NITROGEN MANAGEMENT IN WINTER WHEAT

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IN OUR GRIT, OUR GLORY.

Nebraska Extension

Know how. Know **now**.

EC143

Nitrogen Rate (lbs/acre) = ((N Price / Wheat Price) + (NO_3-N/68.7) - 0.235)*-725

Where:

- N Price is dollars per lb of fertilizer nitrogen,
- Wheat Price is in dollars per bushel of wheat

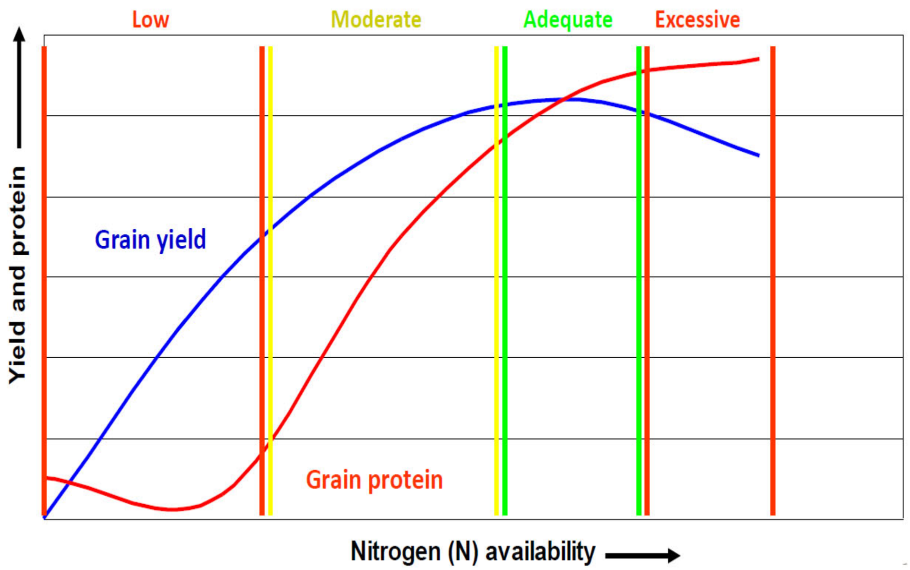
NO_3-N is the average parts per million (ppm) nitrate-nitrogen in the top three or four feet.

N rate (lbs N/acre)
=[(0.4/6.4) + (5/68.7) – 0.235] x (-725)
=72

Recommended nitrogen rates are adequate for dryland yields across the state unless producers expect yields above 75 bushels per acre above which an additional 20 lb of nitrogen per acre should be applied.

If higher grain protein is the goal about 20 lbs N/acre additional N be top-dressed in the spring for each 1% increase, up to a max of 40 lbs/acre.

Nebraska Winter Wheat Production: > 1 m tons
Harvested area: 850,000 acres
(USDA-NASS, 2020).
UNL Winter Wheat Fertility Recommendation: https://extensionpublications.unl.edu/assets/pdf/ec143.pdf

