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# Effect of Corn Plant Maturity on Yield and Nutrient Quality of Corn Plants

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## Summary

*Two corn plots (short season, 102-day, and normal season, 111-day corn) were serially harvested to evaluate nutrient, digestibility, and yield change over the duration from half-milk line through black layer. Digestibility of the corn plant decreased as corn plant maturity and NDF content increased. The lower leaf in the normal season plot decreased in digestibility, but did not change in the short season plot. Little change was observed in the digestibility of the internodes across time. The NDF content of the upper plant increased in both plots. The internodes increased in NDF content across time in both plots. The results of this study suggest there is a delicate balance between plant maturity, nutrient content, and yield.*

## Introduction

The use of corn silage may be economical in times of high priced roughages and corn. Previous research (2013 Nebraska Beef Cattle Report, pp. 74-75) reported that including corn silage in a finishing diet with distillers grains is 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 their study suggested nutritive value and whole corn plant yield was effected by hybrid selection, planting density, and harvest timing. The time of harvest had the greatest impact on both yield and quality characteristics. 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 best time of harvest for optimal percent grain and the impacts of internode quality or cut height on corn silage.

## Procedures

One normal season (NS) DEKALB variety DKC 61-16RIB (111 day) was planted on May 1, 2013, and one short season (SS) DEKALB variety DKC 52-61 VT3 (102 day) was planted on June 12, 2013, both at a seed rate of 33,000 plants/ac at ARDC near Mead, Neb. These plots were both under the same pivot irrigation system in the same section of the field. Both plots were sampled seven (NS) or six (SS) times, from Aug. 22 to Sept. 17 (NS) and Sept. 12 through Oct. 1 (SS), to reflect the time from half milk line through grain harvest. Corn plants were cut at the second crown root in the field. Each sample date consisted of 8 sample sets with 10 plants in each set. Stalk height remaining in the field was measured, then averaged, resulting in approximately 2 inches of stalk left in the field. Samples were weighed and separated into: cob/grain, lower leaf, internodes one, two, and three, and upper plant. Internodes were measured for height. For the NS plot, 2 inches represents the whole plant (minus the grain) down to 2 inches from the ground, this includes all internodes and lower leaf. Six inches represents everything except the grain above 6 inches from the ground, including second and

third internodes. Twelve inches represents everything 12 inches above ground including third internode. Nineteen inches represents the upper plant minus the grain. The SS plot follows similarly, except at 2, 4, 9, and 14 inches. Samples were cut, divided, and analyzed by part to determine the difference in nutritive value as cutting height is adjusted. The upper plant was then ground using a wood chipper. A sub-sample of internodes, lower leaf, upper plant, and all cob/grain samples were dried in a 140°F forced-air oven. Another sub-sample of internodes, lower leaf and upper plant was taken for freeze drying and ground through a 2-mm screen for laboratory analysis.

Concentration of NDF and *in situ* NDF digestibility (NDFd) were analyzed for internodes one, two, and three, lower leaf, and upper plant (28 hour incubation). For each sampling date, internodes and upper plant samples were composited to make four samples instead of eight (1,2; 3,4; 5,6; 7,8). Lower leaf samples were composited by date. This was done to reduce sample numbers. A value for plant residue digestible NDF was calculated using DM percentage, NDF, and NDFd for internodes one, two, and three, lower leaf, and upper plant samples.

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 steer (a composite of 20 corn plants) for digestibility work and plant composite (10 plants) for yield analysis. Harvest timing and plant part were fixed effects.

