N-Rich Reference Zone Case Study: Lassen CO. (Winter-Triticale) 21-22

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Nitrogen (N) rich reference zones were implemented in a 45-acre triticale field in Lassen County where grain yields and grain protein are typically 6000 lb/ac and 11.5%, respectively. This field is located on a silty clay soil with high organic matter and a high pH. Previously this field had been planted into alfalfa for five years. In winter, typically 7 inches of precipitation (rain and snow) falls between October and March, with an additional 2 inches falling between April and May. The grower typically flood irrigates winter cereal crops 2-3 times as needed in the spring depending on precipitation and temperature.

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 during the tillering stage of growth. The field was planted on 10/14/21 and a large rainstorm occurred the following week, dropping 4.5 in. of rain before the end of October. On 12/8/21 three 90ft x 180ft N-rich reference zones were created after the crop had emerged. In each zone, 60 lb/ac N in the form of urea was broadcast with a belly grinder prior to a 4 in. precipitation event on 12/12/21. Local information was used to report precipitation events at this location because the large mountains and small valleys characteristic of this site reduce the accuracy of the web-tool's precipitation estimates.

SITE INFORMATION

Location: Lassen County
Soil type: Humboldt Silty Clay
Previous crop: Alfalfa
Variety: 719 Flex
Seeding method: Grain drill
Seeding rate: 150 lb/ac
Planting date: 10/14/21

Pre-plant N Management

Field rate: 7 lb/ac
N-rich zone: 60 lb/ac
N Form: urea in N-rich zone

Early season conditions:
In addition to the heavy rainfall at the end of October, there was a small storm in early November resulting in ~0.25 in. of precipitation. Germination was relatively uniform by the time the N rich zones were implemented on 12/8/21. Three storms throughout December brought snow and rain and the seasonal total was 10.5 in. by the beginning of January (6 in. more than average for that period). In contrast, there was less than 1 in. of precipitation between February and March, compared to an historical average of almost 4 in. during the same period. In addition, Snow Geese pressure was observed throughout the winter, with heavy feeding on the field multiple times. N rich zones appeared to have better regrowth after the snow geese grazed the fields throughout winter.

Figure 1. Nitrogen exclusion/control plot (center), with surrounding triticale crop showing a significant increase in growth after the addition of in-season N fertilizer application of urea in response to plant and soil measurements indicating probable crop deficiency.

Plant and Soil Measurements:
In-season soil measurements were taken from the top 0-12 in. of the soil on 3/1/22. Soil nitrate quick tests for these samples measured ~ 90 lb/ac nitrate-N fertilizer equivalent in the Humboldt silty clay soil. Heavy geese pressure was also observed at this time. Approximately

three weeks later (3/23/22), additional soil samples were taken and average values from the top 0-12 in. indicated approximately 35 lb/ac fertilizer equivalent nitrate-N. Canopy reflectance (NDVI) was measured via Sentinel 2 satellite on 3/20/22 at the early stage of tillering. 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 field averaged a SI of 0.8 between the three N rich zones indicating a strong likelihood of N deficiency (Figure 2).

Fertilizer recommendations and in-season management actions:
Crop response to in-season N application was likely if followed by sufficient rainfall plus irrigation to meet crop water demand. The grower typically irrigates fully, and chose to make an in-season application of N fertilizer at tillering ahead of a 6 in. flood irrigation. With an expected yield of a 6000 lb/ac at 11.5% protein, approximately 142 lb/ac N uptake remained in the season. Given the soil nitrate-N levels and the degree of plant deficiency measured from the crop canopy, The Nitrogen Fertilizer Management Tool for California Wheat recommended a N application of 90 lb/ac. The grower chose to apply 92 lb/ac as urea at tillering (4/1/22), and irrigation was used to incorporate the fertilizer due to the lack of rainfall. The web-tool predicted that 90 lb/ac N applied at this stage would increase yield 1143 lb/ac ± 299 and protein 1.4% ± 0.2%. This prediction assumes that the crop is not water-limited and that sufficient rainfall or irrigation would follow the application to both incorporate the N fertilizer into the soil and meet crop water demand during the rest of the season.

End of season results:
The crop was fully irrigated through the early-heading stage, and was growing quite prolifically. Given the seasonal price for hay, the grower chose to cut the field for hay, but left test plots to go to grain. However, these test plots did not receive an additional irrigation at the moisture-sensitive flowering stage, as it would have been logistically impossible as the rest of the field was being hayed. There was less than 1 in. of rainfall after 5/1 at the field. Both forage and grain were harvested for yield.

The in-season application of 92 lb/ac N fertilizer increased forage yields 3643 lb/ac ± 1342 compared to control zones where this application was excluded. In contrast, grain yields and were not significantly different from the exclusion zones, and this was most likely due to the lack of adequate moisture available during anthesis and grain filling stages of growth. Of note is that grain N concentration and total N uptake were higher than the control. This demonstrates that when water is the limiting factor, additional nitrogen may not lead to an increase in yield even if it results in higher N uptake by the crop. In all, the grower applied 99 lb/ac N in a budget that typically includes the majority of fertilizer being applied at tillering during the spring. High forage yields were achieved, and N supply and removal were closely aligned, which is an important objective of sustainable N management.

OUTCOMES:

- In-season N fertilizer application recommended?
  - Yes: 90 lb/ac
- In-season N fertilizer applied by grower?
  - Yes: 92 lb/ac
- Yield results (forage)
  - Field yield = 20,902 lb/ac
  - Yield increased 3,643 lb/ac over the control plots
- Yield results (grain)
  - Field yield=3,525 lb/ac
  - Yield did not increase as a result of in-season N fertilizer addition due to of lack of moisture during grain filling.
  - N uptake increased
- Estimated crop N removal
  - 129 lb/ac Forage
  - 107 lb/ac Grain
- Total N fertilizer applied
  - Pre-season: 7 lb/ac
  - In-season: 92 lb/ac

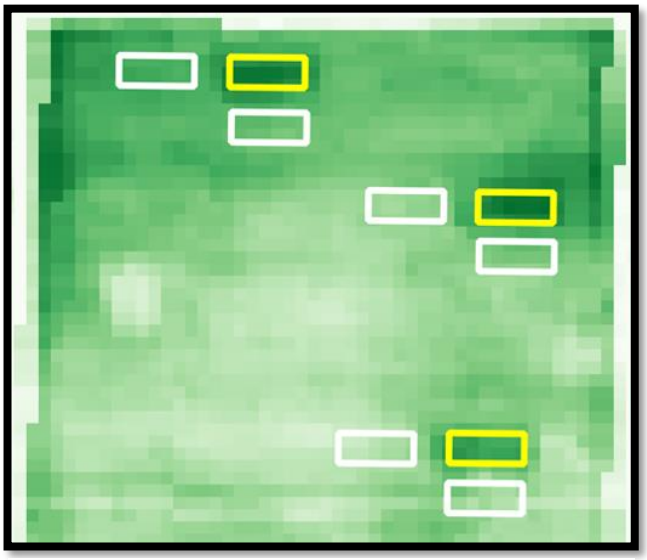

Figure 2. NDVI recorded on 3/20/22 via Sentinel 2 satellite data indicating increased crop vigor in N-rich zones (yellow boxes) relative to nearby field rate (white boxes) in each of the three N-rich reference zones.

The 92 lb/ac N rate (200 lb/ac urea) applied in-season resulted in a 1.8 ton/ac increase in forage. Even with the high cost of fertilizer ($1,400/ton urea), at current hay prices this resulted in a net increase in crop value of $450/ac (after subtracting fertilizer costs).