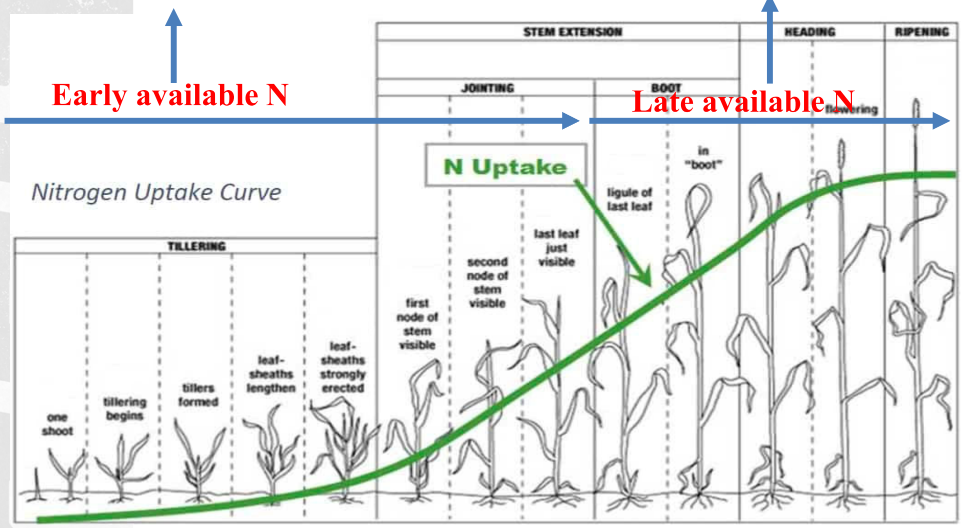


W. Pan & R. Koenig
Adapted from H. Tao 'Managing Nitrogen for Yield and Protein in winter'

There exists an Inverse relation of grain yield and grain protein at low N availability
N availability lower than crop need can compromise the crop yield and quality while higher N supply potentially leads to environmental problems (Singh et al., 1995)
N management based on crop needs is required for better agronomic production and lower impacts on the environment (Yousaf et al., 2016; Goulding et al., 2008)

- Grain Yield : Number of Tillers and kernels/head
- Grain Protein : Remobilized N from vegetative parts

- Increase weight/kernel
- Most N utilized in protein formation



S.A. Ebelhar, University of Illinois

OBJECTIVES

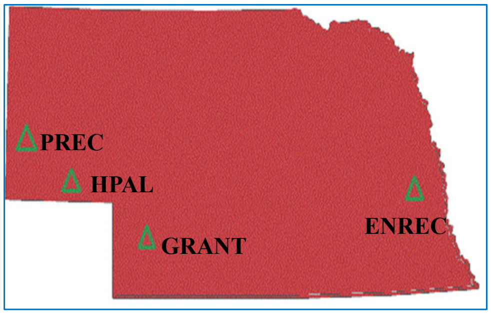
1. To evaluate the effects of different nitrogen rate and application timing on grain yield and protein content of hard red winter wheat across Nebraska.

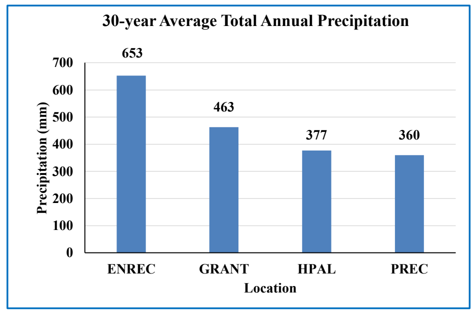
2. To assess the potential of active crop canopy sensor to detect N status and estimate grain yield and protein of winter wheat at different growth stages and growing environments.

Experimental Locations

- **4 locations across Nebraska**
  - ❑ Eastern Nebraska Research and Extension Center (ENREC), near Mead, NE
  - ❑ Henry J. Stumpf International Wheat Center (GRANT), near Grant, NE
  - ❑ High Plains Agricultural Lab (HPAL), near Sidney, NE
  - ❑ Panhandle Research and Extension Center (PREC), Scottsbluff, NE

- Two-year experiment: 2018/2019 (Year 1/ 18) and 2019/2020 (Year 2/ 19)





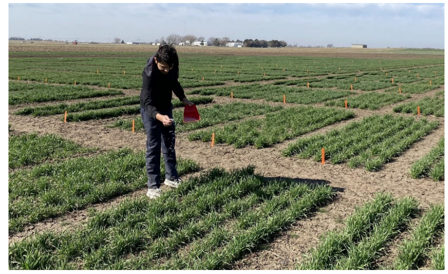
Experimental Design

- Split Plot Randomized Complete Block Design

  Main plot factor: Cultivars ('Ruth' and 'Freeman')

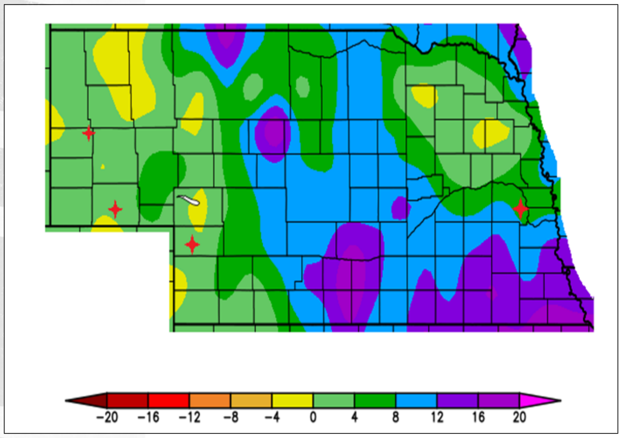
  Subplot factor: Combination of:
  - 6 N Rates – 0%, 25%, 50%, 75%, 100%, and 125% of recommended N rate
  - 3 N application timings
    - 100 % in fall (two weeks after planting)
    - 100 % in spring (Feekes GS 5 -late tillering)
    - Split in between fall (30%) and Spring (70%)

