

# EFFECTS OF LATE SEASON NITROGEN APPLICATION ON CORN KERNEL CHARACTERISTICS IMPORTANT FOR VALUE ADDED USES

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First year of project

## **Justification:**

Specialty grains and value-added traits have become increasingly important for crop producers and the seed industry. Physical characteristics of the grain, such as hardness, and chemical composition such as percent protein or extractable starch are important considerations for some end-users of corn grain. Previous research has shown that crop management practices such as nitrogen fertilizer can affect grain hardness and protein content.

The ethanol industry prefers relatively hard corn kernels to limit storage and handling problems with cracked grain. High amounts of extractable starch increase ethanol yield. The amount of protein can affect kernel hardness. Research in Ohio found that increased kernel protein stored in the endosperm increased kernel density and hardness.

Application of nitrogen fertilizer during grain filling may increase kernel hardness through increased protein content, and this may be beneficial to the ethanol industry. Because of the interrelationship between protein bodies and starch granules, an increase in protein may reduce starch extraction. This reduction in starch extraction would not be beneficial to ethanol industry. This study investigated the effect of late season nitrogen application on corn kernel composition.

## **Methods:**

Three corn hybrids (Dekalb brand DKC61-45, Pfister brand 2656RR-Bt, and Pioneer brand 33R81) were planted on April 18. The seed companies have classified these hybrids as either highly extractable starch or high total fermentable. Plots were planted without tillage into soybean residue, and were 25 feet long and four 30-inch rows wide.

Pre-emergence herbicides were Dual II Magnum, Roundup WeatherMax, and Aatrex. One post emergence application of Roundup WeatherMax was made. Nitrogen fertilizer was top-dressed across all plots at 160 pounds N/acre as ammonium nitrate. Plots were irrigated on three dates (July 1, July 18, and August 1) with about one inch of water on each date delivered by an overhead lateral irrigator.

Three rates of nitrogen (0, 30, and 60 lbs N/acre) were applied at two timings of application (stages of development: R1, silking; R3, milk). Ammonium nitrate was applied by hand to ensure little damage to leaves.

Before harvest the two center rows of each plot were end-trimmed to 20 feet. Six ears were hand-harvested and shelled by hand. This was done to obtain kernel undamaged by mechanical combining. The center two rows were harvested with a plot combine on September 6. Plot weight added to the weight of the grain from the six hand-harvested ears was used to calculate yield. Yield was corrected to 15% moisture.

To measure kernel density, 50 unbroken kernels were weighed. Volume of the 50 kernels was determined by liquid water displacement. Density was calculated dividing kernel weight by kernel volume. All other kernel characteristics (oil concentration, protein concentration, starch concentration, and extractable starch) were measured using NIR technology provided by Monsanto Co.

The experimental design was a split plot with five replication arranged in a randomized complete block. Hybrids were the whole plots. The split plots were all combinations of nitrogen rate and treatment timing. Analyses of variance indicated that time of treatment had no effects on any of the measured variables. All of the two way and three way interactions involving timing of application were not significant. For these reasons, data were pooled over timings of application.

### Results:

The three hybrids were similar for all characteristics (Table 1). Although the plots had been irrigated three times, yields of all three hybrids were much below normal. Apparently the amount of water applied was not adequate to ameliorate the effects from hot and dry weather during silking and grain-filling. The low yield potential may have reduced the effects of late season nitrogen treatments on kernel characteristics.

Hybrids did not differ for kernel density, oil concentration, or protein concentration (Table 1). Although hybrids differed for starch concentration and extractable starch, the differences between the highest and lowest hybrids were only 1%, or less.

**Table 1. Yield and kernel characteristics of three corn hybrids. Numbers are averaged over three N rates and two application timings.**

Characteristic	Pfister '2656RR-Bt'	Dekalb 'DKC 61-45'	Pioneer '33R81' HTF†
Grain yield (bu/acre)	108.2a	98.8b	104.4ab
Density (g/cm <sup>3</sup> )	1.1761a	1.1907a	1.1632a
Oil (%)	3.1a	2.9a	2.9a
Protein (%)	10.5a	10.5a	10.3b
Starch (%)	70.4c	71.1a	70.9b
Extractable starch (%)	64.9b	65.9a	65.7a

Late season application of nitrogen did not affect yield (Table 2). All plots had been fertilized with 160 pounds N/acre before emergence. The intended purpose of the late season N treatments was to affect kernel characteristics and not yield.

Late season application of nitrogen increased kernel protein concentration, but had no effect on either oil or starch concentrations (Table 2). The increased availability of

nitrogen probably stimulated production of storage proteins in the kernel. Often, increased storage protein concentration in the endosperm will increase kernel density, an estimate of kernel hardness. No effect on kernel density from late season nitrogen application was found in this experiment.

Storage proteins in the endosperm are closely positioned to starch granules. Increased storage proteins might reduce starch extraction. Late season nitrogen application reduced the NIR measurement of extractable starch. However, differences among treatments were small, only 0.3%.

**Table 2. Yield and kernel characteristics for three late season nitrogen application treatments. Numbers are averaged over two application timings and three hybrids.**

Characteristic	0 lbs/acre	30 lbs/acre	60 lbs/acre
Grain yield (bu/acre)	105.1a	104.2a	102.1a
Density (g/cm <sup>3</sup> )	1.1795a	1.1771a	1.1734a
Oil (%)	3.01a	2.97a	2.99a
Protein (%)	10.22b	10.54a	10.54a
Starch (%)	70.8a	70.8a	70.8a
Extractable starch (%)	65.63b	65.30a	65.50ab

### **Conclusions:**

1. Hot and dry weather conditions during silking and early grain fill reduced yield potential and may have limited the effects from late season nitrogen applications.
2. Late season nitrogen application did not affect oil or starch concentration in corn kernels.
3. Late season nitrogen application increased kernel protein about 0.3 percentage units, but did not affect kernel density.
4. Late season nitrogen application reduced extractable starch, slightly