IMPROVING THE FERMENTATION CHARACTERISTICS OF CORN THROUGH OPTIMUM N FERTILIZATION AND HYBRID SELECTION

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Abstract

Ethanol processors could increase production efficiency if they had access to corn grain better-suited for fermentation. The objective of this study was to determine the influence of hybrids and N fertility rates on fermentable starch content that will be used for dry-mill ethanol production. Six hybrids were grown under four N fertility levels at two locations in eastern SD. Ethanol yields increased as N fertility levels increased. Higher ethanol yields were achieved by hybrids that produced both relatively high grain protein and starch. In conclusion, applying the recommended N rate and planting certain hybrids would produce grain that yields higher ethanol production.

Introduction

Ethanol is derived from the starch portion of corn grain. Therefore, ethanol yields should increase with farming practices that maximize starch concentrations. Previous research has shown an increase in grain starch by reducing the protein concentration through decreased N fertilization (Singletary and Below, 1989). Aside from N nutrition, some hybrids produce grain with relatively high starch concentrations (Jones et al., 1996). The objective of this study was to evaluate which N fertilizer rate and hybrid combination maximizes ethanol production.

Materials and Methods

Design

A two-year field study was conducted at two eastern South Dakota locations (Brookings and Beresford) that featured six hybrids and four N fertilizer rates at each site. The four N rates were randomized in a hybrid block. The hybrid blocks were randomized in each of four replication blocks.

Hybrids

At Brookings, the hybrids ranged from 92 to 101 days relative maturity. At Beresford, the hybrids ranged from 94 to 108 days relative maturity.

N Fertilizer Rates

The recommended N fertilizer rate was based on the typical yield goal for each location. The N rate was adjusted according to the pre-plant soil test nitrate-N level (0-2' depth) at each site. The N rates were as follows: check (no N fertilizer applied), half the recommended N rate, the recommended N rate, and twice the recommended N rate. N was applied as a urea broadcast prior to planting.

Grain Harvest and Analysis

Grain was harvested with a plot combine when grain moisture dropped below 20%. Grain yield and test weight were measured. Grain samples were analyzed by Near Infrared Transmittance (NIT) for starch, protein, and oil. Ethanol yield was determined by a laboratory fermentation procedure that simulated dry-mill ethanol production.

Results and Discussion

N Rate

Ethanol yields and grain protein concentrations both increased significantly with each additional N rate (Fig. 1). Grain starch increased significantly as the N rate was decreased from 184 to 46 lbs. ac^{-1}. Therefore, lowering the N rate to increase grain starch may actually decrease dry-mill ethanol yields, even though ethanol is derived from starch. Apparently, grain protein serves a purpose in dry-mill ethanol production.

Hybrid

Hybrid H1 had significantly more starch and significantly less protein than all other hybrids (Fig. 2). The high starch and low protein combination of H1 should have made this hybrid superior for ethanol production. However, H1 produced significantly less ethanol than the other hybrids. Therefore, starch alone may not truly reflect a hybrid's ethanol yield. Hybrid H4 had a significantly higher ethanol yield than the other hybrids. This hybrid was relatively high in both protein and starch. Even though hybrids H6 and H3 had similar protein levels as H4, starch obviously limited their ethanol production. So, it appears as though starch and protein can both limit ethanol production in corn hybrids. Also, a hybrid's relative maturity and test weight did not indicate its ethanol yield ranking.

Conclusions

The best agronomic methods for optimizing corn grain for fermentation include fertilizing with the recommended N rate for the yield goal and by planting hybrids with increased fermentation characteristics. The best hybrids for dry-mill ethanol production were relatively high in both grain protein and starch concentrations.

Acknowledgements

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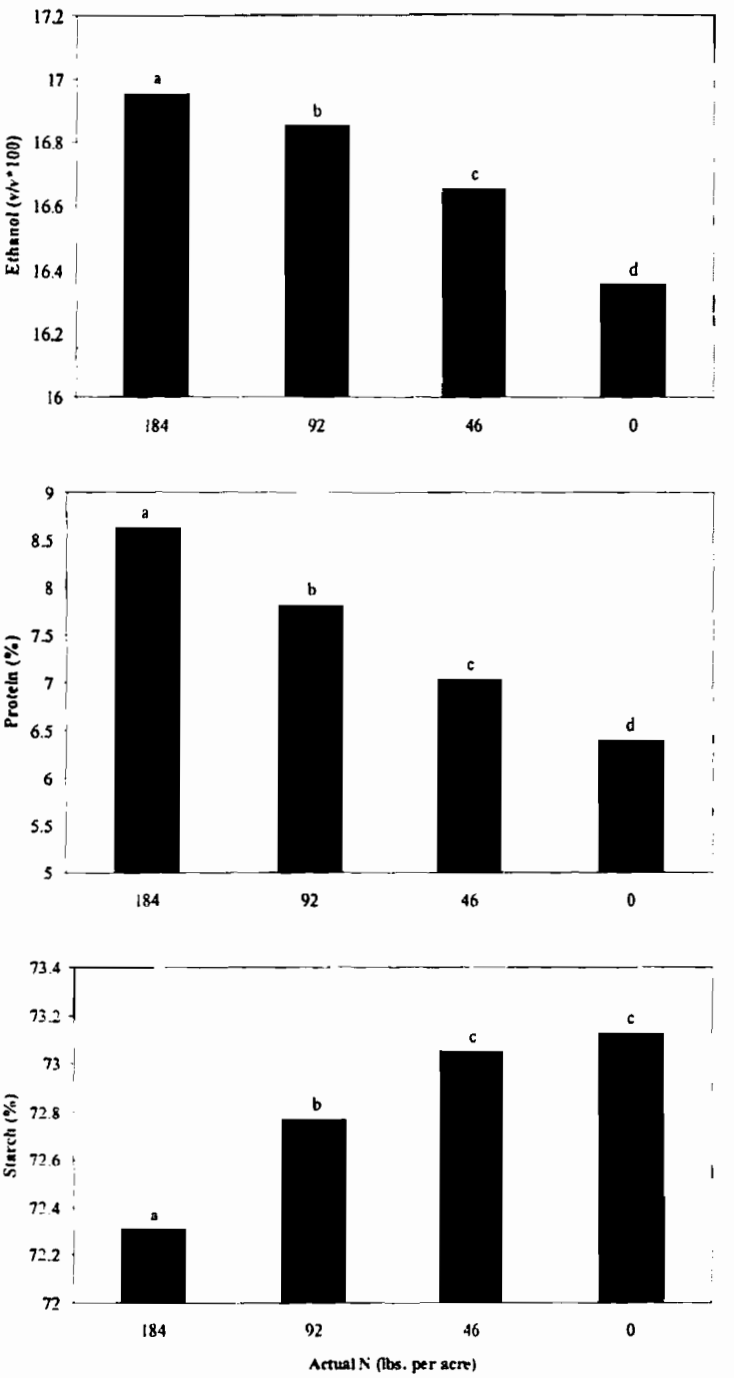

