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Evaluating the Agronomic Feasibility of Planting Late Season Corn for Feedlot Cattle

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Summary

Yield, lb/acre, bushel weight (**BD**), lb/bu, relative maturity (**RELMAT**), chemical composition and in vitro dry matter digestibility (**IVDMD**) were used to screen corn varieties (n = 20) of varying maturities grown under the stress of a shortened growing season. Corn varieties were planted in late June of 1996. Whole shell corn (**WSC**) and ear corn (**EC**) were harvested. Bushel weight was quantified on WSC. Yields for WSC, and EC were 1941 ± 706 and 2307 ± 997 lb DM/acre, respectively. Whole shell corn and EC were sorted into yield (**YGP**) groups. Whole shell corn yields were 2942 ± 248, 2305 ± 138, and 1292 ± 343 lb DM/acre for YGP1 through YGP3, respectively. The EC yields were 3740 ± 207, 2980 ± 208, 1897 ± 235 and 1139 ± 455 lb DM/ acre for YGP 1 through 4, respectively. For WSC, YGP 1, YGP 2 and YGP 3 produced 2529, 1956 and 1099 lb TDN/ac, respectively. Ear corn YGP 1, YGP 2, YGP 3 and YGP 4 produced 2980, 2180, 1437 and 780 lb of TDN/ac, respectively. Increased yield in corn varieties grown under the stress of a shortened growing season was attributed to an increase in starch content. Even so, digestibility and energy content were not related (P > .05) to yield or BD. Relative maturity did not influence (P > .05) chemical composition, digestibility or energy content. Results suggest that while selecting earlier maturing corn for short growing seasons improves yields, it gives no advantage to feed value. Bushel weight, yield or maturity date should not be used as single criteria when predicting feed value of corn grown under the stress of a shortened growing season.

Key words: Stressed corn, Feeding value, Ear corn

Introduction

Wet springs, drought, disease and early frost, are all factors that prevent corn, in this region, from reaching maximum yield, desired moisture content, and full maturity. When corn crops do not reach full maturity and are grown under stressful growing conditions, "soft corn" production or corn with low bushel weights is often the result. Low yielding corn generally is associated with a decrease in BD and assumed to have a lower feeding value for livestock.

However, previous research here and at the University of Nebraska concluded that corn that was below USDA Grade No. 2 corn did not have a lower feeding value than No.2 corn.

The objective of this research was to screen corn varieties grown under the stress of a shortened growing season for usefulness as livestock feed. Corn varieties were evaluated for yield, chemical composition, and digestibility. This information is intended to aid cropping decisions in years when planting is delayed.

Materials and Methods

Twenty corn varieties of varying maturity were planted late June, 1996. Corn plots were located at the South Dakota State University Agronomy research plots at Brookings. Corn varieties planted and their respective growing degree day (**GDD**) requirements are listed in Table 1.

Each corn variety was represented by 12 rows. Three test plots (P1, P2, and P3) consisting of two rows/plot were marked out for each variety to collect harvest yield data.

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Table 1: Research Corn Varieties and Respective Growing Degree Day (GDD) Requirements

Variety	Growing Degree Day Requirement
De Kalb (DK)	
DK 471	NA
DK 646	2830
Cargill (CG)	
CG 7697	2550
CG 3777	2200
Pioneer (PI)	
PI 3357	2610
PI 3559	2530
PI 3733	2400
PI 3563	2550
PI 3751	2400
PI 3730	2400
Dairyland (DL)	
DL 10803	2470
DL 1407	2465
Golden Harvest (GH)	
GH H2502	2502
GH H2547	2547
Terra (TR)	
TR E1106	2560
TR E1136	2620
TR TR1126	2600
TR TR1130	2650
Croplan (CR)*	
CR 661	3394
CR 674	3394

*Croplan varieties GDD were based on a 55-86 °F scale. All other varieties were based on a 50-86 °F scale.

Relative maturity was calculated for each variety by dividing the actual growing degree units (GDU) that occured by the total GDU each corn variety required for full maturity and was expressed as a percentage. Each variety was exposed to 2015 actual GDD (from planting to the first killing frost).

