USING WET DISTILLERS GRAINS AS A FERTILIZER IN CORN AND SPRING WHEAT

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ABSTRACT

Wet distillers grains (WDG), derived from corn grain as a by-product of ethanol production, has high market value as livestock feed. Therefore, despite its nutrient profile which would make it a suitable fertilizer for crop production, it is not normally profitable to use it for that purpose. However, occasionally there is a surplus of distillers by-products, particularly the ones with high moisture content and low storability such as WDG, which become available to local crop producers at very low prices or no cost at all.

In Carrington, North Dakota, a total of nine site years were used to test WDG as a nutrient source for wheat and corn between the years of 2015 and 2026. Six of those were used to test WDG as a phosphorus source compared to tripe super phosphate (TSP) in spring wheat and corn, and three site-years were used to test WDG against urea as a source of nitrogen in corn. As a phosphorus source, WDG consistently performed the same or better than TSP, however, evaluating WDG as a nitrogen source was limited by an overall lack of nitrogen response in all three sites.

INTRODUCTION

Over 5 billion bushels of corn are used to produce fuel ethanol each year in the United States (U.S. Department of Energy). The starch from the corn kernel is converted to ethanol during fermentation, but there are three valuable by-products also produced: corn oil, carbon dioxide and distillers grains. Distillers grains are essentially what remains of the corn kernels after those other components are removed, leaving the proteins, some fats, fibers and minerals behind. These by-product are high in protein and energy and are usually sold as feed for cattle and swine. Distillers grains are available as dry distillers grains at around 10% moisture, wet distillers grains or wet cake (~60% moisture), modified distillers grains (~50% moisture) or distillers syrup (~70% moisture). While their nutrient composition would make them suitable for use as a fertilizer (Yuja & Teboh 2021), due to their high value as feed, they are normally too expensive to consider using them as nutrients for crops. Dry distillers grains (DDG) has the highest value because its low moisture content allows it to be stored easily, whereas the WDG, syrup and modified distillers grains have to be used shortly after purchase. In some instances, ethanol plants end up with a surplus of these high moisture products that they are willing to give away at very low prices or at no charge to nearby crop producers. This can sometimes happen with DDG as well if it is contaminated with aflatoxin and therefore unsuitable for feed (Buenavista et al. 2021).

These are real-life scenarios in which farmers look for guidance on proper application rates and find that there is very little information available to them, particularly in the form of recommendations.

A study in Missouri (Nelson et al. 2009) looked at using DDG as a nitrogen source. Aside from that, the only field studies done with distillers grains and specifically WDG were conducted by researchers at North Dakota State University in the United States (Wiederholt 2008, Ransom & Teboh 2017, Lovering 2017, Teboh et al 2018). These studies looked at the use of distillers grains as a nitrogen and as a phosphorus source comparing it to urea and TSP respectively. To date, the data from these studies have not been published in a comprehensive report. In this paper, discussion will be limited to the use of WDG even though other forms of distillers grains have also been tested, and it will also be limited to field studies done in corn and wheat.

MATERIALS AND METHODS

All field studies were conducted at the Carrington Research Extension Center in Carrington, North Dakota, on Heimdal-Emrick loam soil using a randomized complete block design. WDG was obtained from North Dakota-based ethanol plants and samples underwent complete nutrient analysis in order to calculate product application volumes. The nutrient analysis of WDG varied considerably from year to year; Per ton of fresh WDG, nitrogen ranged from 32 to 52 pounds, phosphate between 14 and 43 pounds, and potash between 11 to 31 lbs (Yuja & Teboh 2021). The carbon to nitrogen ratio was ranged between 9 and 11 to 1 over the years. WDG treatments were hand-applied fresh (as is) to 10 x 25 ft^2 plots. Granular treatments were also hand-applied. Treatments were incorporated after application with a cultivator. Nutrients other than the one being tested were equalized among treatments at all site-years except 2026, when nutrient other than nitrogen were uniformly over-applied in order to better isolate the effect of nitrogen.

