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Field Crops Research

Non-GMO Corn Strip Trial: Yield and Feed Value

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In a Nutshell

- A number of corn hybrids have been developed to have elevated nutrient content.
- Four high-protein or high-lysine non-GMO corn hybrids were selected for testing: Master's Choice 535, GEI 101, Channel 213, and eMerge 600.
- Yield, test weight, protein yield, and lysine and methionine were different among the corn hybrids
- Application of dry fertilizer did not significantly affect nutrient content.

Project Timeline:
April 2013 – October 2013

Practical Farmer John Gilbert of Iowa Falls stands among his dairy cows.

About the Cooperator

John and Bev Gilbert and their family run a diversified hog, grain, and dairy farm south of Iowa Falls that has been in the family for more than a century. They raise corn, soybeans, hay, oats, and forage annuals to provide as much of their livestock's feed needs as possible.

Background

Crops intended for livestock feed may require different nutrient concentrations than corn going for ethanol or human food production. In swine production, for instance, growing and finishing hogs have considerable requirements for dietary protein, which typically means adding soybean meal to the ration. The first limiting amino acid for hogs is lysine, which is found in low concentrations in corn and soybean meal (Meisinger, ed. 2010).

Supplying sufficient lysine with soybean meal usually means other amino acids are provided in excess. Other supplements such as synthetic amino acids may be used to increase the lysine concentration of the ration but are an added cost and aren't allowed in organic hog production. To more closely meet the nutritional needs of humans and livestock, plant breeders isolated and selected for the opaque II gene, found in higher-lysine varieties. While major seed company high-lysine breeding programs have been discontinued, opaque-II varieties are still available from some specialty breeders. Specialty varieties tend to yield less than standard corn varieties (Pick and Meade 1970). The advantage of a more nutritionally-balanced grain must be balanced with the disadvantage of lower yield.

The Gilberts have completed several trials to compare the yield and nutrient concentration of different corn hybrids (Carlson 2012) and the effect of crop fertilization on corn yield and nutrients (Dunn 2013). They decided to investigate cultural practices to improve productivity of the variety with the best nutrient profile. The current trial, focusing on a single hybrid, looks at the effect of both starter fertilizer and a nutrient uptake enhancer, Igniter™ (Innovative Crop Solutions). Igniter™ is a humic product and is reported to enhance nutrient uptake efficiency by crops and improve soil quality (Innovative Crop Solutions 2013).

Materials and Methods

Four high-protein or high-lysine non-GMO The experiment consisted of 72 total rows of corn with 30-in. spacing. Row length varied between 485-590 ft. Three reps of 24 rows each were established, with 12 rows in each rep receiving Igniter™, and 12 left untreated. Within each 12-row main plot, two subplots were established: six rows received starter fertilizer, and six did not. Thus, within each rep of 24 rows, six had no treatments, six had both, six had starter only, and six had Igniter™ only.

During the previous fall, a mixture of two parts monoammonium phosphate and one part soft rock phosphate with humates was knifed into the soil at a rate of 200 lb/ac. At planting, half of the rows received 3-4 gal/ac of an 8-19-3 liquid starter. All rows in the experiment received 12-15 gal/ac of 32% N fertilizer with herbicide and 5 gal/ac calzul (stabilizer), broadcast at planting. Additional N was sidedressed to bring the total amount to about 125 lb N/ac. Igniter™ was applied to assigned main plots in late June at 0.375 gal/ac.

John planted GEI 101, a high-lysine corn variety by Genetic Enterprises International on May 24. Shortly after, heavy rains and cold weather prevented significant germination. Thus some had to be replanted, but the replanting was distributed fairly evenly across replications, maintaining integrity of the replications.

Weather conditions were a major factor in 2013, with cold wet conditions early delaying planting and requiring significant replanting in many fields, followed by hot dry weather through the rest of the growing season. The only positive in the growing season was normal to later than normal killing frost.

Corn yields from the on-board combine yield monitor were adjusted to standard 15.5% moisture.

A hand-harvested grain sample from each 6-row subplot was submitted for nutrient analysis at the Iowa State University Grain Quality Laboratory. NIR analysis determined the moisture, crude protein, lysine, methionine, cysteine, oil, and starch concentrations of the samples.