Fall snow storms delayed harvest until December 26 and 27, 1996. Ears were hand picked from one row of each test plot. Test plots within a variety were pooled. De Kalb 471 was lodged and lost due to the heavy snowfall. Five sample ears from each variety were collected and frozen for subsequent determination of moisture content of the EC at harvest. The remainder of the harvested ears, were dried down to approximately 12% moisture content. After drying, ear corn weights were recorded for each pooled variety sample. Each variety sample was divided into two equal aliquots. One aliquot was shelled for WSC yield and bulk density calculations.

Ear corn samples frozen at harvesting were lypholized to determine the DM content (FIELDM) at harvest. Whole shell corn and EC were analyzed for CP, starch, ether extract (EE), ADF, NDF and ash content.

The TDN content of EC and WSC was estimated based upon ADF content and also by two stage in vitro digestion.

Energy content (ME, NE_m and NE_g) was predicted from both ADF content and IVDMD derived TDN.

Variety data were compared using the General Linear Models procedure of SAS (1996) for a completely randomized design. Statistical analysis was based on assay replication not plot replication since plots 1, 2 and 3 for individual varieties were composited. Linear regression analysis was used to determine relationships among yield, bulk density (bushel weight), RELMAT, chemical composition, digestibility and energy content.

Results and Discussion

Whole Shell Corn Analysis

Chemical composition, yield, BD, RELMAT, IVDMD, and energy content (ME, NE_m, and NE_g) of corn grain varieties are presented in Table 2, along with, 1996 Beef NRC chemical composition and energy content values for 54 lb/bu corn.

Table 2: Whole Shell Corn: Composite Chemical Composition[a] of 17 Corn Varieties

Nutrient	Mean	SD	NRC '96[b]
DM/acre, lb	1941	706	
BD, lb/bu	36	4.28	56
RELMAT,%	80.58	4.46	
Ash, %	1.84	.19	1.60
CP, %	9.42	.72	9.80
NDF, %	17.89	2.58	9.00
ADF, %	4.88	.77	3.30
Starch, %	74.97	4.22	75.3[c]
Ether Extract, %	2.43	.36	4.30
TDN, %[d]	84.72	1.18	88
ME, Mcal/,lb[e]	1.42	.04	1.45
NE_m, Mcal/lb[e]	.95	.04	.99
NE_g, Mcal/lb[e]	.65	.03	.68
IVDMD, %	88.29	2.62	
ME, Mcal/lb[f]	1.45	.04	
NE_m, Mcal/lb[f]	1.00	.03	
NE_g, Mcal/lb[f]	.69	.03	

[a]Differences were detected ($P < .01$) among varieties in chemical composition, yield, and maturity.
[b]National Research Council (NRC), Nutrient Requirements of Beef Cattle
[c]NRC '96 starch content was calculated by subtracting CP, NDF, Ether Extract and ash content NRC '96 values from 100
[d]TDN, % was derived from ADF content
[e]ME, NE_m and NE_g values were calculated using NRC '96 equations applied to TDN estimate
[f]ME, NE_m and NE_g values obtained for IVDMD were calculated by replacing TDN values in the NRC '96 computer program with IVDMD values

As BD increased, there was a linear decrease in NDF (P< .01), ash (P< .01), CP (P< .05) and ADF content (P< .05). Bulk density was positively related to starch (P< .01) and EE content (P< .10). Even though ADF content was influenced by BD, IVDMD and energy content were not related to BD (P> .10). BD and yield were related (r^2=.65; P< .0001).

As RELMAT increased, the agronomically important traits of BD and yield increased linearly (P< .10). However, RELMAT did not influence feed value (P> .10) measured as chemical composition, IVDMD, or energy content. As yield increased, CP, NDF and ash content (%) decreased linearly (P< .05). Ether extract content increased linearly (P< .10), and starch content increased linearly (P< .01) as yield increased. Yield was related to ADF content cubically (P< .05). In vitro dry matter digestibility and energy content were not related to yield (P> .10).

Table 2 compares energy content predicted from TDN content and IVDMD. Energy content predicted from IVDMD values were higher and more closely related to 1996 Beef NRC (1996) energy content values for No. 2 corn than energy content predicted from ADF values.

