Effect of Corn Plant Maturity on Yield and Nutrient Quality of Corn Plants, 2-Year Summary

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Summary

Corn plots were serially harvested over 2 years to evaluate changes in nutrient content, digestibility, and yield as plants matured from half-milk line through black layer. In yr 1 (2013), short (102 d) and normal (111 d) season hybrids were grown. Year 2 used 111 d and 112 d hybrids. Silage and grain yield increased until black layer. Silage DM increased with maturity to 42% at black layer. Percent NDF in the stover, NDF-digestibility and overall silage TDN increased quadratically as maturity increased. There is a balance between moisture content, nutrient content, and silage yield, as corn plants mature.

Introduction

Previous research (*2013 Nebraska Beef Cattle Report*, pp. 74–75) showed that including corn silage in a finishing diet with distillers grains was economical and has more incentive in times of higher priced corn. With high land prices and production costs, corn silage production must be optimized for both yield and nutritive value. Previous research (*2013 Nebraska Beef Cattle Report*, pp. 42–43) investigated the effect of hybrid, growing season length, plant density, and harvest timing on whole corn plant DM yield and nutritive value. The results of that study suggested nutritive value and whole corn plant yield was affected by hybrid selection, planting density and harvest timing. Overall, the study showed that corn grain yield and corn plant DM yield increased over time, yet had little effect on nutritive quality. The objective of this experiment was to investigate the optimal time of harvest and the impacts of cutting height on corn silage yield and quality.

Procedures

In the fall of 2013, two irrigated corn plots contained a 111-d maturing DEKALB variety DKC 61–16RIB and a 102-d maturing DEKALB variety DKC 52–61RIB, and fields were planted on May 1, 2013 and June 12, 2013, respectively. Both plots were sampled weekly either 6 (102 d planted late) or 7 times (111 d planted normal date) around grain maturing (before and after black layer). Sample dates were from August 22 to September 17 (111 d normal) and September 12 through October 1 (102 d early) to reflect the time from half milk line through dry grain harvest. Each sample date consisted of eight sampling replications with 10 plants in each replication.

In the fall of 2014, two hybrids, Pioneer 1151AM (111-d maturity) and Pioneer 1266AM (112-d maturity) were sampled in a dry land corner of the field and under irrigation. Sampling occurred from August 21, 2014 to October 2, 2014, with all plots sampled over the 7 week period.

In both years, plants were cut at the third node, to approximately 18 in above ground. In the fall of 2013, plants were harvested at different cutting heights and samples segregated at the lower stem at 2, 6, 12, and 18 in. heights corresponding with the nodes 1, 2, 3, and 4, respectively. For the two-year summary, data for 18 in. cutting height were used from 2013. Each week, samples were collected 20 feet past where the sampling ended the week before.

The total sample was weighed and maturity stage recorded based on the kernel. Dry matter was determined on all samples in both year 1 and 2 and used for yield calculations. The ear was weighed, and dried for a minimum of 72 hours in a 140°F oven. The last 24 hours, the grain was separated from the cob and allowed to continue to dry. After drying, grain and cobs were weighed. The remaining stover and husk were ground through a wood chipper and thoroughly mixed. Subsamples were collected from ground stover for DM analysis at 140°F for a minimum of 48 h, or freeze dried and then ground through a 2-mm screen for laboratory analysis. Ground stover samples were analyzed for concentration of NDF and in situ NDF digestibility (NDFd; 28 hour incubation). A value for stover residue digestible NDF was calculated using DM percentage, NDF, and NDFd for stover samples. Crude protein was determined on ground stover. Data from the 2 years were combined to determine the change across time for percent grain, silage yield, silage DM, grain yield, percent CP, percent cell solubles, DM NDFd, and DM NDF content. Stover digestible dry matter (DMD) was calculated as digestible NDF plus cell solubles minus 12 (metabolic loss). To calculate silage DMD, grain was assumed to have 90% DMD.

Yield and nutritive value data were analyzed using the MIXED procedure of SAS (SAS Institute, Inc., Cary N.C.). The experimental unit was classified as plot (ten corn plants) for digestibility work. Harvest timing was a fixed effect, and dry land or irrigated field and year hybrid were considered random. Differences were considered statistically significant at $P \leq 0.05$.

Results

Percent grain increased linearly as maturity increased ($P < 0.01$; Table 1) and averaged 52% grain at black layer when cut at 18 in. height above ground. Silage yield increased quadratically as maturity increased ($P < 0.01$), peaking at black layer. Grain yield also increased quadratically as maturity increased ($P = 0.02$), peaking around black layer. It is unclear why grain yield subsequently decreased after black layer. Silage DM increased linearly as maturity increased ($P < 0.01$). The silage first increased in DM slowly, until approximately a week before black layer; then DM increased at a faster rate. Silage DM was 33 to 38% at 1 to 2 weeks prior to black layer when traditionally cut for silage. However, silage DM was 42% at black layer. Crude protein had a tendency to decrease linearly with maturity in both years ($P = 0.14$). Cell solubles in the stover decreased quadratically and % NDF (DM basis) increased quadratically ($P = 0.03$) as

Table 1. Yield and nutrient characteristics of hand harvested whole plants cut at 18 in. above ground in the fall of 2013 and 2014. Data are combined for both years