## Results

Approximate black layer for the NS plot was Sept. 9, 2013, and Sept. 29, 2013, for the SS plot. The SS plot reached maturity late due to being

**Table 1. Effect of maturity on yield characteristics of normal season corn.**

Item	Days from Black Layer <sup>1</sup>							SEM	P-value <sup>2</sup>		P-value <sup>4</sup>	
	-18	-13	-10	-6	-3	3	8		Lin.	Quad.	Sample Day	Cutting Height
Silage yield <sup>3</sup> (~2 in)	11.07	11.41	11.59	11.43	13.88	12.99	13.89	0.38	0.96	1.00	<.01	<.01
Silage yield (~6 in)	10.82	11.16	11.31	11.21	13.73	12.78	13.49	0.38	0.96	1.00	<.01	<.01
Silage yield (~12 in)	10.42	10.72	10.92	10.87	12.56	12.37	12.94	0.38	0.96	1.00	<.01	<.01
Silage yield (~19 in)	9.98	10.24	10.48	10.50	12.20	11.94	12.42	0.38	0.96	1.00	<.01	<.01
Grain % (~2 in)	38.8	42.1	46.1	46.1	44.9	50.2	47.8	0.01	0.89	<.01	<.01	<.01
Grain % (~6 in)	39.7	43.0	48.3	47.0	46.2	51.0	49.2	0.01	0.89	<.01	<.01	<.01
Grain % (~12 in)	41.3	44.8	49.0	48.5	49.1	52.7	51.3	0.01	0.89	<.01	<.01	<.01
Grain % (~19 in)	43.1	46.9	51.0	50.1	52.3	54.6	53.4	0.01	0.89	<.01	<.01	<.01
% DM (~2 in)	32.6	31.5	34.5	33.0	37.4	38.2	39.5	0.01	0.93	0.09	<.01	<.01
% DM (~6 in)	33.1	32.0	35.2	33.7	37.8	38.9	40.1	0.01	0.93	0.09	<.01	<.01
% DM (~12 in)	33.6	32.8	36.1	34.8	38.0	40.2	41.0	0.01	0.93	0.09	<.01	<.01
% DM (~19 in)	34.6	33.8	37.2	36.0	38.3	41.6	42.2	0.01	0.93	0.09	<.01	<.01

<sup>1</sup>Days from black layer: -18 = Aug. 22, 2013; -13 = Aug. 27, 2013; -10 = Aug. 30, 2013; -6 = Sept. 3, 2013; -3 = Sept. 6, 2013; 3 = Sept. 12, 2013; 8 = Sept. 17, 2013. Black layer approximately Sept. 9, 2013.

<sup>2</sup>Lin. = P-value for the linear interaction response to plant maturity Quad. = P-value for the quadratic interaction response to plant maturity.

<sup>3</sup>Silage yield in DM tons/ac.

<sup>4</sup>Sample day = P-value for effect on day of sampling cutting height = P-value for effect on plant cutting height.

**Table 2. Effect of maturity on yield characteristics of short season corn.**

Item	Days from Black Layer <sup>1</sup>						SEM	P-value <sup>2</sup>		P-value <sup>4</sup>	
	-17	-12	-9	-5	-2	4		Lin.	Quad.	Sample Day	Cutting Height
Silage yield <sup>3</sup> (~2 in)	11.00	10.10	10.52	9.89	10.91	10.39	0.53	1.00	0.51	0.58	0.35
Silage yield (~4 in)	10.87	9.98	10.39	9.79	10.78	10.29	0.53	1.00	0.51	0.58	0.35
Silage yield (~9 in)	10.64	9.80	10.21	9.63	10.59	10.10	0.53	1.00	0.51	0.58	0.35
Silage yield (~14 in)	10.40	9.62	10.03	9.46	10.39	9.90	0.53	1.00	0.51	0.58	0.35
Grain % (~2 in)	47.0	50.3	51.0	52.2	52.8	52.8	0.01	1.00	<.01	<.01	<.01
Grain % (~4 in)	47.6	50.9	51.6	52.7	53.5	53.3	0.01	1.00	<.01	<.01	<.01
Grain % (~9 in)	48.6	51.8	52.5	53.6	54.5	54.3	0.01	1.00	<.01	<.01	<.01
Grain % (~14 in)	49.7	52.8	53.5	54.6	55.5	55.4	0.01	1.00	<.01	<.01	<.01
% DM (~2 in)	29.7	30.2	33.1	37.5	40.1	45.4	0.01	0.89	<.01	<.01	<.01
% DM (~4 in)	30.1	30.6	33.7	38.0	40.8	46.0	0.01	0.89	<.01	<.01	<.01
% DM (~9 in)	30.8	31.3	34.5	38.8	41.7	47.1	0.01	0.89	<.01	<.01	<.01
% DM (~14 in)	31.5	32.1	35.2	39.5	42.7	48.1	0.01	0.89	<.01	<.01	<.01

