Corn Production Optimization with Distiller's Grains and Condensed Distiller's Solubles as Phosphorus Fertilizer Sources

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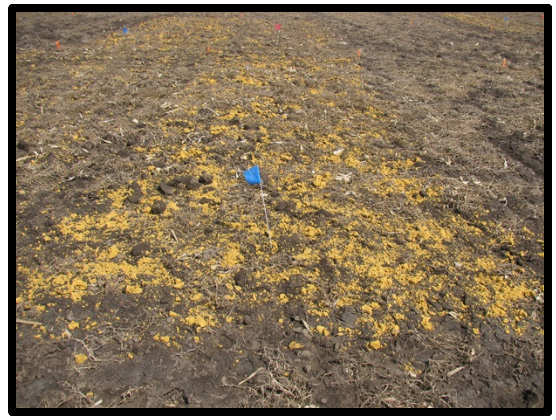
Rationale: Wet distiller's grains (WDGs) and condensed distiller's solubles (CDS), also called syrup, are organic co-products of ethanol production from corn with potential fertilizer values. These by-products, especially CDS, are considered wastes because the amount produced sometimes far exceeds its demand as feed supplements for livestock. Cost of storage, and disposal of the wet co-products are a big concern for the ethanol industry. It is also believed that WDGs with high content of aflatoxins, which are unsuitable for livestock consumption, would have to find alternative uses as fertilizer. Limited research has been conducted thus far to assess the fertilizer value of CDS despite some sample analyses showing high P and N content, as well as other nutrients (S, K, Ca, etc.). Condensed distiller's solubles may have the advantage over WDGs because CDS presents a bigger disposal problem, and is much cheaper than WDGs.

Objectives: To assess CDS and WDGs as P fertilizer sources for corn production in North Dakota.

Materials and Methods

This study was conducted at the Carrington Research Extension Center (CREC) and at Fairmount, ND, to test corn yield and protein response to three rates of phosphorus at 40, 80, 120 lbs. P_2O_5/ac plus a control (0 lbs./ac). Three sources of P were applied as triple super phosphate (TSP), CDS (photo 1), and WDG. Solid treatments were broadcast on the surface (photos 2 and 3), and the CDS liquid was diluted with water before spreading unto soil surface (photos 1 and 2). All treatments were incorporated before planting. The trial was designed as randomized complete block with four replicates. Seeds were planted in 25-feet rows at 30-inch row spacing. Corn was harvested from the two middle rows. Means were compared using Tukey's Minimum Significant Difference at the 95 percent probability level. Previous crop was field pea at CREC, and soybeans at Fairmount. The N and S in CDS and WDG were enough to meet the N demands of corn at the CREC site. N was applied at 85 lbs. with TSP treatments to meet plant N needs. Previous crop N discounts and residual soil N were used to determine if ad how much N was needed.

Photo 1. Condensed distillers solubles.



Photos 2 and 3. Condensed distillers solubles being broadcast on the soil surface and soil after application.

Results

At CREC, corn yields responded significantly to P rates and the source of P used (Table 1). Mean yields and protein content increased linearly with rates across P sources (Fig. 1). Mean yield from CDS application was significantly higher than the means of the check, WDG, and TSP treatments (Fig. 2). Lower grain protein observed for CDS was probably due to the dilution effect from higher grain yields. The CDS treatment produced the highest yields at each level of P, compared to TSP and WDG (Fig. 3). At Fairmount, yield response to P was weak, and differences were not statistically significant among treatment means. It can be observed that at Fairmount, yields consistently increased at 40 lbs. P_2O_5 for each P source, before decreasing at the 80 lb. P rate (Fig. 4). Pending grain analysis results for nutrient content may be helpful in explaining the possibility that P rates over 40 lbs. had some antagonistic effect on Zn availability and negatively affected yields to some extent. The lack of response at Fairmount was likely from availability of adequate P and other soil nutrients in the soil. At Carrington, no other nutrients were added besides nitrogen to the TSP plots. These first year results showed that distiller's grains can be a valuable source of nutrients for corn since no additional N or other nutrients were added to supplement the distiller's grain treatments.

Table 1. Analysis of variance for yield and protein at Carrington.

Effect	Df	Yield		Protein		TWT		Starch		Height	
		F	*P*-value	F	*P*-value	F	*P*-value	F	*P*-value	F	*P*-value
P Source	2	9.11	0.0008	2.61	0.09	1.57	0.2266	1.09	0.349	0.1	0.908
P Rate	2	4.45	0.0196	0.14	0.869	1.58	0.2253	0.03	0.974	0.76	0.476
P Source x P Rate	4	1.39	0.2597	0.52	0.722	0.48	0.7469	0.18	0.947	0.33	0.856

P-values < 0.05 indicate that the treatment had significant effect on the response variable (e.g. yield).