	Weeks from Blacklayer								*P*-value	
	−4	−3	−2	−1	0	1	2	3	Lin.[a]	Quad.[b]
Percent Grain, %	48.8	45.2	48.9	50.9	52.3	53.5	55.2	59.4	< 0.01	0.29
Silage Yield, DM tons/ac	10.28	10.49	10.65	11.22	12.59	11.95	10.33	9.07	0.73	0.01
Silage DM, %	33.4	32.2	33.4	38.1	42.2	43.3	49.1	59.0	< 0.01	0.01
Grain Yield, bu/ac	210.8	198.5	218.4	237.8	274.5	266.6	239.8	226.4	0.03	0.02
Stover (entire plant without grain)										
Crude Protein, %	5.86	7.27	6.93	6.39	5.76	6.67	5.26	5.55	0.14	0.84
Cell Solubles, %	33.7	35.3	34.9	35.4	36.7	36.4	30.6	25.6	0.08	0.03
NDF, % of DM	66.3	64.7	65.1	64.6	63.3	63.6	69.4	74.4	0.08	0.03
NDF digestibility, %[c]	51.9	62.8	63.6	63.7	61.1	61.3	53.0	38.6	0.08	< 0.01
Digestible DM, %	56.2	63.6	63.7	64.1	62.5	62.5	55.1	42.2	0.04	< 0.01
Silage (entire plant with grain)										
Digestible DM, %	72.7	75.8	76.9	77.6	77.4	77.7	74.6	70.6	0.50	0.01
Dig DM yield, tons/acre	7.47	7.97	8.20	8.74	9.81	9.34	7.71	6.40	0.68	< 0.01

[a]*P*-value for linear response to maturity (weeks from blacklayer)
[b]*P*-value for quadratic response to maturity (weeks from blacklayer)
[c]28-h in-situ digestibility

Table 2. Effect of cutting height at harvest on yield characteristics of 111 day season corn in Exp 1

Item	Cutting Height[a]				SEM	*P*-value[b]
	2 in.	6 in.	12 in.	18 in.		linear
% DM	35.2	35.8	36.6	37.7	0.24	< 0.01
Silage Yield[c]	10.1	10.0	9.5	9.2	0.06	< 0.01
Grain %	45.2	46.2	48.1	50.2	0.32	< 0.01
NDF-dig. (stover)[d]	44.2	45.3	47.1	49.2	0.40	< 0.01
Crude Protein	7.3	7.5	7.8	8.3	0.06	< 0.01

[a]2 in.=cut at second crown root; 6 in.= cut at first node above second crown root; 12in.=cut at second node above the second crown root; 18 in.= cut at third node above second crown root
[b]Cutting Height = Lin response of cutting height
[c]Silage Yield in DM ton/ac
[d]28-h in-situ digestibility as percent of plant

Table 3. Effect of cutting height at harvest on yield characteristics of 102 day season corn in Exp. 1

Item	Cutting Height[a]				SEM	*P*-value[b]
	2 in.	6 in.	12 in.	18 in.		linear
% DM	36.0	36.5	37.4	38.2	0.25	< 0.01
Silage Yield[c]	8.6	8.6	8.4	8.2	0.08	0.37
Grain %	51.0	51.6	52.6	53.6	0.23	< 0.01
NDF-dig. (stover)[d]	36.7	37.3	38.3	39.4	0.59	< 0.01
Crude Protein	7.2	7.3	7.4	7.6	8.1	0.08

[a]2 in. = cut at second crown root; 6 in. = cut at first node above second crown root; 12in. = cut at second node above the second crown root; 18 in.= cut at third node above second crown root
[b]Cutting Height = Lin response of cutting height
[c]Silage Yield in DM ton/ac
[d]28-h in-situ digestibility as percent of plant

maturity increased. Digestibility of NDF was quadratic ($P < 0.01$) as maturity of the stover increased, with little change early, and a dramatic decrease in digestibility one week past black layer.

The DMD of the whole plant silage was estimated based on digestibility of the NDF and assuming 100% digestibility of cell solubles and 12% metabolic loss. The estimated values may not be absolute but give good relative values to predict the change in silage DMD with advancing maturity. Because NDF content increased and NDF digestibility decreased with maturity, the DMD of the stover decreased with maturity. However, because the percent grain was simultaneously increasing, the DMD of the silage did not change from the first to the last sampling time.

As cutting height increased, yield of stover decreased linearly as expected for both the 111 d hybrid (Table 2) and the 102 d hybrid (Table 3). If plants were cut higher, % DM linearly increased suggesting the bottom portions of stem are considerably lower in DM than upper portions of the plant. In addition, % grain (as a proportion of total plant corn silage) and % NDF digestibility (of stover) increased as cutting height was increased in both hybrids in year 1 (Table 2, Table 3).

Dry matter content of the silage was 35% at about 1.5 weeks prior to black layer. Silage yield increased up to black layer (42%) which means that the cost per ton of dry matter would be least at black layer. In addition, hauling dryer silage should decrease harvest, transport, and packing costs, but additional work is required on storage. The DMD of the silage (silage quality) did not change from 35 to 44% DM. These data suggest that silage should be harvested at black layer assuming steps are taken to assure adequate preservation of the drier silage.

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