

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

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Nitrogen (N) rich reference zones were implemented on a 135 acre wheat field in Colusa County. Average grain yields are approximately 7000 lb/ac. Pre-plant aqua ammonia was shanked in at 60 lb/ac N on 10/30/19. Soil samples were taken after pre-plant fertilization on 11/12/19. The top foot of soil had an average nitrate-N fertilizer equivalent of 66 lb/ac N. Urea was broadcast at 60 lb/ac N with a belly grinder in three 90ft x 180ft N-rich zones on 12/17/19, just prior to a multi-day rainfall event totaling more than 1 in. of precipitation.

Early season conditions: The field was planted about a month later than planned due to heavy early-season rainfall. Seed was flown on at 145 lb/ac. The field was not harrowed after planting due to wet soil conditions. This seeding practice is not common in the area and there was concern over stand establishment. Despite some seed rolling off the beds into the furrows, stand establishment was strong. In mid-February the stand averaged almost 40 plants per square foot. There was heavy weed pressure, including volunteer sunflowers from the previous season, in much of the field. Between planting (12/16/19) and the final in-season assessment on 3/4/20 the crop received 2.3 in. of rainfall and one irrigation (2/24/20-3/7/20) via furrow irrigation totaling approximately 6-7 in. Rainfall during this period was 7.4 in. less than the historical average. The crop was at the mid-tillering stage of growth and approximately 21% of total seasonal N uptake had occurred at this point.

Plant and Soil Measurements: Plant and soil measurements were taken throughout the early vegetative growth stages in order to evaluate whether the crop would respond to additional N fertilizer. These measurements began later than in previous seasons since the field was planted late.

On 2/14/20, soil samples were collected in the top foot of soil from both the N-rich reference zones and the broader field. The samples indicated that approximately 37 lb/ac N fertilizer equivalent nitrate-N remained in the N-rich reference zones and 13 lb/ac in broader field. Canopy reflectance was also measured on 2/14 in both the N-rich reference zones and the surrounding field using a handheld GreenSeeker NDVI meter. 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. SI values less than 0.97 indicate possible crop N deficiency, and values less than 0.93 indicate likely crop N

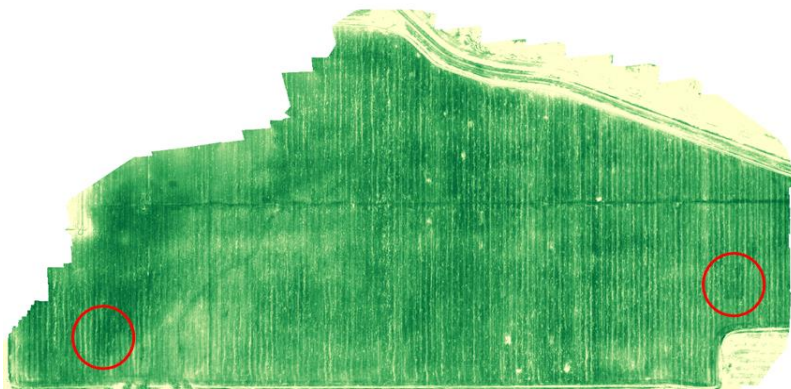


Figure 1. The two N-rich reference zones on the south side of the field were detected on 3/4/20 using drone-based NDRE measurements.

SITE INFORMATION

Location: Colusa County

Soil type: Grandbend loam & Corbiere silt loam

Previous crop: Sunflowers

Variety: Patwin 515HP

Seeding method: Flown on

Seeding rate: 145 lb/ac

Planting date: 12/16/19

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)

deficiency. The SI for the two N-rich reference zones in the southern part of the fields was 0.9 on 2/14, while the SI for the northern N-rich reference zone was 1.0. Canopy reflectance (NDRE) was again measured on 2/19 and 3/4/20 using a drone. The average SI from these measurements was slightly higher than the handheld measurements recorded on 2/14. They also indicated possible deficiency in the same two N-rich reference zones in the southern end of the field and no deficiency in the northern N-rich reference zone (Fig 1).

