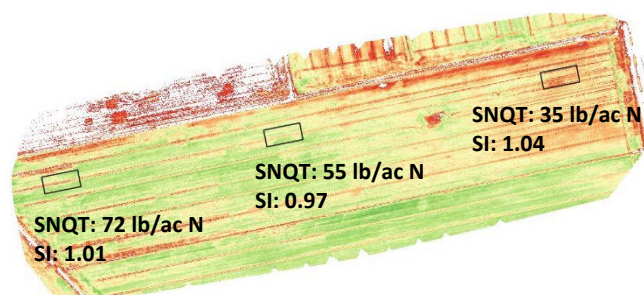


Figure 1. Drone imagery taken on 2/16/21, when the field was tillering to 1 node (i.e. Feekes 6). The imagery shows field variability from the top of the field (left side of the image) to the bottom of the field, where flooding occurred earlier in the season. Black polygons represent the N-rich zones. SNQT and SI values are shown for each replicate. SNQT values are an approximation of available N.

SITE INFORMATION

Location: Sacramento County

Soil type: Rindge mucky silt loam

Previous crop: Corn

Variety: WestBred 9699

Seeding method: Grain drill, 2-in depth

Seeding rate: 150 lb/ac

Planting date: 11/13/20

Bedded: No

PRE-PLANT N MANAGEMENT

Field rate: 60 lb/ac of UN-32

N-rich zone: 120 lb/ac

N fertilization decisions based on the low end of the field where flooding had occurred. The sufficiency index (SI) calculation and [the Nitrogen Fertilizer Management Tool for California Wheat](#) indicated that the field would not benefit from topdressing with N. SI values less than 0.97 indicate possible crop N deficiency, and values less than 0.93 indicate likely crop N deficiency. Likewise, there was no indication of field response to topdressing based on 3/14/21 (2 nodes) measurements.

Fertilizer recommendations and in-season management actions:

Since monitoring data did not indicate a benefit from topdressing, and with no rain in the forecast, the grower decided not to apply additional N this season. We decided to apply small topdress zones outside the N-rich zones in order to measure whether a topdress would have benefitted yield or protein. On 3/14/21, we applied 40 lb/ac N as urea to zones ahead of 0.45 in of rain. We monitored satellite imagery (Figure 2) and leaf chlorophyll on 4/6/21 when approximately 72% of the annual crop N uptake had occurred, and we concluded that the crop was unlikely to respond to in-season N fertilizer.

End of season results:

The field was harvested on 6/14/21. We hand-harvested from the N-rich zones, topdress zones, and surrounding field, and there were no differences among them for yield ($p = 0.65$). The lower end of the field yielded lower than the middle and upper sections. For protein, there was no statistical difference between the field and the N-rich zones, but the topdress improved protein by about 0.5% ($p = 0.07$). We estimate that N uptake (including straw) was approximately 163 lb/ac N in the field, 172 lb/ac N in the N-rich zones, and 175 lb/ac N in the topdress zones.

OUTCOMES:

- In-season N fertilizer application recommended? No
- In-season N fertilizer applied? No
- Yield
 - 6800 lb/ac (ranch average)
 - 1000 lb/ac higher than historical average
- Protein
 - 11% (ranch average)
 - 1% higher than historical average
- Crop N uptake for the field
 - 163 lb/ac
- Total N fertilizer applied
 - Pre-season: 60 lb/ac
 - In-season: 0 lb/ac

