

N-Rich Reference Zone Case Study: Lassen CO. (Spring Barley) 2022

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Nitrogen (N) rich reference zones were implemented in a 33-acre barley field in Lassen County where grain yields and grain protein are typically 5000 lb/ac and 11%, respectively. This field is located on a silty clay soil with high organic matter and a high pH. Previously, this field was planted in alfalfa. In winter, rainfall averages less than 10 in. with minimal precipitation for spring cereal crops planting which are irrigated as needed.

N-rich reference zone creation:

Typical N management for this grower is to apply 60 lb/ac 11-52-0 (7 lb/ac N) as a starter fertilizer and top-dress 100 lb/ac N during the tillering stage of growth. The field was planted on 3/27/21 into moisture. On 4/20/22 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 an irrigation event on 4/20/21. N reference zones were established in parts of the field representing two different varieties that were being managed together.

Early season conditions:

After planting into moisture, there was no precipitation at the site and germination was inconsistent. After an April irrigation event of 6 in., additional seeds germinated, and there were barley plants of differing ages and stages of growth in the field. Spring precipitation was minimal (less than 0.5 in. after 5/1/22), but the crop's water needs were met through flood irrigation totaling approximately 18 in. across the season. As the stand progressed, later-germinating plants appeared to catch up to the earlier-germinating plants to some extent over the following weeks.

SITE INFORMATION

Location: Lassen County

Soil type: Humboldt Silty Clay

Previous crop: Alfalfa

Variety: Eureka

Seeding method: Grain drill

Seeding rate: 150 lb/ac

Planting date: 3/27/22

Pre-plant N Management

Field rate: 7 lb/ac

N-rich zone: 60 lb/ac

N Form: urea in N-rich zone

Plant and Soil Measurements:

In-season soil measurements were taken from the top 0-12 in. of the soil at the time of N rich reference zone establishment (4/20/21). [Soil nitrate quick tests](#) for these samples measured ~76 lb/ac nitrate-N fertilizer equivalent in the Humboldt silty clay soil. Additional soil samples were taken on 5/2/22 (subsequent to the irrigation event at the end of April) and the values averaged 32 lb/ac nitrate-N fertilizer equivalent. On 5/18/22 NDRE values were obtained from Planet satellite imagery and used to calculate 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



Figure 1. Stand of barley at the time of N application. The tarp was used to create a N exclusion zone/control plot where no fertilizer was applied. By this time the stand had begun to thicken up, and it was more uniform than after planting.

likely crop N deficiency. The field averaged a SI of 0.98 across the three N rich zones, indicating a weak signal, and no current sign of plant nitrogen deficiency. Another measurement of the soil nitrate quick test values from the top 0-12 in. of soil on 5/23/22 indicated that average nitrate-N fertilizer equivalent was similar (42 lb/ac) to the sample taken on 5/2. These values indicated that the crop was likely not deficient in nitrogen at that early growth stage.

Fertilizer recommendations and in-season management actions:

The grower decided to fertilize the field since it was being grown for a seed contract. The expected grain yield was 5,000 lb/ac at 11% protein. Given the yield goal, the in-season plant and soil measurements, the stage of growth (Feekes 3-4 tillering), and an approximate remaining crop N uptake of 100-113 lb/ac, [The Nitrogen Fertilizer Management Tool for California Wheat](#) recommended a 30-40 lb/ac N application rate. The model indicated that the crop would respond to a moderate amount of N fertilizer at this growth stage, even though a visual deficiency had not been detected. Some of the factors leading to this recommendation were the current soil nitrate level, along with the expected N uptake remaining to achieve the target yield. The model predicted that 40 lb/ac N applied at this stage would increase yield 396 lb/ac \pm 234 and protein 1.1% \pm 0.2%. The grower decided to apply 92 lb/ac N to the field (200 lb/ac urea) on June 1st. However, he was also interested in the model prediction. So, on one of the checks with the N-rich reference zone, he applied 46 lb/ac N; on another 69 lb/ac N, and on the last 92 lb/ac N to see if differences would result. The model predicted a 550 \pm 205 lb/ac yield increase and a protein increase of 2.3 \pm 0.2% with an application of 90 lb/ac N. These