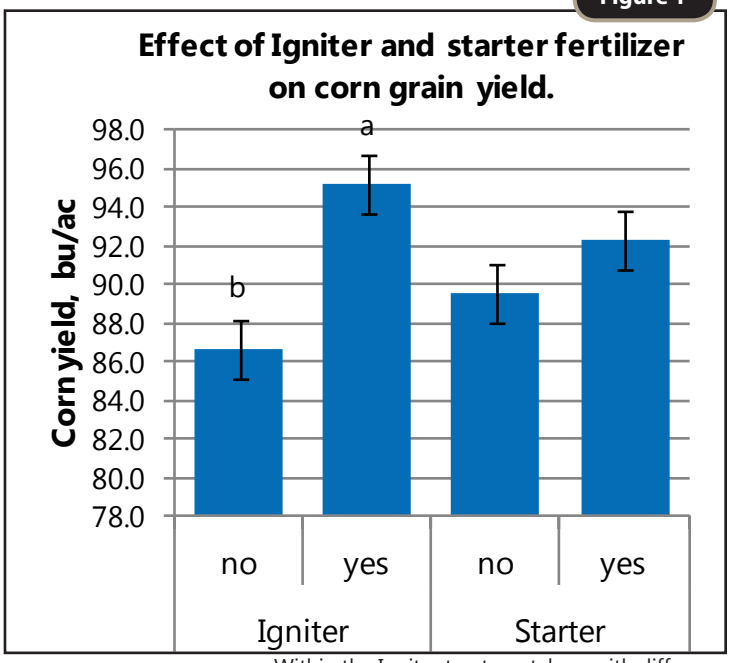
Data were analyzed with SAS 9.3 (SAS Institute Inc., Cary, NC) to determine statistical differences between fertilizer and Igniter treatments. Significance was determined if $P < 0.05$, with tendencies noted if $0.05 < P < 0.10$.

Results and Discussion

Corn yield and moisture at harvest

Igniter™ significantly increased corn grain yield ($P = 0.06$) while the use of starter fertilizer did not affect yield (**Figure 1**). There were differences between some of the replications for both moisture ($P = 0.08$) and yield ($P = 0.05$), but no interactions between Igniter™ and starter treatments ($P > 0.10$). Average corn yield across all treatments was 91.0 bu/ac, which is far below the 10-year average yield in Hardin county (177 bu/ac, Smith 2013) and the 2012 average yield (163.6 bu/ac, NASS 2013). Local data from 2013 is not yet available, but on the farm, the yield was comparable with other fields with similar portions of replanting.

Figure 1



Within the Igniter treatment, bars with different letters above them tend to differ ($P < 0.10$).

Corn nutrient analysis

NIR analysis results for concentration of protein, lysine, cysteine, and methionine are shown in **Table 1**, as well as the standard yellow dent corn analysis used in balancing swine rations (Meisinger, ed. 2010).

Use of Igniter™ or starter fertilizer did not affect nutrient concentration, except for methionine. Even then, values were so close as to not make a significant difference when balancing rations. The values for the yellow dent corn, from the nutrient guidelines for swine (Meisinger, ed. 2010), is less precise than was the NIR analysis used in this trial. Regardless of treatment, corn in the trial had a lower protein concentration than standard yellow dent corn, but greater concentrations of lysine and methionine. In 2012, this corn hybrid had 9.80% protein, 0.38% lysine, 0.29% methionine, and 0.23% cysteine. Lower protein in the current year may indicate a deficiency in available soil N to the corn. In a drought year, delayed maturity of plants generally causes increased protein concentration; however, both 2012 and 2013 were droughty. The late planting of corn in 2013 may have influenced production and yield.

Table 1

Effect of Igniter and starter fertilizer on corn grain nutrient concentration

Treatment		Protein (%)	Lysine (%)	Methionine (%)	Cysteine (%)
Igniter	no	8.38	0.38	0.257 b	0.19
	yes	8.08	0.38	0.262 a	0.19
Starter	no	8.02	0.37	0.255 b	0.19
	yes	8.45	0.38	0.264 a	0.20
Average		8.23	0.38	0.260	0.19
Yellow dent corn		8.30	0.26	0.17	0.19

Values within a column and treatment followed by different letters differ ($P < 0.05$).
Yellow dent corn analysis from Meisinger, ed. (2010)

