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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 2012 – October 2012

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 in Iowa Falls that has been in the family for over a century. They raise corn, soybeans, hay, oats, and forage annuals to feed their own livestock.

Background

A number of corn hybrids have been developed to have elevated nutrient contents. Some have greater oil, some have above-average protein, and others have increased amino acids. Of particular interest to swine producers is high-lysine corn; lysine is an essential amino acid that is most often limiting in swine diets (Lewis and Southern, 2001). Providing adequate lysine is essential to optimizing growth, production, and health (Pick and Meade 1970; Brown et al. 1985). While selection for increased lysine often costs the hybrid in terms of grain yield (Brown et al. 1985), it also means that feed costs may be reduced by feeding less corn overall or by using corn as a lysine source instead of expensive supplements (Pick and Meade 1970). The current trial, one of a series by PFI Cooperator John Gilbert of Gibralter Farms, was designed to test the effects of corn hybrid and fertilization on total yield and quantity of specific nutrients. Past non-GMO strip trials performed by the Gilberts examined the yield and protein content of corn hybrids (Carlson 2012).

Method

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. Hybrids were replicated and randomized three times across the field. Each corn hybrid plot was split in half. On each half of the plot two different forms of nitrogen fertilizer was applied at different times.

Before planting all plots were fertilized with 32% liquid fertilizer providing approximately 50 lb of N per acre. Shortly after planting (May 8-9, 2012), dry fertilizer (100 lb/A each of ammonium sulfate and monoammonium phosphate including a total of about 33 lb N/A) was applied to half of the plots. Then additional liquid fertilizer was applied so that each subplot treatment received approximately 110 lb N, though in different forms and at different times.

The corn hybrids used were selected for several reasons. Channel 213 is a 113-day maturity hybrid that the Gilberts have used with success in the past, reporting that it yields well in both long and short seasons. GEI 101 is a 101-day, high-lysine hybrid. eMerge 600 is a 107-day hybrid lauded for high test weights and yield potential. MC 535 is a 107-day hybrid and was of interest for its high feed quality. All corn was harvested on approximately October 9, 2012, and sent to the Iowa State University Grain Quality Laboratory for analysis using Near-Infrared Spectroscopy (NIR).

Data were analyzed with SAS 9.3 (SAS Institute Inc., Cary, NC) to determine statistical differences between hybrids and fertilizer treatments. Significance was determined at $\alpha = 0.05$.

Results

Yield (measured in both bu/A and dry matter (DM) per acre), test weight (lb/bu), protein yield (lb/bu), and lysine and methionine (percent content and lb/bu) were different among the corn hybrids (**Table 1**).

GEI 101, a high-lysine hybrid, had the lowest yield and test weight. While the percentage crude protein of GEI 101 did not differ from other hybrids, the lower test weight meant it produced less protein per bushel. As expected it had a higher percentage of lysine and methionine than other hybrids, and despite lower test weights, it yielded more lysine per bushel than other hybrids.

In many cases the other three hybrids did not differ significantly from one another. eMerge 600 contained the least lysine and methionine on a percent basis and yielded less per bushel. Channel 213 had the greatest crude protein yield per bushel and was among the greatest yielding for lysine and methionine yield.

Application of dry fertilizer did not significantly affect any measurements except test weight at 15.5% moisture (the industry standard). Corn grown without dry fertilizer had a standard test weight of 59.2 lb/bu, which was greater than corn grown with the dry fertilizer at 58.93 lb/bu ($P = 0.0233$). The yield of methionine per bushel was also slightly lower in the dry fertilized corn (0.1351 lb vs 0.1302 lb methionine/bu; $P = 0.0699$).

There were significant differences in yield, crude protein, and methionine between replicates, likely due to underlying differences between replicates. Fertilizer treatment affected test weight (lb/bu) and tended to affect methionine yield (lb/bu).

Differences were observed between the three replicates, which were located at different places within the field (**Table 2**). A plausible explanation is variable soil

Table 1

Yield, test weight, and nutrient content of four non-GMO corn hybrids

Variety	Yield		Test Weight	Crude Protein		Lysine		Methionine	
	bu/A	lb DM/A	lb/bu	%	lb/bu	%	lb/bu	%	lb/bu
Channel 213	124.7 a	5844.5 a	60.5 a	10.08	5.2 a	0.334 b	0.170 ab	0.273 b	0.140 a
eMerge 600	117.6 a	5559.9 a	61.3 a	9.63	5.0 ab	0.301 c	0.156 c	0.230 c	0.119 b
MC 535	119.7 a	5621.5 a	60.6 a	9.65	4.9 b	0.329 b	0.168 b	0.267 b	0.137 a
GEI 101	79.5 b	3748.4 b	55.1 b	9.80	4.6 c	0.377 a	0.175 a	0.291 a	0.135 a
Standard Error	8.85	416.85	0.354	0.149	0.079	0.00367	0.00209	0.00457	0.00252
P-value	0.0079	0.0084	< 0.0001	0.1569	0.0005	<0.0001	< 0.0001	<0.0001	0.0001

*means with similar letters are not statistically different

Table 2

Nutrient content and yield of corn varieties grown in one of three replicates

Replicate	Yield		Test Weight	Crude Protein		Lysine		Methionine	
	bu/A	lb DM/A	lb/bu	%	lb/bu	%	lb/bu	%	lb/bu
South	84.3 b	3965.9 b	59.5	10.06 a	51 a	0.338	0.169	0.272 a	0.137 a
Central	115.4 a	5432.6 a	59.7	9.75 ab	4.9 ab	0.336	0.169	0.265 ab	0.133 ab
North	131.3 a	6182.3 a	58.9	9.56 b	4.8 b	0.331	0.165	0.259 b	0.128 b
Standard Error	7.67	360.98	0.307	0.129	0.069	0.00294	0.00181	0.00396	0.00219
P-value	0.0015	0.0015	0.1995	0.0415	0.0236	0.3816	0.1650	0.0812	0.0530