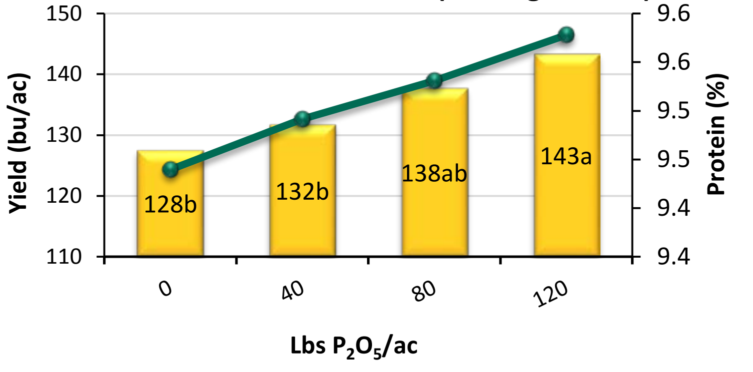


Fig 1. Corn yields and protein response to rates of P across sources (Carrington, ND)

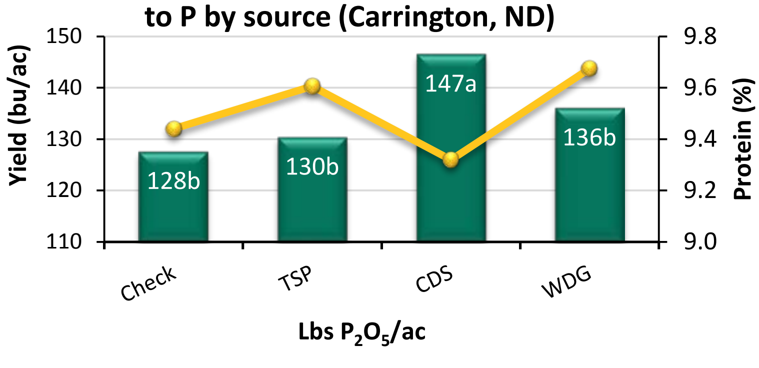


Fig 2. Corn yields and protein response to P by source (Carrington, ND)

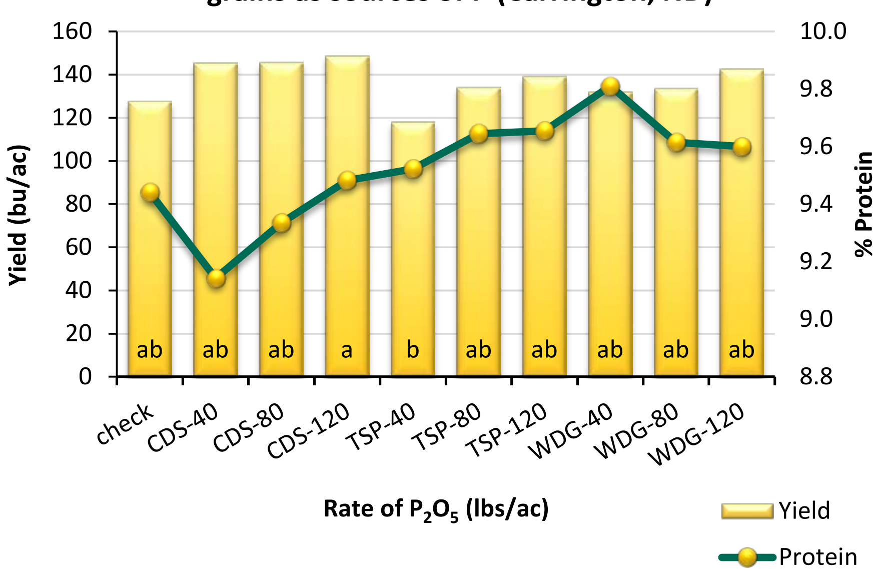


Fig 3. Corn yields and protein respone to distillers grains as sources of P (Carrington, ND)

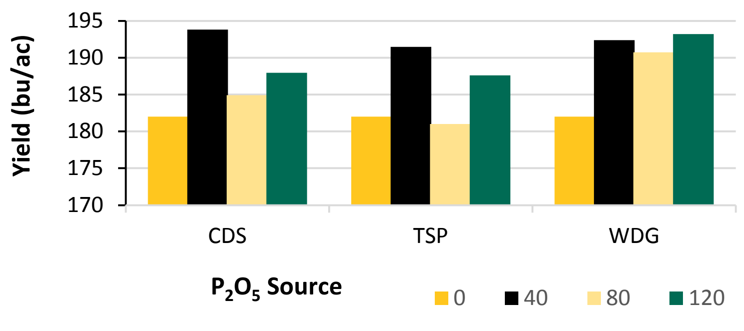


Fig 4. Yield response to P by source, Fairmount, ND