# N-Rich Reference Zone Case Study: Yolo County 2021-22 (irrigated)

Konrad Mathesius, Eric Willson, Rick Rominger, Micah Levinson, Taylor Nelsen, Mark Lundy

A nitrogen (N) rich reference zone was created on a 70-acre field of AP Octane wheat in Yolo County where average grain yields are approximately 6000 lb/ac and average protein content is 11.5%. The previous crop was sunflower. The field was set up for irrigation and fertilization via sub-surface drip installed approximately 12 in. below the soil surface and centered on 60 in. beds.

**N rich reference zone creation**:
The field was fertilized on 11/23/21 with 109 lb/ac N as granular urea using a ground rig with a 30 ft. width. A N-rich reference zone was established by making an extra pass over a designated area, thus doubling the rate in the reference zone (218 lb/ ac N). As a result, the N-rich reference zone was 30ft wide and ran the length of the field (~2400 feet x 30 ft = 1.65 acres).

**Early season conditions**:
The season began with above-average rainfall, and the ground had been saturated prior to planting by October rain storms resulting in approximately 8 in. of precipitation. The damp conditions slightly delayed the planting date. Nevertheless, stand establishment and weed control were ideal. Between planting on 11/23/22 and the first in-field assessment on 2/8/22, the crop had received an additional ~8.8 in. precipitation (resulting in a cumulative seasonal precipitation total of ~16.8 in. as of 2/8/22). However, there had been no rain since 1/6/22, and this dry trend continued for all of February and most of March. As a result, the grower irrigated approximately 4.5 inches over the course of 3 irrigation events across the season.

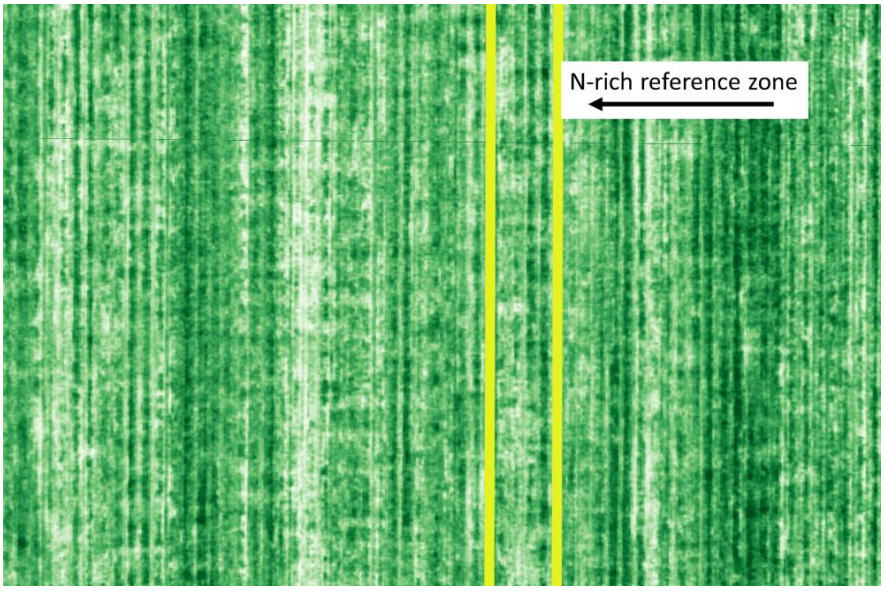


*Figure 1. Canopy NDRE measured 2/8/2022 indicating no difference in crop vigor between N-rich reference zone and the main field. The N-rich reference zone was created using an additional pass of the fertilize rig prior to planting, and is indicated by the area outlined in yellow.*

## SITE INFORMATION

**Location:** Yolo County
**Soil type:** Marvin silty clay loam
**Previous crop:** Sunflower
**Variety:** AP Octane
**Seeding method:** Grain drill
**Seeding rate**: 150 lb/ac
**Planting date:** 11/23/2021
**Bedded:** Yes (60-inch beds)