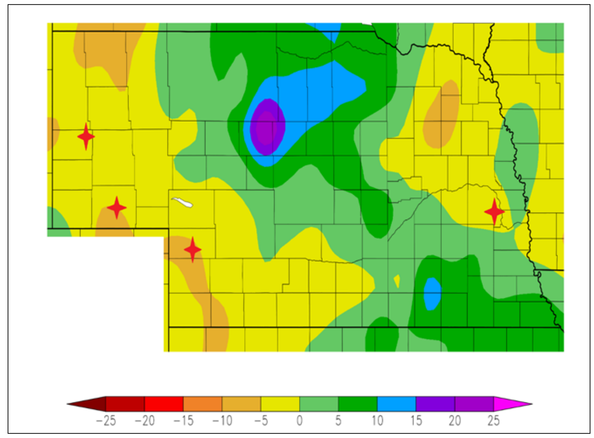
- Recommended N rates: 80 lb N ac^{-1} as 100% at ENREC
  60 lb N ac^{-1} as 100% at other sites



Recommended N rate calculated using UNL N Rate Algorithm (Hergert and Shaver, 2009)
Additional N at ENREC considering higher yield potential due to favorable growing environment
N Fertilizer Source: Ammonium Nitrate (34-0-0)
P fertilizer applied wherever soil test results for P were low
Fertilizer Application Method: Manually applied via surface broadcast
Pre-plant and spring application of herbicides as necessary to control weeds
Spring application of fungicide at GRANT in Year 1 and at ENREC in Year 2
Higher seed rate at ENREC (2.44 Million seeds per ha) for higher yield potential and at other sites seed rate = 2.06 million seeds per ha

Departure from Normal Precipitation (Sept-Jul)



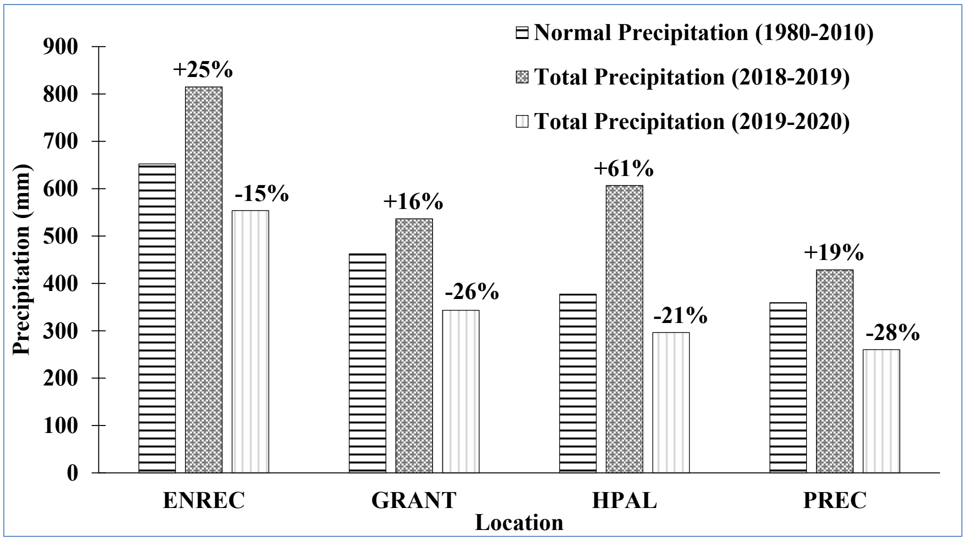


NOAA Regional Climate Center

There are promising experiments from other states that report improved grain yield and grain protein content at a higher rate of N fertilizer in rainfed environment (Brown et al., 2005; Mohammed et al., 2013; Romero et al., 2017) However, little research has been done to evaluate the effects of different N rates and application timing on grain yield and protein content of HRW wheat in Nebraska.