Whole shell corn varieties were sorted into DM yield groups (YGP 1, YGP 2, and YGP 3) based on natural separations in yield production records. Yield group 1 consisted of the following varieties: PI 3559, PI 3733, and PI 3751. Pioneer 3357, CG 3777, PI 3563, PI 3730, DL 1407 and GH H2547 were the varieties represented by YGP 2. Yield group 3 was represented by the remaining varieties: CG 7697, DK 646, DL 10803, GH H2502, TR E1106, TR TR1126, CR 661 and CR 674. Dry matter group yields and chemical composition results are represented in Table 3.

Bushel weight decreased linearly (P< .01), as yield declined from YGP 1 to YGP 3. Crude protein, NDF, and ash content decreased (P< .05) linearly as yield increased, while ADF content was not influenced (P> .10).

Table 3: Whole Shell Corn: Corn Yield Groups (YGP)

	YGP 1 n = 3	YGP 2 n = 6	YGP 3 n = 8	
Nutrient	Mean	Mean	Mean	EMS
DM/acre, lb	2949[a]	2310[b]	1295[c]	67108
BD, lb/bu	41[a]	38[b]	33[c]	1301
RELMAT, %	82.52	82.10	78.09	52.97
Ash, %	1.66	1.80	1.94	0.02
CP, %	8.93[a]	9.22[ab]	9.76[b]	0.42
NDF, %	15.51[a]	16.81[a]	19.60[b]	3.84
ADF, %	4.25	4.93	5.09	0.53
Starch, %	79.61[a]	77.06[a]	72.03[b]	10.68
Ether Extract, %	2.63	2.53	2.28	0.11
IVDMD, %	87.82	88.32	89.13	8.43
ME, Mcal/kg[d]	1.44	1.46	1.45	0.002
NE_m, Mcal/kg[d]	.99	1.00	.99	0.001
NE_g, Mcal/kg[d]	.68	.69	.68	0.001

[a,b,c]Means in a row with uncommon superscripts differ (P < .05)
[d]ME, NE_m and NE_g values obtained for IVDMD were calculated by replacing TDN values in the NRC '96 computer program with IVDMD values

Ear Corn Analysis

Chemical composition, yield, RELMAT, IVDMD and energy content (ME, NE_m, and NE_g) of whole ear samples (n = 19) are presented in Table 4 along with 1996 Beef NRC chemical composition and energy content values for 56 lb/bu (No. 2) EC.

As FIELDM content increased, EC yield was influenced quadratically (P < .05). As yield increased, EE content (%) increased linearly (P < .01). Starch, CP, and ash content (%) were affected quadratically (P < .001) by yield. NDF and ADF content (%) were affected cubically by yield (P < .01).

As RELMAT (%) increased, yield increased (P < .01). The DM content of EC at harvest was influenced cubically (P < .05) by RELMAT. Relative maturity also had a cubic effect (P < .05) on ash, starch, NDF, and ADF content (%) of EC.

In vitro dry matter digestibility was not related to (P > .10) yield. As ADF and NDF content increased, IVDMD decreased (P < .01). Relative maturity influenced IVDMD cubically (P < .05).

Ear corn varieties were sorted into DM yield groups (YGP 1, YGP 2, YGP 3, and YGP 4) based on natural separations in yield production records (Table 5). Pioneer 3559 and PI 3733 varieties made up YGP 1. Yield group 2 consisted of the following varieties: PI 3357, CG 3777, PI 3563, PI 3751, PI 3730, DL 1407, GH H2502 and GH H2547. Yield group 3 was represented by the following varieties: DK 646, DL 10803 and TR TR1126. Yield group 4 consisted of the remaining varieties: CG 7697, TR E1106, TR E1136, TR TR1130, CR 661 and CR 674.

As yield increased from YGP 4 to YGP 1, FIELDM, RELMAT, starch and EE content increased linearly (P < .10). Crude protein, ADF, NDF and ash content decreased linearly (P < .10) as yield increased, while energy content and IVDMD were not influenced (P > .10).

To evaluate the feed potential per acre of cropland, TDN production per acre was calculated based upon dry matter yields and IVDMD. Whole shelled corn from yield group 1, 2, and 3 produced 2529, 1956 and 1099 lb TDN/ac respectively. Total TDN production could be increased by harvesting the crops as ear corn. , This would also accommodate dry down and shelling problems associated with soft corn. TDN production for the four ear corn yield groups was 2980, 2180, 1437 and 780 lb/ac.

