

## N-Rich Reference Zone Case Study: Solano County 2019 - 20

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Nitrogen (N) rich reference zones were implemented on a 35 acre triticale field in Solano County where average grain yields are approximately 6000 lb/ac. This field is located on deep, fertile soils, and winter cereal crops are grown in rotation with irrigated summer crops. Winter rainfall averages 19 in. at the location, and the grower does not typically irrigate winter cereal crops.

### N-rich reference zone creation:

The previous crop on the field was processing tomatoes. No pre-plant N fertilizer was applied because the grower estimated that the residual soil N from the previous crop would be sufficient to support crop N needs early in the season. A pre-plant soil sample was taken from the top 1 foot of soil on 11/4/19. The soil nitrate-N in the sample indicated that there was approximately 72 lb/ac N fertilizer equivalent in the top foot of soil. The field was planted on 11/26/19. On 11/29/19 three 90ft x 180ft N-rich reference zones were created. In each zone 60 lb/ac N in the form of urea was broadcast with a belly grinder prior to a multi-day rain event.

### Early season conditions:

Between planting and the end of January, the field received 8.3 in. of rainfall. The 10-year average for the same period of time is 7.8 in. By the end of January, the crop was at the early-tillering stage of growth. The stand was healthy and vigorous, and there were few weeds present in the field. An extended period of drought followed. Between 1/26/20 and 3/13/20 the field received no precipitation. The field typically receives an average of 5 in. of rainfall between those dates. As a result of the dry conditions, crop vigor decreased during February and early March as available soil moisture decreased. By the time rain appeared in the forecast in early March, the crop was near the end of the stem elongation growth stage. Approximately 55% - 65% of the seasonal N uptake had occurred at this point in the season.

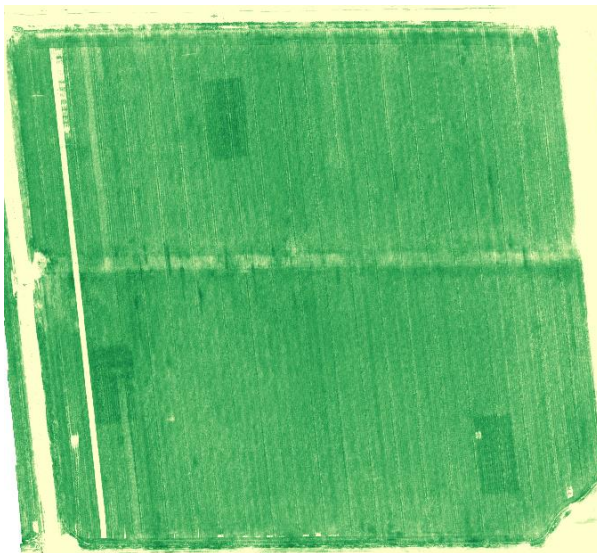


Figure 1. Normalized Difference Red Edge (NDRE) measurement recorded on 2/20/20 by a drone-mounted multi-spectral camera. Darker green areas indicate N-rich reference zones. The triticale crop was in the late-tillering stage and N uptake was estimated to be 25% of the seasonal total at this stage.

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### SITE INFORMATION

**Location:** Solano County

**Soil type:** Capay silty clay loam

**Previous crop:** Tomatoes

**Variety:** SY 115 (triticale)

**Seeding method:** Grain drill

**Planting date:** 11/26/19

**Bedded:** No

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### Pre-plant N Management

**Field rate:** 0 lb/ac

**N-rich zone:** 60 lb/ac

**N Form:** urea in N-rich zone

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**Plant and Soil Measurements:**

In-season soil and canopy measurements were taken throughout the early vegetative growth stages. Soil nitrate-N measured from the top foot of soil on 1/29/20 and 2/20/20 indicated that only 31 lb/ac N and 21 lb/ac fertilizer equivalent N, respectively, still remained. This was 43% and 29%, respectively, of the nitrate measured pre-plant on 11/6/19. In addition, canopy NDVI and NDRE measurements were taken on three occasions (see below). 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 zone. SI values less than 0.97 indicate possible crop N deficiency, and values less than 0.93 indicate likely crop N deficiency. The SI values based on GreenSeeker handheld measurements were 0.95, 0.96 and 0.92 on 1/29/20, 2/11/20, and 2/20/20, respectively. These values indicated that the crop was likely deficient in N and showing increasing signs of deficiency throughout the vegetative growth stage. There was consistency among the SI measurements recorded in the field's three N-rich reference zones (see Figure 1).