Economic analysis of treatments and feed value of corn

John reported that the specialty seed (GEI 101) cost was comparable to other commercial varieties. If the nutrient profile of the specialty variety allows it to be substituted for more expensive dietary components like soybean meal, it can reduce feed costs significantly. Two rough rations and economic analysis of those rations is shown below. The first is balanced first for 0.75% lysine (**Table 2**) and the second is balanced for 15% crude protein (**Table 3**), values representing the average requirement for hogs in the 125-175 lb weight range (Whitney et al. 2010). In general, hog diets are balanced to meet individual amino acid requirements, not total crude protein. As mentioned earlier, corn lacks the amino acid profile necessary for optimal growth of hogs. The following tables demonstrate how balancing according to amino acid requirements, rather than protein, is important. Prices were obtained from national averages during the week of Dec 8-14, 2013 (USDA-AMS) and are used for both standard corn and the high-lysine hybrid tested.

Because of the greater lysine concentration of the specialty corn from this trial, it replaced a considerable amount of soybean meal, more accurately meeting the nutrient requirements of the hogs, and reducing the price per ton of feed compared to the standard corn diet.

Because of the greater crude protein concentration in the standard corn, slightly less soybean meal was required in the standard corn diet. However, the lysine concentration of that corn diet falls slightly short of the hogs' requirements, and their growth could be compromised. Meanwhile, the specialty corn diet, when balanced for protein, supplies more lysine than is needed. This is not harmful nutritionally, but the cost of the diet is quite high because of the additional soybean meal required compared to the standard corn diet when balancing for protein. The least amount of soybean meal was necessary when balancing rations to meet lysine requirements using the specialty corn. Furthermore, balancing rations to meet lysine requirements is more accurate and beneficial for the hogs being fed, and can significantly reduce cost compared to balancing rations for protein.

Table 2

Lysine-balanced diets based on standard corn & specialty (GEI 101) corn supplemented with soybean meal					
0.75% lys	**Cost ($/lb)**	**Lysine (%)**	**% of diet**	**lb/ton of diet**	**$/ton**
standard corn	0.08	0.26	80.93	1618.60	505.48
soybean meal	0.23	2.83	19.07	381.40	
GEI 101	0.08	0.38	84.90	1698.00	432.15
soybean meal	0.23	2.83	15.10	302.00	

Table 3

Protein-balanced diets based on standard corn & specialty (GEI 101) corn supplemented with soybean meal					
15% CP diet	**Cost ($/lb)**	**Crude protein (%)**	**% of diet**	**lb/ton of diet**	**$/ton**
standard corn	0.08	8.30	81.23	1624.60	499.94
soybean meal	0.23	44.00	18.77	375.40	
GEI 101	0.08	8.23	81.07	1621.40	502.89
soybean meal	0.23	44.00	18.93	378.60	

Nutrient analysis of grain samples is essential to properly balance diets. In the current trial, GEI 101 crude protein concentration was lower than that of standard yellow dent corn. This may be due to environmental conditions in this particular year. However, a larger trend exists where standard corn protein has decreased. As corn yields have increased over the past several decades, the protein concentration in the grain has decreased (Baker 1997); the feed department of John's local mill and the scientists in charge of the grain nutrient analysis for this trial both agreed that they rarely see crude protein values near the "standard." These conversations suggest that even standard corn protein (and presumably lysine) concentrations may be lower than expected, making these specialty hybrids even more useful.

John reported that Igniter™ cost approximately $11.50/ac. It increased corn yield compared to plots without Igniter™ by 8.5 bu/ac, an increase of 9.8%. At an average corn price of $4.48/bu, Igniter™-treated corn brought in an extra $36.42/ac. This more than justifies the use of Igniter™, which is also reported to improve soil quality, resulting in benefits for the future and for sustainability.

Conclusions and Next Steps

Specialty high-lysine corn yield was increased when Igniter™ was applied, but not when starter fertilizer was applied. Corn yields were lower than historical averages in the county, but greater lysine concentration in the specialty variety may allow for use of the grain as a substitute for soybean meal when balancing rations. In the future, Igniter™ and other fertilizer treatments will be tested to continue improving high-lysine corn yield. The ultimate question driving the Gilbert research remains finding practices and approaches to improve the overall farm performance, including soil health, livestock performance and economic resilience.

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