

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

Sarah Light, Kim Gallagher, Taylor Nelsen, Mark Lundy

Nitrogen (N) rich reference zones were implemented on a 180-acre wheat field in Colusa County. Average grain yields are approximately 7000 lb/ac. Pre-plant aqua ammonia was shallowly shanked in at a depth of 4-5 in. at a rate of 60 lb/ac N in mid-October, 2020. Beds were listed and shaped after aqua application. Soil samples were taken after pre-plant fertilization on 11/9/20. The top 0-12 in. of soil had high starting average nitrate-N fertilizer equivalent of 164 lb/ac N. Urea was broadcast at 60 lb/ac N with a belly grinder in three 90ft x 180ft [N-rich reference zones](#) on 12/11/20. A rainfall event with a 0.5 in. of precipitation occurred two days later.

Early season conditions: The field was drill seeded with Patwin 515 HP variety on 11/13/20 on 60-inch beds with 6-inch row spacing. Severe drought conditions in the Western US led to [heavy geese damage](#) in wheat fields in the Sacramento Valley. At the study field, the geese had eaten approximately 20% of the emerged wheat plants by early February. Tiller counts in the geese-damaged area were taken on 2/8/21 and averaged 24 tillers per square foot, which is lower than the optimum target of 30 tillers per square foot. Despite very low precipitation, which reduced crop emergence, tiller counts were fine in the rest of the field. The crop received 7 inches of rainfall for the season which is 40% of historical average. Thus, the field was irrigated twice during the season using furrow irrigation. The first irrigation began on 2/25/21 and the second on 4/10/21. Both applied approximately twelve inches of water. The second irrigation was to ensure adequate moisture during grain fill.

Plant and Soil Measurements: Plant and soil measurements were taken throughout the season to evaluate whether the crop would respond to additional N fertilizer. Monitoring on 2/8/21 did not indicate a likely crop response. Soil samples were collected in the top 0-12 in. of soil from both the N-rich reference zones and the broader field. There was variability in the field, with the [soil nitrate quick test](#) indicating that approximately 90 to 166 lb/ac nitrate-N fertilizer equivalent remained in the broader field.

SITE INFORMATION

Location: Colusa County

Soil type: Grandbend loam

Previous crop: Sunflower

Variety: Patwin 515HP

Seeding method: Drill seeded

Seeding rate: 120 lb/ac

Planting date: 11/13/20

Bedded: Yes (60 in.)

Pre-plant N Management

Field rate: 60 lb/ac N

N-rich zone: 120 lb/ac N

N Form: Aqua ammonia (field) + urea (N-rich zones)

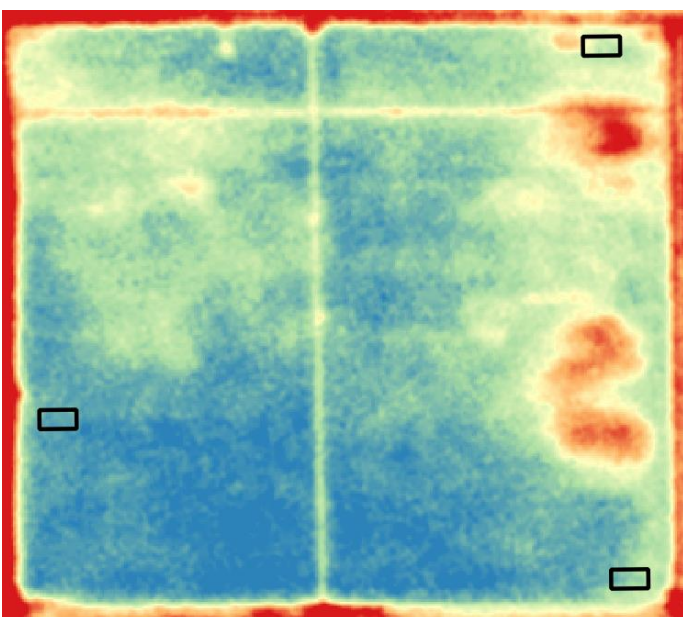


Figure 1: N-rich strips were not visible using aerial imagery which measured NDRE on 2/27/21. The heaviest geese damaged areas are visible (red) in the east side of the field.