*means with similar letters are not statistically different nutrient or moisture levels throughout the field. John Gilbert confirmed that a gravel bed exists south of the cornfield, which may have increased drainage of water from the southern end of the field – possibly accounting for the lower yields of the south replication. This would have exacerbated existing drought conditions. Maturity may be delayed in plants experiencing low-moisture conditions, as in the 2012 summer drought. Slower-growing plants harvested based on date (rather than actual maturity) have higher crude protein and digestible dry matter concentrations than plants grown with adequate moisture (Genter et al 1956).

The Gilberts intend their corn to be for livestock consumption. Since protein and the amino acids lysine and methionine are of particular importance when formulating rations, it is often beneficial to maximize the amount of those nutrients in the feedstuffs. In addition, depending on the price of feed, a cost savings may be realized by replacing expensive supplements with farm-grown corn. In this trial, the high-protein, high-lysine corn hybrid failed to yield more lysine per acre than other hybrids because of the others' advantage in yield performance (data not shown). However, per pound of feed (think – per mouthful for a hog or cow), the high-lysine hybrid provides more essential amino acids. This is important because of the high cost of soybean meal ($0.22/lb) relative to corn ($0.125/lb). Replacing soybean meal with corn may reduce feed costs sufficiently to make up for the lesser yield. **Table 3** shows the costs of diets balanced for the same amount of protein or lysine. Using the non-GMO hybrids tested here results in savings compared to diets using a "standard" corn in most cases.

Table 3

Composition and price of diets formulated to equal crude protein or lysine, using different corn hybrids

15% CP diet	Cost ($/lb)	% Crude Protein	% of Diet	lb/ton	$/ton
standard corn soybean meal	0.125 0.22	9.43* 49.44	86.08 13.92	1721.57 278.43	276.45
Channel 213 soybean meal	0.125 0.22	10.08 49.44	87.50 12.50	1750.00 250.00	273.75
eMerge 600 soybean meal	0.125 0.22	9.63 49.44	86.51 13.49	1730.22 269.78	275.63
MC 535 soybean meal	0.125 0.22	9.65 49.44	86.55 13.45	1731.09 268.91	275.55
GEI 101 soybean meal	0.125 0.22	9.8 49.44	86.88 13.12	1737.64 262.36	274.92
0.66% lys diet	**Cost ($/lb)**	**%lys**	**% of diet**	**lb/ton**	**$/ton**
standard corn soybean meal	0.125 0.22	0.3318* 3.25	88.75 11.25	1775.07 224.93	271.37
Channel 213 soybean meal	0.125 0.22	0.3328 3.25	88.78 11.22	1775.68 224.32	271.31
eMerge 600 soybean meal	0.125 0.22	0.3013 3.25	87.84 12.16	1756.71 243.29	273.11
MC 535 soybean meal	0.125 0.22	0.3287 3.25	88.66 11.34	1773.18 226.82	271.55
GEI 101 soybean meal	0.125 0.22	0.3769 3.25	90.15 9.85	1802.93 197.07	268.72

*Values for standard corn and soybean meal are reported in Meisinger (2010).

Calculate the amount of corn and soybean meal needed

It is valuable for a producer to calculate the amount of corn and soybean meal needed depending on a hybrid's nutrient composition.

First, a target nutrient value must be set – 15% CP was used here. Given the % CP in the ingredients, an equation can be written (here, using the standard corn and soybean meal)

15% CP total = (9.43% x amt of corn) + (49.44% x amt of soybean)

In addition, assuming that corn and soybean meal are the only ingredients used, we know that:

% soybean meal + % corn = 100%

therefore, **soybean meal + corn = 1.00**

therefore, **soybean meal = 1 – corn**

By substitution, we can say:

15% CP = 9.43(corn) + 49.44(1 - corn)

The remainder is algebra:

15 = 9.43(corn) + 49.44 – 49.44(corn)

40.01(corn) = 34.44

corn = 0.8608; multiply by 100 to get a percent: 86.08% corn

Thus:

100 – 86.08 = 13.92% soybean meal

Conclusions and Next Steps

Corn breeding has an impact on nutrient composition of harvested grain. Feed savings may be realized by substituting specialty corn hybrids for more expensive feedstuffs. When four non-GMO corn hybrids were grown and tested, variations in crude protein and lysine content as well as yield were measured. The greatest nutrient content (on a percentage basis) did not necessarily translate into the greatest nutrient yield (on a per bushel or per acre basis). However, the needs of the livestock and farmer are important considerations when choosing and planting hybrids for feed. Assuming an equal price for all corn hybrids, the lower-yielding, higher-nutrient dense hybrids resulted in lower feed costs. Application of a dry fertilizer did not significantly affect corn yield or nutrient content. Variations within the field caused differences between replicates in yield and nutrient content. Orienting the replications perpendicular to known gradients, or avoiding fields with gradients altogether, will reduce the effects of within-field variation.

Because of the 2012 drought, repeating this trial may be beneficial to reduce the effects of climate on the results. Other trials may include testing animal performance of these different corn hybrids, planting other or more hybrids, or testing other methods of soil fertilization.

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