Conclusion

Delayed planting and/or early frost create several concerns for farmer/feeders. When planting is delayed and corn is being planted for the sole purpose of livestock feed production, neither, maturity or bushel weight, (lb/bu) were consistently related to total digestible nutrient production/acre. Yield (lb DM/acre) and especially production/acre are the top priority when the production of livestock feed is the goal. Among the corn varieties screened, Pioneer 3559, Pioneer 3733 and Pioneer 3751 were the most suitable for the production of livestock feed when corn was grown under the stress of a shortened growing season.

Table 4: Ear Corn Chemical Composition[a] of 19 Corn Varieties

Nutrient	Mean	SD	NRC '96[b]
DM/acre, lb	2307	997	
RELMAT, %[h]	80.65	5.07	
Ash, %	1.95	.37	1.90
CP, %	8.52	1.38	9.00
NDF, %	35.79	8.56	28.00
ADF, %	14.46	3.86	9.20[c]
Starch, %	57.97	13.08	57.4[d]
Ether Extract, %	2.04	.31	3.70
TDN, %[e]	71.93	7.33	82.00
ME, Mcal/lb[f]	1.18	.05	1.35
NE_m, Mcal/lb[f]	.77	.04	.91
NE_g, Mcal/lb[f]	.49	.03	.61
IVDMD, %	82.54	2.82	
ME, Mcal/lb[g]	1.35	.05	
NE_m, Mcal/lb[g]	.92	.04	
NE_g, Mcal/lb[g]	.62	.03	
FIELD DM, %	47.87	12.60	

[a]Differences were detected ($P < .01$) among varieties in chemical composition, yield, and maturity.
[b]National Research Council (NRC), Nutrient Requirements of Beef Cattle
[c]ADF was calculated from 1996 NRC TDN content
[d]NRC '96 starch content was calculated by subtracting CP, NDF, Ether Extract and ash content NRC '96 values from 100
[e] TDN, % was estimated from ADF content
[f]ME, NE_m and NE_g values were calculated using NRC '96 equations applied to estimated TDN
[g]ME, NE_m and NE_g values obtained for IVDMD were calculated by replacing TDN values in the NRC '96 computer program with IVDMD values

Table 5: Ear Corn: Yield Groups (YGP)

	YGP 1n = 2	YGP 2n = 8	YGP 3n = 3	YGP 4n = 6	
Nutrient	Mean	Mean	Mean	Mean	EMS
DM/acre, lb	3740^{a}	2980^{b}	1897^{c}	1139^{d}	98972
RELMAT, %[e]	87.10^{a}	82.14^{ab}	76.76^{ab}	77.36^{b}	435319
FIELD DM, %	58.43^{a}	54.52^{a}	47.55^{ab}	35.65^{b}	92.19
Ash, %	1.70^{a}	1.71^{a}	1.99^{ab}	2.33^{b}	0.07
CP, %	7.75^{a}	7.76^{a}	8.67^{ab}	9.72^{b}	1.30
NDF, %	27.14^{a}	33.09^{ab}	32.66^{ab}	43.93^{b}	45.63
ADF, %	10.66^{a}	13.93^{ab}	12.39^{ab}	17.47^{b}	11.29
Starch, %	68.41^{a}	63.11^{ab}	61.66^{ab}	45.81^{b}	114.69
EE, %[f]	2.47^{a}	2.08^{ab}	2.10^{ab}	1.81^{b}	0.07
IVDMD	85.71	81.90	84.61	81.31	6.53
ME, Mcal/kg[g]	1.41	1.35	1.39	1.34	.002
NE_m, Mcal/kg[g]	.96	.91	.95	.90	.001
NE_g, Mcal/kg[g]	.65	.61	.64	.60	.001

[a,b,c,d]Means in a row with uncommon superscripts differ $P < .05$

[e]RELMAT (relative maturity) for YGP 4, there are only 4 varieties included in the mean. Croplan 674 and Croplan 661 were eliminated from the data set because of different growing degree day ratings.

[f]Ether Extract

[g]ME, NE_m and NE_g values were calculated using NRC '96 equations applied to estimated TDN