## Pre-plant N Management

**Field rate:** 109 lb/ac N
**N-rich zone:** 218 lb/ac N
**N Form:** pelletized urea

**Plant and soil measurements, fertilizer recommendations, and related management actions:**
On 2/8/22, the crop growth stage was estimated to be at 3.8 Feekes (mid-tillering). This indicates that crop N uptake was ~ 12% of the seasonal total at that point. Canopy reflectance was measured by a drone-based multispectral camera on 2/8/22 as well as well as by a Greenseeker handheld NDVI meter on 2/4/22. These measurements resulted in average sufficiency index (SI) values between 0.99 and 1.0. The 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. Therefore, the crop did not have any apparent signs of N deficiency at the tillering-stage. Soil nitrate in the top 1 ft. of soil was also measured on 2/4/22 using the soil nitrate quick test. These measurements indicated that ~46 lb/ac nitrate-N fertilizer equivalent was available in the top foot soil. Given this information and a yield and protein goal of 6,000 lb/ac and 11.5%, respectively, The Nitrogen Fertilizer Management Tool for California Wheat recommended an in-season N fertilizer application of 20 lb/ac N to maximize yield, but the likelihood of crop response to N fertilizer was uncertain. The grower applied 20 lb/ac N as fertigation during irrigation events totaling 4.5 in. between 2/11/22 and 2/24/22.

Monitoring of the crop continued via satellite imagery on 2/22/22 and 3/7/22, with no indication of crop N deficiency (SI ~ 0.99). On 3/8/22 the crop was approaching the boot stage with approximately 60% of the seasonal N uptake complete. Dry conditions had persisted, and the grower was considering irrigation via the subsurface drip system. The web-tool indicated that additional N fertilizer applied at this stage was unlikely to increase yield or protein given the recent SI measurements, the soil nitrate-N values measured in February and the preplant N rates. Positive control/counterfactual plots were established at a rate of 60 lb/ac N as urea applied ahead of a small (~0.5 in) rainstorm to assess whether the crop would have responded to N fertilizer. A drone flight was conducted on 4/13/22, and no differences in canopy reflectance were measured among the main field, the N-rich reference zones and the control plots.

OUTCOMES:

- In-season N fertilizer application recommendation
  - 20 lb/ac N
- In-season N fertilizer applied
  - 20 lb/ac N
- Yield
  - 5,524 lb/ac
  - No differences between field, N-rich zone, or positive control
- Protein
  - 10.9% (~ historical average)
- Crop N removal
  - 109 lb/ac N
- Total N fertilizer applied
  - Pre-season: 109 lb/ac N
  - In-season: 20 lb/ac N
  - Similar to historical N fertilizer management (i.e. 100 lb/ac N preplant; 0 - 50 lb/ac N in-season)

**End of season results:**

Overall, the season was dry, with rainfall between the months of February and June (when the vast majority of crop growth and development occurred) totaling 21% of the historical average (~6 in. less than normal for this location). Although the field was irrigated via subsurface drip, crop vigor was noticeably affected by proximity to the subsurface drip lines (see the vertical striping visible in Figure 1). Typically, this is an indication of crop water limitation in a field. Therefore, although subsurface drip irrigation was utilized early-on, crop growth and overall yields were likely still constrained by late-season water availability at this site.

The SI measurements recorded between February and April never indicated crop N deficiency. In addition, the February soil nitrate quick test measured a moderate amount of plant-available soil N, and this was followed by an additional application of 20 lb/ac N fertilizer during the subsequent irrigations in February. As such, crop productivity was not likely limited by N availability at this field. This conclusion is supported by the end of season measurements of yield and protein, which were equivalent among the main field, the N-rich reference zone, and the positive control plots established in March.

Of note is that the grower applied the majority of the fertilizer N budget preplant. N-rich reference zones are most effective as a diagnostic tool when the majority of the seasonal N budget is applied in-season rather than preplant. In addition, fertilizer applied in-season is more likely to be utilized by the crop compared to preplant N fertilizer. It is possible that the grower could have reduced total fertilizer use or further improved fertilizer use efficiency by applying a smaller proportion of the seasonal N fertilizer budget preseason.

Historically, in-season N applications for this grower range between 0 and 50 lb/ac N. The grower applied 20 lb/ac N in February and none in March. Overall, the use of the N-rich reference zone and in-season plant-soil measurements helped to confirm that a large crop response to in-season applications of N fertilizer was unlikely.

In-field monitoring indicated a low probability of crop response to in-season N fertilizer applications. The grower applied 20 lb/ac N in-season out of a typical in-season budget that ranges between 0 and 50 lb/ac N.