**Fertilizer recommendations and in-season management actions:**

Crop response to in-season N application was likely if followed by sufficient rainfall to meet crop water demand. This was based on SI values consistently below 0.97 during tillering and stem elongation and relatively little residual nitrate remaining in the top foot of the soil profile. When rain appeared in the forecast in March, there was approximately 35%-45% of seasonal N uptake remaining. For a 6000 lb/ac triticale crop with 11% protein, this equates to between 55 and 65 lb/ac of N uptake remaining. If N fertilizer were applied at these rates this crop was likely to see a 600 – 1100 lb/ac (10% - 18%) increase in yield compared to no fertilizer application. This prediction assumes that the crop is not water-limited and that sufficient rainfall would follow the fertilizer application to incorporate the N fertilizer into the soil and meet crop water demand during the remainder of the season.

The grower did not apply any in-season N fertilizer to the field. The extended drought period between late-January and early-March and the uncertainty about future precipitation argued against a fertilizer application at this stage. Nevertheless, fertilizer was applied as urea broadcast in 1350 ft<sup>2</sup> strips on both 3/6/20 (63 lb/ac N) and 3/13/20 (42 lb/ac N) ahead of forecasted rain to test the accuracy of the prediction. Only trace amounts of rainfall fell immediately after the first application. More than 1 in. of rain fell immediately after the second application. Almost 3 in. fell between 3/13/20 and the end of the season, which is more than 1 in. less than average for that period.

**End of season results:**

Yields on the broader field, where no N fertilizer was applied, were 4910 lb/ac. This was 1090 lb/ac less than the average yield. In the N-rich reference zone, where 60 lb/ac N was applied at planting, there was no change in yield compared to the broader field. Where 63 and 42 lb/ac N were applied on 3/6/20 and 3/13/20, respectively, yields were slightly higher (398 and 186 lb/ac, respectively), but these differences were not statistically significant. Therefore, the apparent increase in crop N uptake evident from the 4/7/20 canopy NDRE measurement (Figure 2), did not result in large yield increases. The lack of yield response was likely the result of a decreased overall yield potential due to drought and the relatively late crop growth stage when the N fertilizer application occurred.

**OUTCOMES:**

- In-season N fertilizer application recommended?
  - Yes: 40-65 lb/ac
- In-season N fertilizer applied by grower?
  - No
- Yield results
  - Field yield = 4910 lb/ac (-1090 lb/ac below average)
  - Yield in N-rich strip was equal to the rest of the field
  - Where extra N fertilizer was applied in March, yield was 104-108% higher.
- Estimated crop N removal
  - 117 lb/ac
- Total N fertilizer applied
  - Pre-season: 0 lb/ac
  - In-season: 0 lb/ac (field), 42-63 lb/ac (strips)

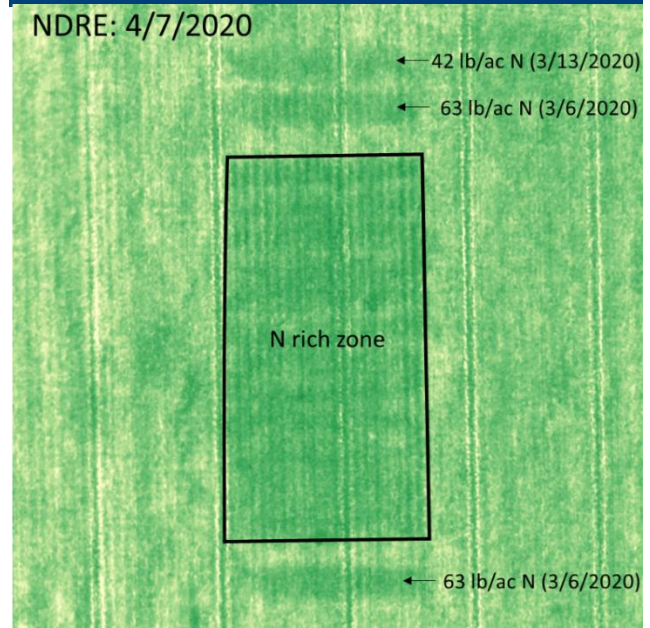


Figure 2. NDRE recorded on 4/7/20 via drone mounted multi-spectral camera indicating increased crop vigor in N-rich reference zone and in locations where N was applied as urea on 3/6 and 3/13/20.