

# The effect of nitrogen application timing on grain yield and protein content in Long-term Winter Wheat Fertility Studies in Oklahoma

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## Introduction:

For wheat, nitrogen (N) is a limiting factor. High yields and high protein content result from proper N management timing and rates. When appropriately applied, N can increase agricultural yields and nitrogen use efficiency while reducing costs and N losses in the environment. However, determining the optimum rate is a challenge, especially at the time of planting. While an in-season application allows for the use of more precision ag (PA) tools, growers have been reluctant to move to the top-dress N timing as the primary application. This work reviews the body of research from the OSU soil fertility program to evaluate the opportunity to apply all N in-season allowing for more site-specific, growing season specific data to be collected and utilized.

## Methodology:

- We collected the results of nine research studies carried out in 49 locations in Oklahoma from 2017 to 2022;
- For each site, we examined the effect of an equivalent rate in the two different timing applications (all N pre-plant and all N applied top-dress) on grain and protein content;
- All the experiments design were randomized block designs (RCBD) with at least 3 replications. Sources of N varied, including UAN, Urea, and  $\text{NH}_4\text{NO}_3$ ;
- The in-season application was considered any application made after spring green up to jointing. All in-season applications analyzed were applied at the Feekes 5 to Feekes 6 growth stages;
- Wheat yield and grain protein content responses to application timing were statistically analyzed using SAS software.



## Support and References

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## Results and Discussion

Table 1: Percentage of sites that responded to N application, and percentage of sites that had better grain and protein in Pre-plant and In-season

Sites responded to N application	Pre-plant > In-season		In season > Pre-plant	
	Grain	Protein	Grain	Protein
	95.92%	0%	31.91%	59.57%

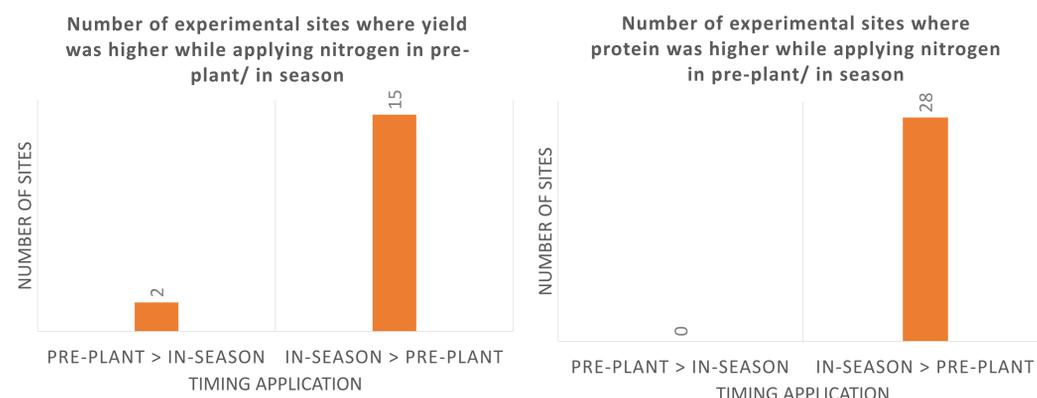


Figure 1: Number of experimental sites where yield and protein were higher in the Pre-plant and In-season

- This work results were consistent with the research of Adeyemi and al., (2020) and Abedi and al., (2011): They also observed that the highest value of grain yield when N was applied through vegetative growth stage for both wheat and corn;
- Dhillon and al., (2020) found as well that top dress application and split application led to a higher grain protein concentration;
- However, Kostić and al., (2021) detected a low and unstable impact on wheat performance while applying N in the spring ( in-season application);
- This work also conflicts with Haq and al., (2022) and Sohail and al., (2018), who stated that N applied at equal split doses before sowing and during wheat growth led to higher protein concentration.

## Conclusion

- Not only N could be delayed and yield not be sacrificed, but when delayed to the in-season application, the yield and protein content were equal to or greater than pre-plant in the majority of the studied sites;
- These results provide solid scientific evidence that N application can and maybe should be delayed;
- More importantly, this means that the application of N can be delayed so that plant, soil, and environmental data may be collected so that more information and more PA tools may be utilized to improve the nitrogen use efficiency and economic viability of the farmers;
- This review directly supports the use of N-rich strip for the determination of in-season Timing N application rates in Oklahoma winter wheat production.