UNIVERSITY OF CALIFORNIA
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N-Rich Reference Zone Case Study: Yolo 2019-20

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A Nitrogen (N) rich reference zone was created in a rainfed wheat field in the Hungry Hollow area of Yolo County (north of Esparto).

N rich reference zone creation:

- The field was fertilized and disked with the equivalent of 26 lb/ac N in the form of composted poultry manure.
- Pre-plant soil samples taken from the top 1 foot of soil on 11/20/20 (after poultry manure application) indicated a fertilizer N equivalence of 13 lb/ac nitrate-N.
- One 90ft x 180ft N-rich reference zone was fertilized with an additional 60 lb/ac N in the form of pelletized urea applied on 11/23/19 ahead of a rainstorm that resulted in 0.33 in. of rain.

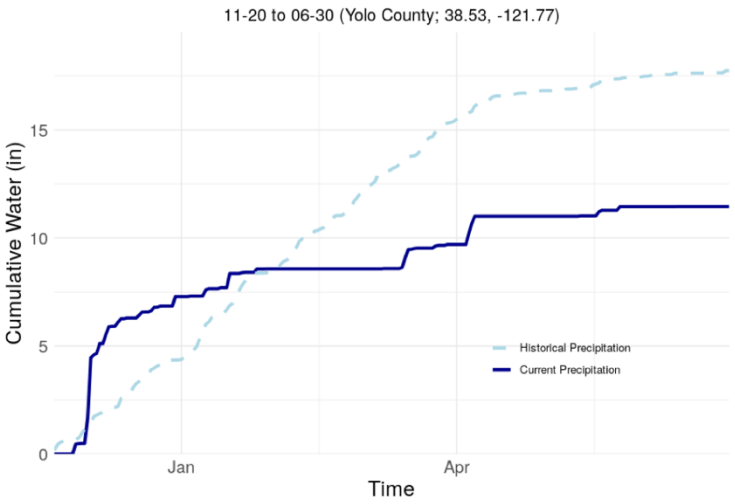

Figure 1. A graph showing the accumulation of precipitation over the course of the season. The dark blue lines shows the long periods of drought that the crop experienced this season compared to the historical precipitation patterns (light blue, dotted line).

SITE INFORMATION

Location: Yolo County
Soil type: Marvin silty clay loam
Previous crop: Oats and peas for hay
Variety: Patwin 515
Seeding method: Seed drill
Seeding rate: 900,000 plants/ac
Planting date: 11/20/20
Bedded: No

Pre-plant N Management

Field rate: 26 lb/ac N (poultry manure)
N rich zone: 86 lb/ac N (poultry manure + 60 lb/ac N as urea)

Plant and Soil Measurements:

- Early in the season (December) Italian ryegrass pressure was higher in the N-rich reference zone than in the surrounding field. Italian ryegrass seedlings in the N-rich reference zone, likely capitalizing on the extra N available, covered about 40% of the soil surface (wheat canopy cover was roughly 30%), whereas Italian ryegrass seedlings in the field coverd roughly 15% of the soil surface (wheat canopy cover was roughly 20%).
- NDVI measurements were recorded from the N-rich reference zone and the surrounding field using both drone imagery and handheld devices on 1/14/20 and 2/13/20, respectively. 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.

- In late January and mid-February, the SI values were 0.84 and 0.79, respectively. This means that the canopy in the N-rich zone was greener and/or fuller than the field rate area, and that the nitrogen status in the rest of the field was likely deficient.
- There was no rainfall from 1/27/20 until 3/14/20.
- Soil moisture during this time declined by 50%, meaning most of the available water had been transpired or evaporated.
- Plants were stressed due to a lack of rain during the rapid growth phase (Feekes stages 6-10: From 1st node to boot stage). Beyond reducing growth through a lack of moisture, this would have also reduced plant capacity to take up N.
- During the rapid growth phase (where nitrate uptake is highest), soil nitrate was low (~13 lb/ac nitrate-N as of 2/14/20) in both the N-rich reference zone and the rest of the field.

OUTCOMES:

- In-season N recommendation
  - 55 lb/ac N
- In-season N fertilizer applied
  - 50 lb/ac N
- Yield
  - 1451 lb/ac (41% historical avg.)
  - No difference between field and N-rich zone yields
- Total N fertilizer applied
  - Pre-season: 26 lb/ac N
  - In-season: 50 lb/ac N
  - This is typical N management for this grower

Fertilizer recommendations and in-season management actions:
Prior to a rainfall event forecast in early March, the grower applied 50 lb/ac N as UAN32 to the soil surface on 3/6/20. A yield increase of 340-650 lb/ac would be expected at these rates if followed by sufficient rainfall to incorporate the N fertilizer and meet crop water demand during the rest of the season. This is based on a SI value of 0.81 on 2/27/20 (indicating likely deficiency), soil nitrate fertilizer equivalent of 13 lb/ac nitrate-N in the top foot of soil, a yield and grain protein expectation of 3500 lb/ac and 12%, and approximately 40 lb/ac of N uptake remaining on 3/6/20. After the N application on 3/6/20, no rain fell until 3/14/20, and it is possible that some portion of the N applied was lost to volatilization. From 3/14/20 to 4/7/2020, the field received 2.3 in. of rain, which was slightly lower than the 2.5 in. historical average during the same period.

End of season results:
There were some visual differences between the N-rich reference zone and the rest of the field. Plants appeared to have senesced earlier and were darker and more dried out at harvest (June) in the N-rich reference zone. It is difficult to identify exactly what caused the earlier senescence, but it may be related to the initial rapid growth rate of the crop/weed population in response to pre-season applications of additional fertilizer in the N-rich reference zone. Despite this visual difference, there were no significant differences in yield between the different fertility management zones. In addition to the duration of the early-season drought period, low overall seasonal rainfall reduced yields by around 60% compared to averages. The severe lack of soil moisture meant that soil N status was secondary to drought stress. That is, because plants were water limited they were unable to use the additional fertilizer N, and therefore there were no differences among fertility management zones. This site demonstrates how drought conditions and weed pressure can reduce the predictability of N decision support tools in a rainfed field. Decision support tools require the use of a yield estimate but the estimates used ended up being too high (anticipating late-season rains, the expected yield on 3/6/20 was 3500 lb/ac; actual yield was 1451 lb/ac).

Image 2. A picture showing a darker N-rich reference zone (foreground) and the rest of the field (background). Note the differences in color in the N-rich reference zone. This is likely due to early senescence that may have been linked to rapid growth early in the season and/or higher weed pressure in the N-rich reference zone.

Nevertheless, even in this scenario, in-season fertility management reduced N applications. The reason is that the grower typically expects yields closer to 4000 lb/ac in this field. In contrast to pre-season N application, which typically use N rates that target average yields, the in-season N rates were based on a combination of grower intuition and in-field data. This allowed for an adjusted yield estimate following the drought conditions and thereby reduced the amount of unutilized N lost to the environment.