Evaluating the Effects of Droplet Size and Nitrogen Rate on Protein Content of Hard Red Winter Wheat

Ethan C. Wyatt[1], Jeremiah Mullock[1] William R. Raun[1], and Randy K. Taylor[2]

[1]Department of Plant & Soil Sciences, Oklahoma State University and [2]Bio-Systems & Agriculture Engineering, Oklahoma State University

Introduction

- Hard red winter wheat is grown extensively in the Great Plains region which accounts for 40% of the total wheat grown in the U.S.
- Grain protein concentration (GPC) levels determine the degree of milling and baking quality of processed wheat products and price
- In past years, grain protein levels have been highly variable from one location to the next due to environmental and genetic factors (Kramer, 1978)
- As of November 30, 2010, marketable grades of HRWW must contain a protein level of at least 11% or a 10 cent dockage to the contract price with a protein level of 10.5% (KCBT, 2010)

Literature Review

Research conducted on late-season top-dress N as either dry of liquid material has shown an increase in GPC (Woodward and Bly, 2003)

Woolfolk et al., (2002) reports GPC was increased with late season foliar N applications before and immediately following flowering

According to Mercer (2007), decreasing the size of the droplet leads to an increase in uptake of the active ingredient and increasing the spread area of the droplet is found to increase the uptake of active ingredient

Objective

- The objective of this study is to evaluate the effects of adjuvant, droplet size, and foliar N rate on wheat grain protein and yield

Methods & Materials

Research Sites

- Efaw (Stillwater, OK)
  - Norge silt loam (fine-silty, mixed, thermic Udic Paleustolls)
- Perkins, OK
  - Konawa fine sandy loam (fine-loamy, mixed, active, thermic, Ultic Haplustalfs)
- Lake Carl Blackwell (West of Stillwater, OK)
  - Port silt loam (fine-silty, mixed, thermic Cumulic Haplustolls)

Design & Treatments

- Treatments were arranged in a RCBD with 3 replications and ten treatments with alleys positioned between every other plot
- Foliar N rates, 11.2 and 22.4 kg N ha^{-1}, were applied post-flowering
- Using the ASBAE Standard 572.1, three droplet sizes: fine, medium, and coarse were used for each N rate
- The 11.2 kg N ha^{-1} rate included an adjuvant and non adjuvant mixture per droplet size
- Foliar N rate and droplet size were controlled by: using a pressure valve, nozzle tip type, and a speedometer on the ATV
- Grain yield, GPC, grain N uptake and flag leaf total N were analyzed by using PROC GLM. Single degree of freedom contrasts and mean separation using Least Significant Difference were used to analyze treatment effects