[Canopy reflectance](#) was also measured on 2/8/21 in both the N-rich reference zones and the surrounding field using a handheld GreenSeeker NDVI meter. The field was also monitored by drone on 2/8/21 and via satellite on 1/26/21, 2/21/21, 2/27/21 (Figure 1), and 3/10/21. 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 reference zones. SI values less than 0.97

indicate possible crop N deficiency, and values less than 0.93 indicate likely crop N deficiency. The GreenSeeker measurements on 2/8/21 indicated that the SI was above 1 for two of the strips and between 0.90 and 0.93 for the third. However, the SI of the third strip was affected by stand establishment issues in that area of the field and was not considered representative of the field. Canopy reflectance (NDRE)

was again measured on 3/31/21 using a drone to evaluate the potential benefit of a fertilizer application prior to the second irrigation. On this date, the SI for the field was 0.99 and [The Nitrogen Fertilizer Management Tool for California Wheat](#) indicated 81.8% of season N had been taken up (Figure 2).

Fertilizer recommendations and in-season management actions:

The SI measured from the crop canopy on 2/8/21 indicated no crop response to addition N application. Soil nitrate levels were high throughout the field. The crop measurements on 3/31/21 indicated that there could be a minimal increase in protein with an additional 20 lb/ac N. However, the economics of the cost of the material and application via airplane were not worth the minimal increase in protein. No N was applied in-season. Soil nitrate-N levels were high throughout the season and crop monitoring indicated an adequate SI. In addition, the yield potential of the field was uncertain due to extreme drought conditions and geese damage.

End of season results: The wheat crop yielded 5475 lb/ac with 12.3% protein despite challenging conditions. There was no difference in yield between the N-rich reference zone or the broader field. Overall, the crop removed approximately 146 lb/ac N. This is 86 lb/ac N more than was applied. In addition, total N application per acre was 60 lb/ac lower than typical management practices. This reduction in fertilizer application is a cost savings of approximately \$45 per acre (@ \$0.75/lb N applied fertilizer).

There were many in-season challenges including uncertainty around stand establishment due to dry conditions throughout the entire season and heavy geese damage. Since the grower applied only 60 lb/ac N prior to planting, they had the opportunity to assess whether it was worth it to spend money on an additional fertilizer application. Typically the grower might apply 120 lb/ac N for the season, all at pre-plant. Though grain yields were lower than usual, this is likely due to factors other than nitrogen. Using the decision support tools, the grower was able to save money during a difficult year and still produce a profitable crop. In the end, the field achieved close to normal yields in challenging conditions while using less N fertilizer than normal.

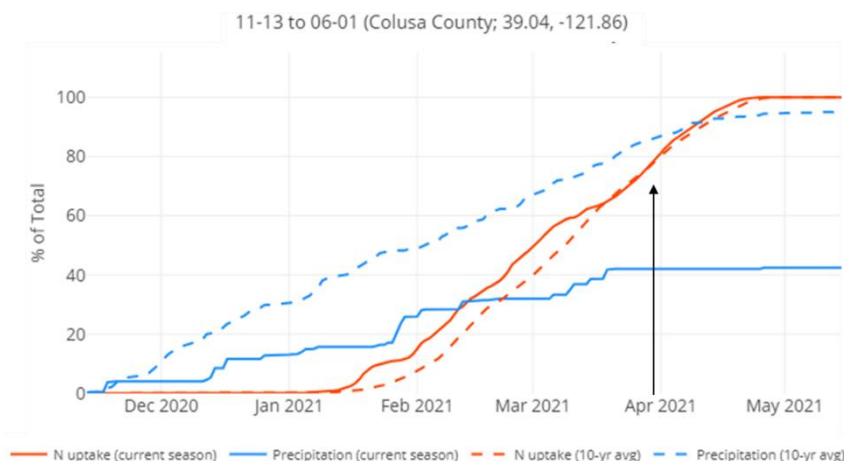


Figure 2. Wheat N uptake (red) and precipitation (blue) as a percent of average annual totals. The solid lines show the 2020-21 season while the dashed lines show the 10-year historical average. The arrow indicates when the SI was measured at the end of March.

OUTCOMES:

- In-season N fertilizer application recommended? No
- In-season N fertilizer applied
 - None
- Yield = 5475 lb/ac
- Protein = 12.3%
- Crop N removal = 146 lb/ac N
- Total N fertilizer applied = 60 lb/ac N
 - Pre-season: 60 lb/ac N
 - In-season: 0 lb/ac N
 - 60 lb/ac less than grower's typical N rate
- Cost savings: Approximately \$45/ac

Despite a very challenging year due to external factors, wheat yield was higher than anticipated. Total crop N removal was almost 80 lb/ac N higher than fertilizer applied. No N was applied in-season and there was not a measurable reduction in yield or protein.