Figure 1. Mean ethanol yield, grain protein percentage, and grain starch percentage for corn grown under four different levels of N fertility. Different letters within a graph indicate significant differences at $P<0.05$.

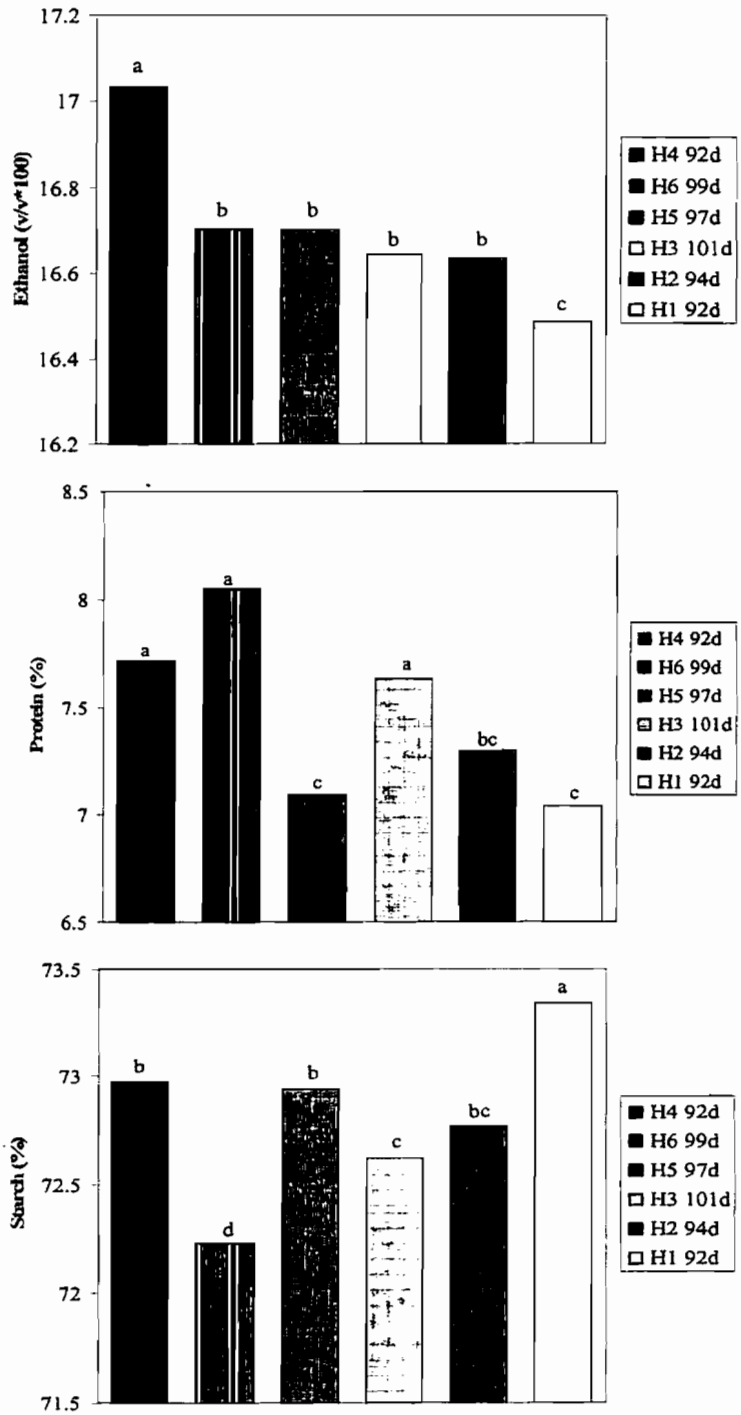

Figure 2. Mean ethanol yield, grain protein percentage, and grain starch percentage for six hybrids grown at Brookings, SD in 2003. Different letters within a graph indicate significant differences at $P<0.05$.

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