Wet Distillers Grains as a Phosphorus Source

From 2015 to 2019 there were four site-years of studies using WDG as a phosphorus source compared to TSP in wheat, and two studies in corn (2015 and 2017). WDG was compared to TSP as a phosphorus source at the rates of 0, 40, 80 and 120 lb P_2O_5 per acre in in the corn trials. The wheat trials included only the 0, 40 and 80 lb rates.

Wet Distillers Grains as a Nitrogen Source

Data for using WDG as a nitrogen source were available for this publication from only three site-years: a dryland site in 2015, and an irrigated and a dryland site in 2026. Nitrogen rates were set based on the economic optimum at the 0, 50%, 75% and 100% levels. Thus, nitrogen rates were 0, 67.5, 90 and 112.5 lb nitrogen per acre in 2015; 0, 45, 67.5, and 90 at the dryland site in 2026 and 0, 60, 90 and 120 at the irrigated site in 2026.

RESULTS AND DISCUSSION

Wet Distillers Grains as a Phosphorus Source in Spring Wheat

Among the four site-years there were two where a significant treatment effect was observed (Figure 1). In all the site-years WDG-treated plots yielded numerically higher than the TSP treated plots, but the difference was significant in 2016 only. In 2018, treated plots yielded significantly higher than the check but the TSP-WDG comparison was non-significant. The 2018 and 2019 sites had significant linear responses to phosphorus rate for both products. At these two sites, the slopes for the two products did not differ significantly.



Figure 1. Spring wheat response to wet distillers grains and triple super phosphate as a phosphorus source from 2016 through 2019. Means with different letters differ significantly at the alpha=0.05 level

Wet Distillers Grains as a Phosphorus Source in Corn

Response to phosphorus rates and products was not significant for either site-year in corn (Figure 2). WDG yields were numerically higher than TSP yields at two of the three phosphorus rates in both years.

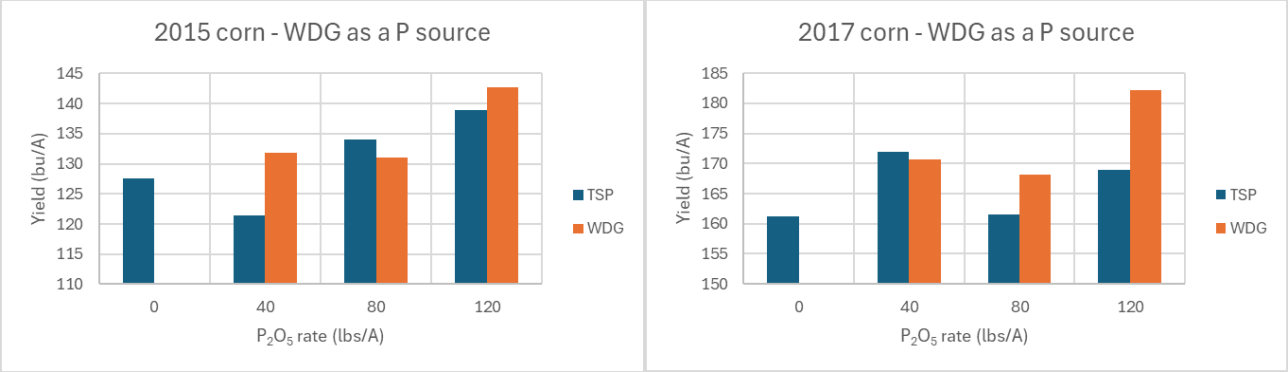


Figure 2. Corn yield response to wet distillers grains and triple super phosphate in 2015 and 2017

Wet Distillers Grains as a Nitrogen Source in Corn

Treatment means suggest differences in rate response between urea and WDG in 2015 and at the 2026 dryland site (Figure 3), however, neither the treatment differences nor the response curves were statistically significant.