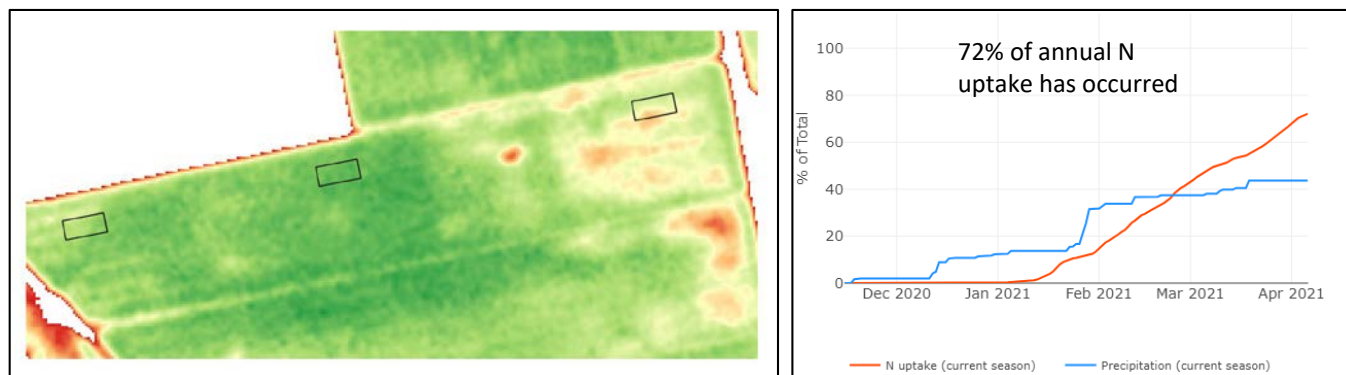


Figure 2. Satellite imagery taken on 4/6/21, when the field was heading (i.e. Feekes 10.1). Black polygons represent the N-rich zones. The graphed output from the [webtool](#) showed an estimated 72% of the crop N uptake had occurred by this date. Due to field variability, no clear indication from the online tool, and no rain in the forecast, the grower decided not to apply in-season N fertilizer.

We thank Dennis Lewallen for his collaboration and insights.

N-Rich Reference Zone Case Study: Sacramento County 2019-20

Michelle Leinfelder-Miles, Taylor Nelsen, Mark Lundy

Nitrogen (N) rich reference zones were implemented on a 55 acre wheat field in the Sacramento County Delta where the 2019-20 seasonal average grain yield and protein on the ranch were approximately 6500 lb/ac and 10.5%. Historically, this ranch averages about 5500 lb/ac and 10% protein. The grower attributed the better-than-average season to the dry conditions where soils were not waterlogged and applied nitrogen stayed in the root zone.

N-rich reference zone creation:

The field had two different soil types: Gazwell mucky clay and Rindge mucky silt loam. The Gazwell series is characterized as having approximately 11% organic matter in the top foot of soil, and the Rindge series has approximately 18%. The grower's pre-plant aqua ammonia application provided approximately 60 lb/ac N. The wheat was planted on 11/15/19. Soil samples for nitrate-N in the top 1 ft of soil on 11/18/19 indicated that there was approximately 40 lb/ac N fertilizer equivalent in the Gazwell soil and 27 lb/ac N fertilizer equivalent in the Rindge soil. Three N-rich reference zones were created on 11/25/19— two in the Gazwell soil and one in the Rindge soil (each zone was 90ft x180ft). To create the N-rich zones, urea was broadcast at a rate of approximately 60 lb/ac N. The application was timed ahead of a storm that resulted in 0.5 in. of rainfall.

Early season conditions:

Overall, the 2019-20 season was a dry season. Between planting and the in-season assessments made on 2/19/20, the crop received approximately 4.3 in. of rain, which was 4.2 in. less than historical average. No rain fell in the month of February. Environmental losses of N may have been reduced as a result of the dry conditions. At of the 2/19/20 assessments, the crop was at the mid-tillering stage of growth, and approximately 21% of the total seasonal N uptake had occurred at this point. March and early-April rainfall provided another 4.1 in.

Plant and soil measurements:

At tillering, soil was sampled for nitrate-N from the top foot and canopy reflectance measurements were taken on 14-day intervals. On 2/19/20, the N-rich reference zones had a fertilizer N equivalent of 25-37 lb/ac N. The surrounding field had a fertilizer N equivalent of 13-21 lb/ac N. The GreenSeeker canopy reflectance readings were similar between the N-rich reference zones and the surrounding field, indicating