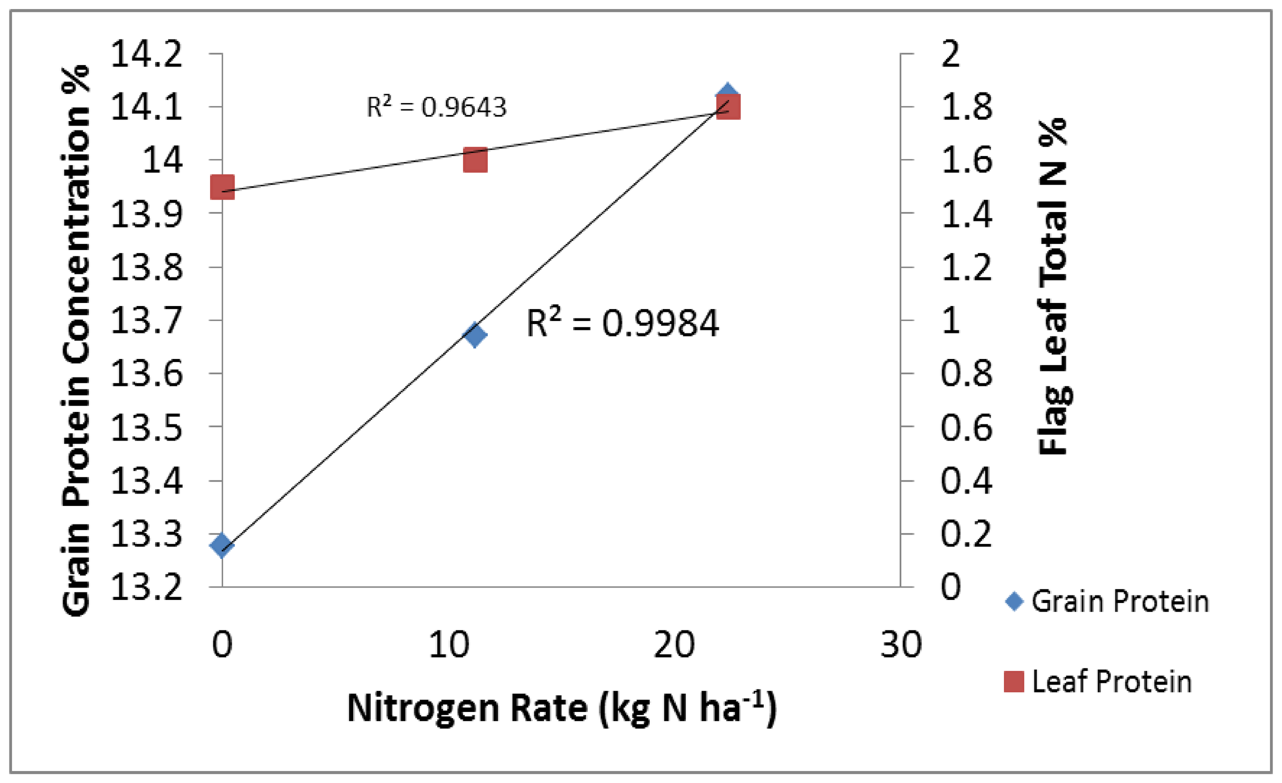

Figure 1. Relationship of flag leaf total N and GPC with foliar N rate, Efaw, OK, 2012. GPC showed a significant linear response to N rate.

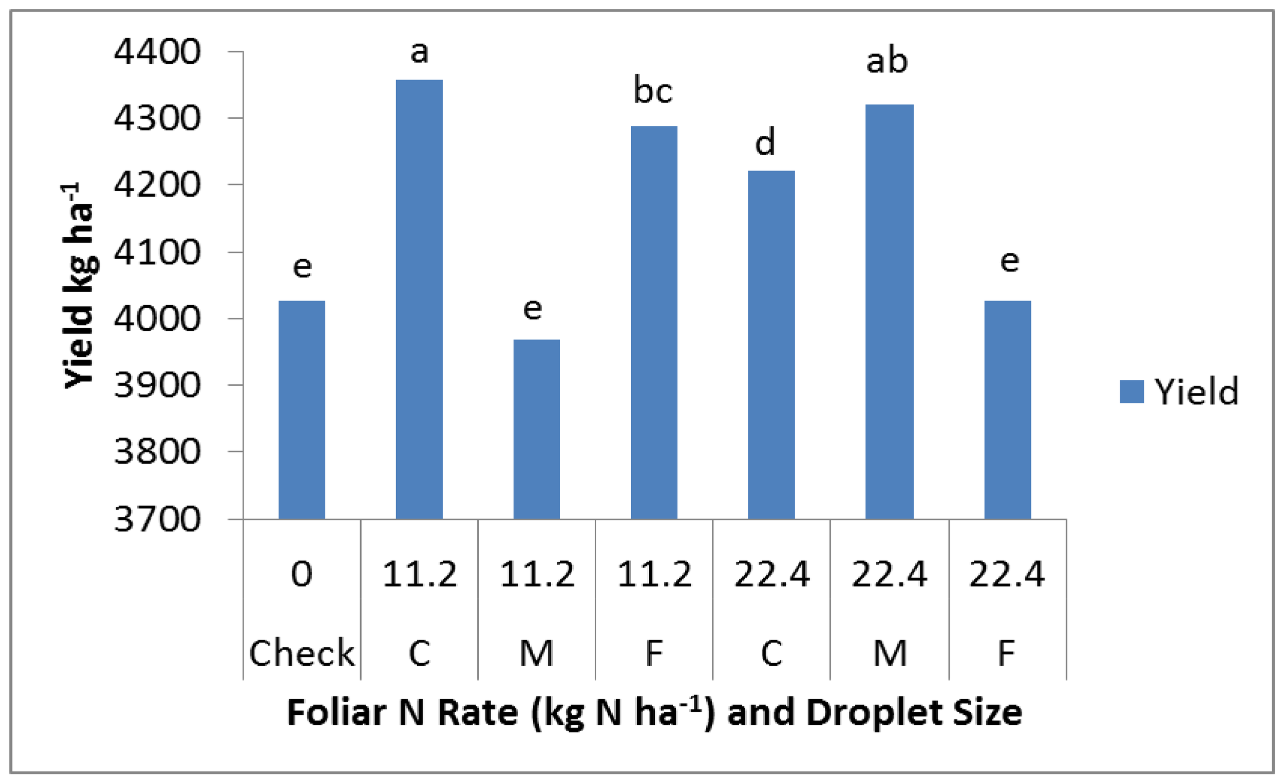

Figure 2. Treatment comparisons for grain yield as influenced by the interaction of droplet size and foliar N rate, LCB, OK, 2013. [a] denotes significant difference in means by LSD $_{.05}$ = 60 kg ha^{-1} .