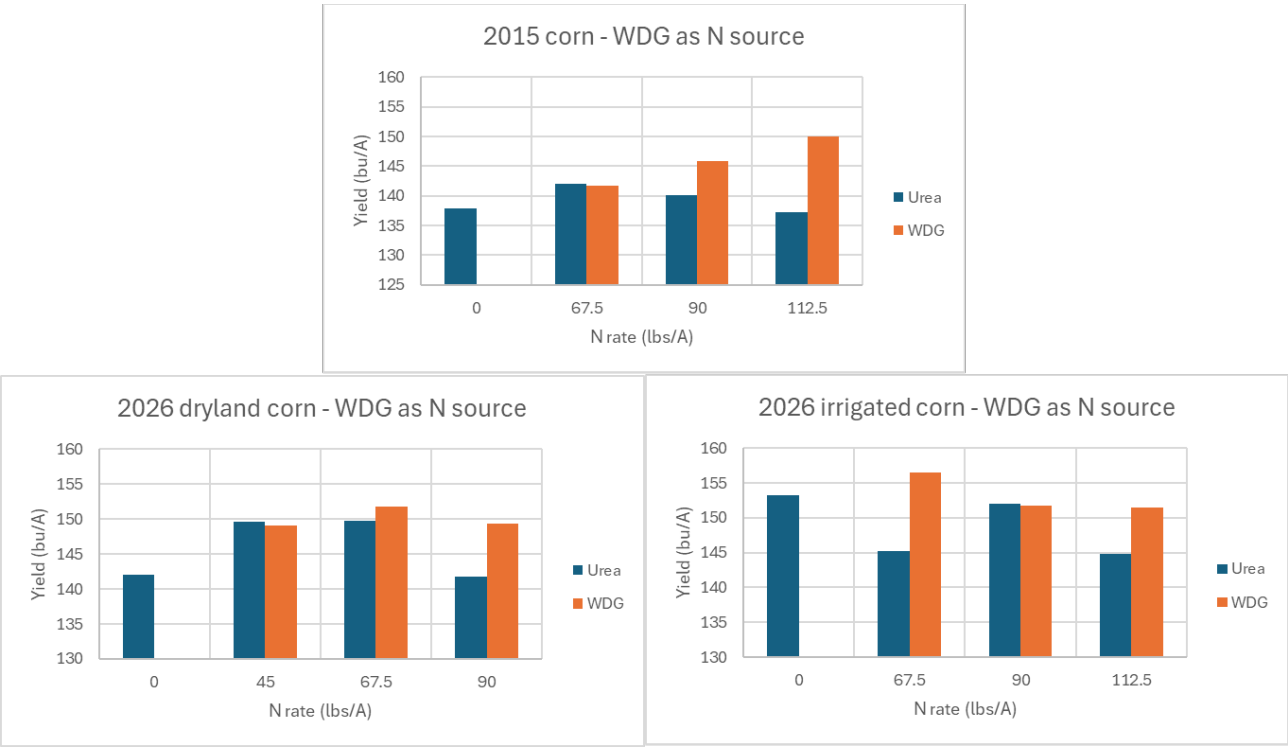


Figure 3. Corn yield response to wet distillers grains applied as a nitrogen source in comparison with urea in 2015 and 2026

CONCLUSION

WDG consistently performed as well as or better than TSP as a phosphorus source in both spring wheat and corn. In the spring wheat trials, WDG-treated plots yielded numerically more than TSP-treated plots at every site-year.

The effectiveness of WDG as a nitrogen source could not be determined, because none of the three site-years showed a significant overall response to nitrogen. Even so, treatment means suggested a rate response to WDG at two of the sites.

At the yield levels observed, WDG performed comparably to synthetic fertilizers, and it supplies a range of nutrients besides the one studied. Applying WDG at nitrogen-based rates adds a substantial amount of phosphorus. However, WDG is rarely available at an affordable price, so repeated heavy applications to the same field are unlikely.

In 2027, two more site-years will be added to continue testing WDG as a nitrogen source.

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