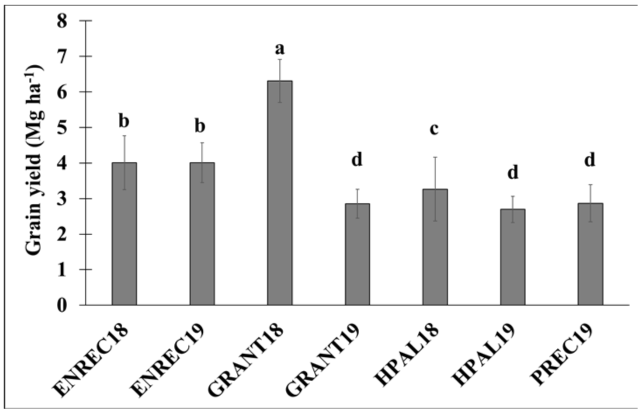
Determination of optimum rate and timing of N application specific to region and that accounting for weather is important from agronomic, economic and environment perspectives.

Weather

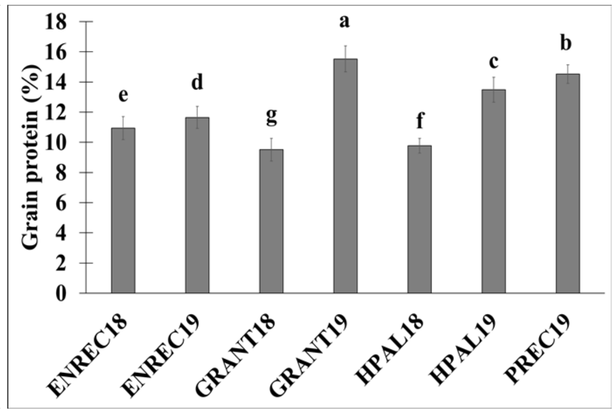


The values of the top of the bar shows the % of additional precipitation at respective years than that of Normal Precipitation.

Grain Yield and Protein



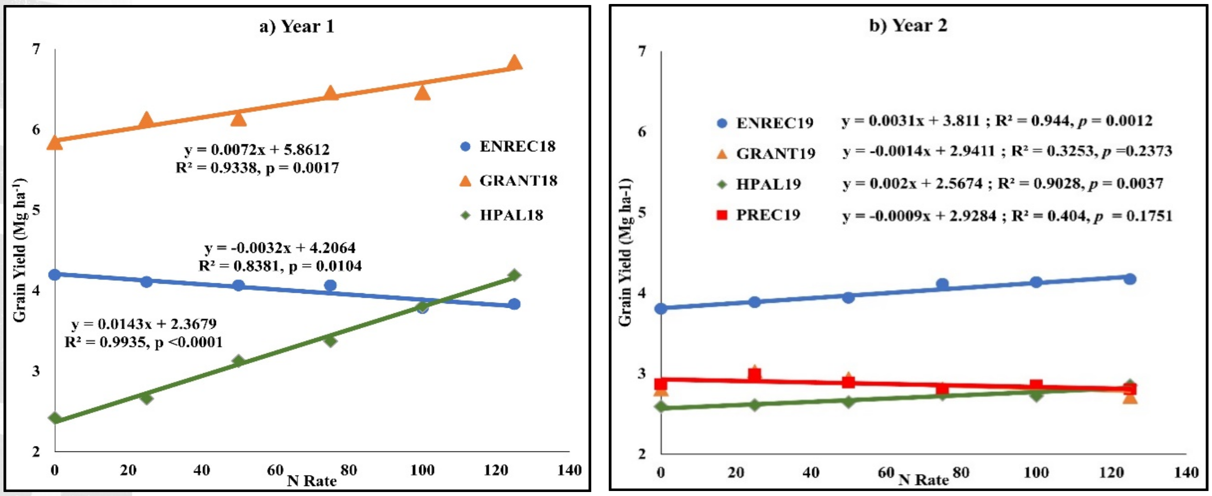
Mean grain yield at different site-years. (Bars with different letter differ significantly from each other at *P*<0.05)