SITE INFORMATION

Location: Sacramento County

Soil type: Gazwell mucky clay & Rindge mucky silt loam

Previous crop: Corn

Variety: WestBred 9229

Seeding method: Grain drill, 2" planting depth

Seeding rate: 150 lbs/ac

Planting date: 11/15/19

Bedded: No

Weed Management: Osprey (4.75 oz product/ac) and MCPA (0.5 pint product/ac)

PRE-PLANT N MANAGEMENT

Field rate: 60 lb/ac

N-rich zones: 120 lb/ac

N Form: Aqua ammonia + urea in N-rich reference zones

N sufficiency in the field. These measurements were expressed as a Sufficiency Index (SI). A SI is the ratio of the measurements taken from the broader field to the measurements taken in the N-rich zones. This field had a SI of 0.98 around all three N-rich zones. SI values less than 0.97 indicates possible crop N deficiency, and values less than 0.93 indicate likely crop N deficiency. There were also no fertility differences indicated by drone imagery (Figure 1).

Fertilizer recommendations and in-season management actions:

Since there was no rain on the horizon by late-February, the grower decided not to apply additional N. The crop was unlikely to respond to additional N fertilizer based on the plant and soil measurements. Monitoring continued, but there was never a SI below 0.97. By mid-March, work restrictions due to the COVID-19 pandemic limited the ability to address whether an N application ahead of a March storm would have had a yield effect.

End of season results:

Hand harvested samples from the N-rich reference zones and the surrounding field indicate that there was no differences between the yield of the N-rich reference zones and the surrounding field ($p = 0.68$). Yield in the N-rich reference zones was approximately 8600 lb/ac, and yield in the field was 8400 lb/ac. The hand-harvest yields likely overestimated the field yield. Since no in-season N deficiency was detected with the canopy measurements and the field yield was comparable to that in the N-rich zones, the crop was unlikely to have responded to an in-season N fertilizer application.

OUTCOMES:

- In-season N fertilizer application recommended? No
- In-season N fertilizer applied? No
- Yield
 - 6500 lb/ac (ranch average)
 - 1000 lb/ac higher than historical average
- Protein
 - 10.5% (ranch average)
 - 0.5% higher than historical average
- Crop N removal
 - 148 lb/ac
- Total N fertilizer applied
 - Pre-season: 60 lb/ac
 - In-season: 0 lb/ac

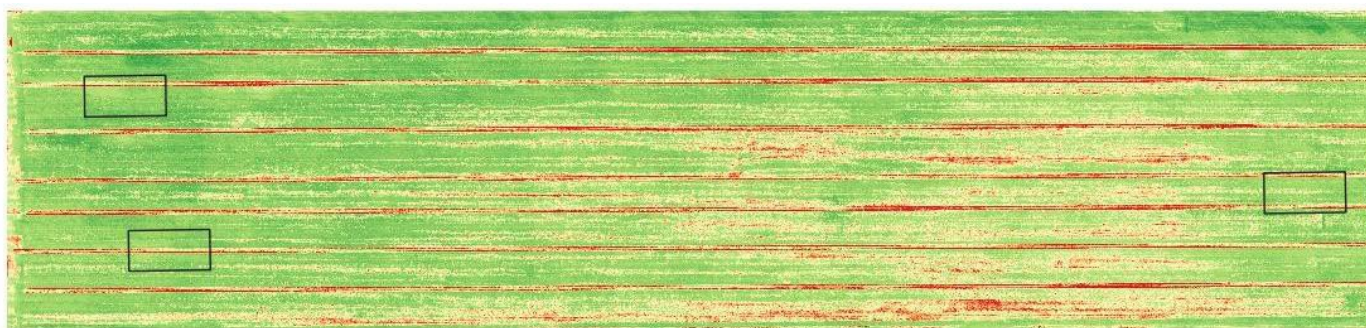


Figure 1. Drone imagery representing canopy reflectance (NDRE) measured on 2/19/20. N-rich reference zones are illustrated by rectangular shapes, but a lack of color differentiation indicates no differences in nitrogen uptake between plants in the field and those in the N-rich zones.

We thank Dennis Lewallen for his cooperation and insights.

"It was a warm February with no rain. I haven't seen that since 1991. We could have lost the crop, but the rains in March saved it." Dennis