Fertilizer recommendations and in-season management actions:

The SI measured from the crop canopy on 2/14, 2/19 and 3/4/20 indicated possible N deficiency in the crop. The low soil nitrate values supported the conclusion that an in-season N fertilizer application would increase yield if it was followed by sufficient rainfall or irrigation to incorporate the fertilizer and meet crop water demand. However, when making an in-season N fertilizer decision, the estimated yield and protein target for the field (5000 lb/ac and 12%) were much lower than normal (7000 lb/ac and 12%). This reflected uncertainty due to a combination of the unconventional seeding method, the droughty early season conditions, the inconsistent deficiency signal between the north and south ends of the field, and early season weed pressure (including volunteer sunflowers). With approximately 90 lb/ac of crop N uptake remaining, the grower chose to fly on 46 lb/ac N as urea on 3/6/20 in advance of a forecasted rain event. During the application, three 15ft x 15ft areas were covered with a tarp to exclude the in-season N fertilizer. These areas were the control areas that allowed the effectiveness of the in-season N application to be measured.

End of season results: The wheat crop yielded 6339 lb/ac with 11.3% protein despite challenging conditions. This was 824 lb/ac higher than the control areas, which did not receive any in-season urea application. Yields were higher in the N-rich reference zones in the southern part of the field as compared to the adjacent bulk field. These differences in yield are consistent with in-season measurements. The two N-rich reference zones in the southern part of the field indicated there was early-season N deficiency, whereas there were no SI or yield differences in the northern part of the field. Overall, the crop removed approximately 157 lb/ac N. This is almost 50 lb/ac N more than was applied. In addition, total N application per acre was 44 lb/ac lower than typical management practices.

There were many in-season challenges including uncertainty around stand establishment, weed pressure, and low seasonal rainfall. In addition, the rainstorm predicted to follow the 3/6 urea application ended up being a drizzle, and there was not a significant rainfall event until 8 days after the urea application. Thus, there were concerns that a portion of the urea might have been volatilized. These challenges meant that there was a risk of lower than normal yield. However, having only applied 60 lb/ac N pre-plant, there was also an opportunity to react to the uncertainty and minimize fertilizer costs. Thus, the grower applied 46 lb/ac N in-season rather than the full 90 lb/ac of crop N uptake remaining to hedge against the uncertain conditions. Rainfall was relatively normal during the second part of the season. In the end, the field achieved close to normal yields in challenging conditions while using less N fertilizer than normal.

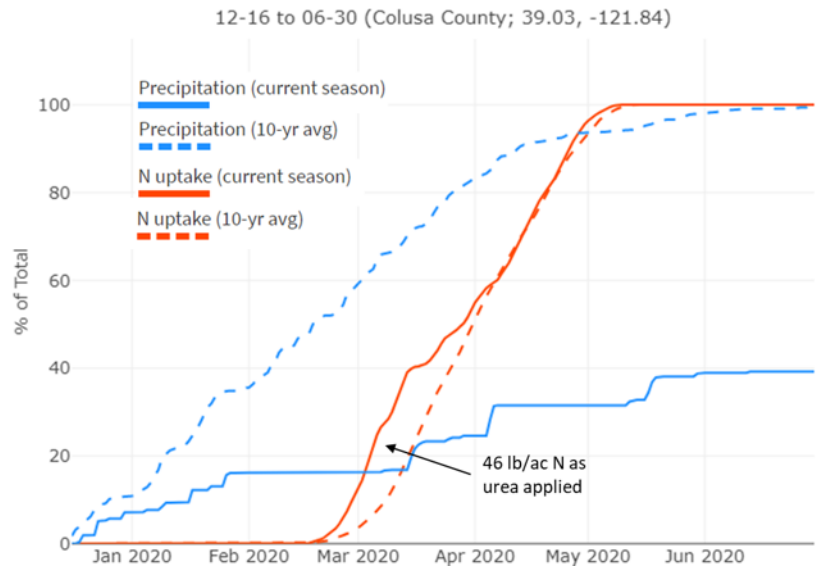


Figure 2. Wheat N uptake (red) and precipitation (blue) as a percent of average annual totals. The solid lines show the 2019-20 season while the dashed lines show the 10-year historical average.

OUTCOMES:

- In-season N fertilizer application recommended? Yes
 - 40 - 60 lb/ac N
- In-season N fertilizer applied
 - 46 lb/ac N
- Yield = 6339 lb/ac
 - 1400 lb/ac higher than anticipating
 - 824 lb/ac higher than the control
- Protein = 11.3%
 - 0.7% lower than anticipating
- Crop N removal = 157 lb/ac N
- Total N fertilizer applied = 106 lb/ac N
 - Pre-season: 60 lb/ac N
 - In-season: 46 lb/ac N
 - 44 lb/ac less than grower's typical N rate

Despite many challenges in this field, wheat yield was higher than anticipated. Total crop N removal was almost 50 lb N/ac higher than fertilizer applied.