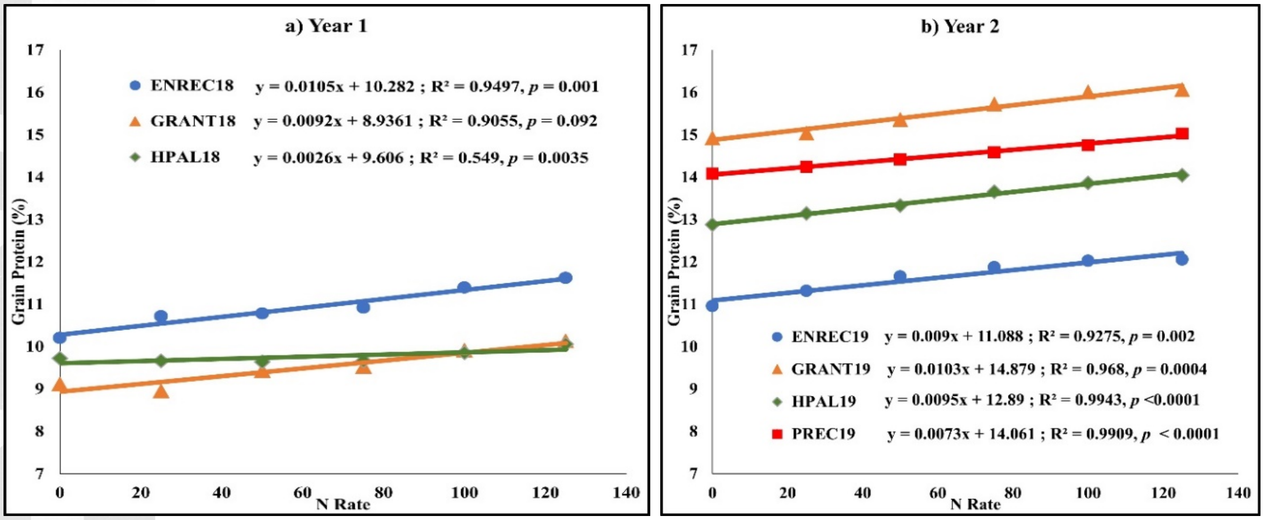
Mean grain protein at different site-years. (Bars with different letter differ significantly from each other at *P*<0.05)

1 Mg/ha=14.9 bushels/ac of wheat.

Grain Yield vs N rate



Grain Protein vs N rate



There was a Negative Correlation between Grain yield and Grain protein

Post-harvest Soil Test

N rate (%)	ENREC18	ENREC19	GRANT18	GRANT19	HPAL18	HPAL19	PREC19
		kg N ha^{-1}					
0	28.0	53.1^{b}†	45.8	131.1	19.2^{b}	43.9^{b}	219.8
75	34.9	75.4^{b}	49.8	155.0	17.3^{b}	51.1^{ab}	230.0
100	33.5	110.0^{a}	51.5	100.2	20.1^{ab}	67.7^{a}	261.0
125	32.2	101.7^{a}	53.9	112.8	26.5^{a}	63.6^{a}	294.7
P- value	0.5098	**<0.0001**	0.6867	0.1387	**0.0419**	**0.0287**	0.5248

SUMMARY

- Winter wheat yield response to applied N rates was evident in the year with above average precipitation (wet year).
- There was no yield advantage to spring and split N application over fall except for one site-year out of seven.
- Application of N increased winter wheat grain protein content in both dry and wet years.
- In a dry year, grain protein content was elevated in an inverse reciprocation to the reduced grain yield.

CONCLUSION

- Variation in yield and protein response to N input due to weather effects
- Split application compared to all N in fall might be beneficial.
- No plateau observed for yield response to incremental N – infers revision in current N recommendation rate
- Crop sensors work better in site-years where there is grain yield and protein response to N
- Intensive field experiments will be required to determine the best growth stage for measurement of canopy reflectance, to test multiple vegetation indices, and to develop functional algorithm for in-season N management.

Weather affects so much for yield response to N input, - this underscores the value of having spring application – if you decide in fall, no luxury to decide in spring – weather tool, split application useful
Yield response did not plateau at all- suggesting, due to improvement in cultivar yield potential over years – N recommendation rate should be revised
Crop sensors work better in wet year than dry yeas in Eastern Nebraska

ACKNOWLEDGMENTS

IANR ARD Wheat Innovation Fund
Nebraska Wheat Board

Deepak Ghimire | Nathan Mueller |Yeyin Shi |Cody Creech |Rex Nielsen
Amanda Easterly |Dipak Santra |Brian Maust |Teshome Regassa |Devin Rose | Stephen Baenziger

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