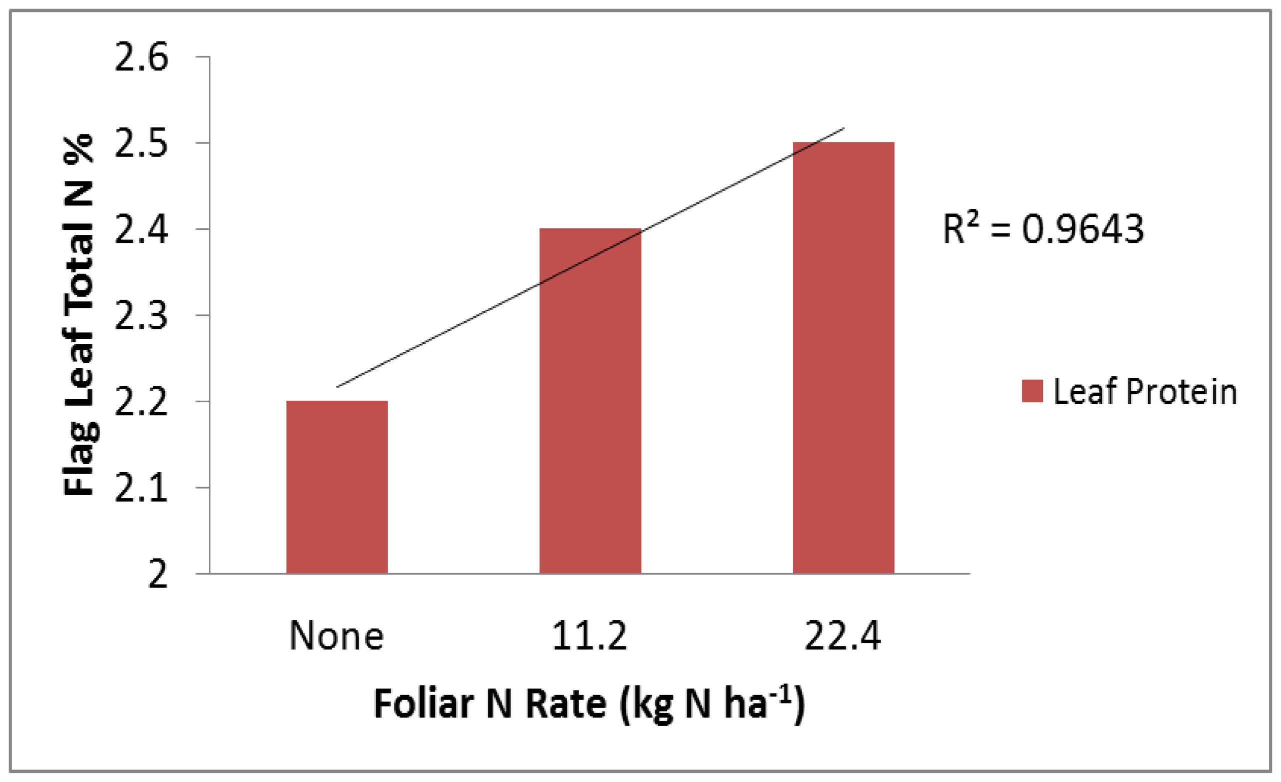

Figure 3. Flag leaf total N showed a significant linear response to increased rates of foliar N, LCB, OK, 2013.

Treatment Foliar N kg ha^{-1}	Droplet Size	Adjuvant	Means Yield kg ha^{-1}	Protein %	N uptake kg N ha^{-1}	Leaf Total N %
0	None	No	4027	12.65 g	89.03	2.2
11.2	Fine	Yes	4013	14.70 a	103.00	2.5
11.2	Medium	Yes	3978	14.40 ab	100.23	2.5
11.2	Coarse	Yes	4299	14.30 abc	107.82	2.5
11.2	Fine	No	4563	14.00 abcdef	111.90	2.4
11.2	Medium	No	3955	13.44 bcdefg	93.12	2.4
11.2	Coarse	No	4416	13.61 abcdefg	105.40	2.4
22.4	Fine	No	4026	14.25 abcd	100.48	2.4
22.4	Medium	No	4321	14.14 abcde	107.30	2.4
22.4	Coarse	No	4221	13.20 cdefg	97.39	2.3
		LSD$_{.05}$	NS	1.11	NS	NS

Table 1. Treatment means for grain yield, grain protein , grain N uptake, and flag leaf total N, LCB, OK, 2013. [a] denotes significant difference in means by a LSD$_{.05}$.

Figure 4. Nozzles used in the droplet size and nitrogen rate experiment donated by Gary James at HYPRO Global Spray Solutions.

Figure 5. Foliar N burn was more frequent over all treatments in 2013. On the left shows the increased signs of foliar N burn compared to the right where no foliar N was applied.

Figure 6. Foliar N application was applied with an ATV mounted with a 3.05 m offset spray boom and nozzles 50.8 cm apart.

Results & Conclusions

- For most locations and years GPC was increased linearly with higher rates of foliar N applied
- When compared to the check, late season foliar N application can improve grain protein by up to 2.0%
- Use of the fine droplet size with a foliar N rate of 11.2 kg N ha^{-1} with an addition of an adjuvant resulted in the highest GPC
- This technique generally is only needed in high yielding environments (irrigated or high rainfall areas)
- This work suggests that more emphasis should be placed on protein prediction and improving mechanisms to efficiently move foliar N into the plant

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