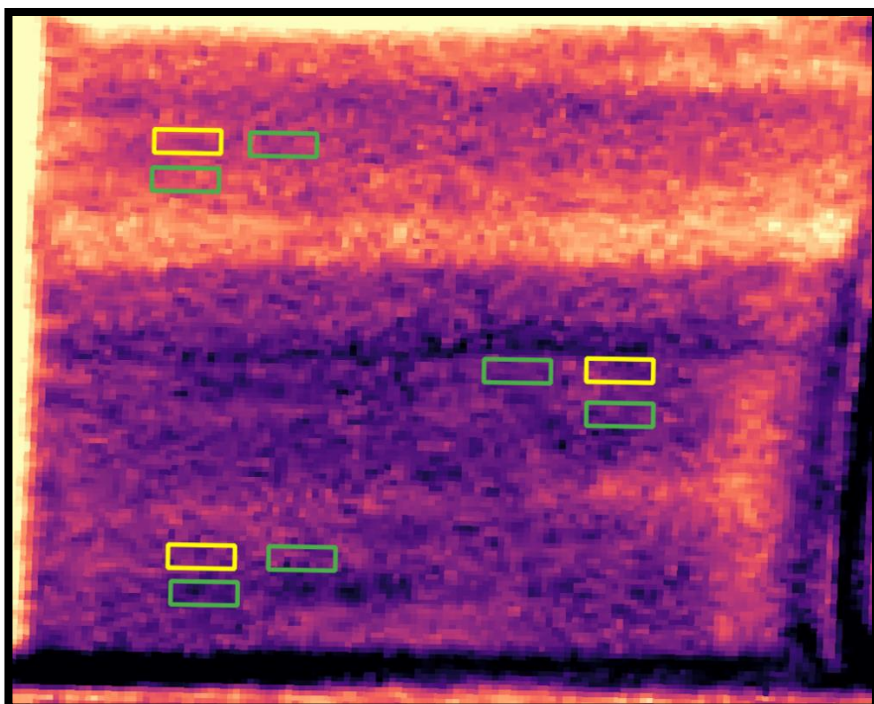


Figure 2. NDRE recorded on 5/18/22 via Planet Satellite imagery. N-rich zones (yellow) are not visibly different than the nearby field rate (green). The sufficiency index at this time averaged 0.98 across the three plots, indicating that the field was not likely nitrogen deficient at that point, which is expected following rotation with alfalfa. The lighter shade in the top of the image reflects a different variety, which is an example of why localized N-rich control zone are needed to interpret canopy reflectance/SI values.

OUTCOMES:

- In-season N fertilizer application recommended?
 - Yes: 40 lb/ac
- In-season N fertilizer applied by grower?
 - Yes: 92 lb/ac
- Forage Yield results
 - Field yield = 13,750 lb/ac
 - Yield increased 1600 lb/ac over the control plots as a result of the in-season N fertilizer application.
- Grain Yield Results
 - Field Yield 4,700 lb/ac
 - Yield increased 600 lb/ac
- Estimated crop N removal
 - 187 lb/ac Forage
 - 127 lb/ac Grain
- Total N fertilizer applied
 - Pre-season: 7 lb/ac
 - In-season: 92 lb/ac

predictions assumed the crop would not be water-limited. In line with this assumption, the crop was fully irrigated through harvest.

End of season results:

Both forage and grain yields were measured from the trial. Forage yield was estimated for 69 and 92 lb/ac N rates of fertilizer, and there were not statistical differences in yield between the two rates applied. Averaged across both rates, there was an increase in yield of 1600 lb/ac dry forage compared to the exclusion/control zones where no in-season N application was made (Fig 1.). In terms of grain yield, there were also no statistical differences between the three rates of fertilizer applied (but this was based on a limited sample size per rate, n=3). Averaged across all three rates, there was a 600 lb/ac increase in grain yield where N fertilizer was applied compared to the unfertilized exclusion/control zones.

In-season N fertilizer application increased yields within the range predicted by the web-tool. Yield of both forage and grain were higher than expected despite the lack of uniform germination in the stand due to early-season moisture limitations.