<sup>1</sup>Days from black layer: -17 = Sept. 12, 2013; -12 = Sept. 17, 2013; -9 = Sept. 20, 2013; -5 = Sept. 23, 2013; -2 = Sept. 27, 2013; 4 = Oct. 1, 2013. Black layer approximately Sept. 29, 2013.

<sup>2</sup>Lin. = P-value for the linear interaction response to plant maturity Quad. = P-value for the quadratic interaction response to plant maturity.

<sup>3</sup>Silage yield in DM tons/ac.

<sup>4</sup>Sample day = P-value for effect on day of sampling cutting height = P-value for effect on plant cutting height.

planted 43 days later than the NS plot. Silage yield was calculated in tons produced per acre. Percent grain was calculated as the percentage of the dry plant being composed of grain. As the corn plant matures, a linear increase ( $P < 0.01$ ) in silage yield was observed in the NS plot, but interestingly no change ( $P = 1.00$ ) was observed in the SS plot. As expected, percent grain increased with increasing plant maturity. Percent grain increased quadratically for both the NS and SS plot ( $P < .01$ ; Tables 1 and 2). An interaction was observed between cutting height and plant maturity in both plots for percent grain. With

increasing maturity, lower plant parts contributed less to the percent grain. Percent grain peaked at approximately black layer, then tended to decrease slightly. Also expected, an increase in percent DM was observed as the corn plant matured. A quadratic interaction was observed between cutting height and maturity for percent DM in the SS plot, but no interaction was observed in the NS plot. The NS plot did however increase in DM linearly as the plant matured during the time of sampling (Tables 1 and 2). As cutting height was increased, there was an increase in percent grain and a decrease in percent DM at later

maturity but at the expense of less silage yield.

Overall digestibility of the corn plant decreased, as expected, with an increase in corn plant maturity for both the NS and SS plots (Table 3). The NS plot decreased linearly with a cutting height by day interaction, but the SS plot showed no interaction ( $P < .01$ ,  $P = .17$ ). Interestingly, there was also a day by day interaction for the NS plot as well, but not the SS plot ( $P < .01$ ,  $P = .07$ ). The higher digestibility of the lower leaf brings the overall digestibility of the plant up slightly at the lowest cutting height.

(Continued on next page)

**Table 3. Effect of maturity on plant NDF digestibility.<sup>3</sup>**

Item	Days from Black Layer <sup>1</sup>							SEM	P-value <sup>2</sup>		P-value <sup>4</sup>		
	-18	-13	-10	-6	-3	3	8		Lin.	Quad.	Day*Day	Sample Day	Cutting Height
Normal Season													
~2 in	50.61	49.27	46.11	44.32	41.06	41.87	42.40	0.01	0.51	0.98	<.01	<.01	<.01
~6 in	51.48	50.31	46.96	44.80	41.75	42.41	42.95	0.01	0.51	0.98	<.01	<.01	<.01
~12 in	53.44	52.50	48.48	45.85	43.37	43.67	43.96	0.01	0.51	0.98	<.01	<.01	<.01
~19 in	55.85	55.12	50.91	47.32	44.97	44.46	46.04	0.01	0.51	0.98	<.01	<.01	<.01
Short Season													
~2 in	38.38	37.76	38.71	35.97	35.18	35.11	0.02	0.99	1.00	0.66	<.01	<.01	<.01
~4 in	38.97	38.19	39.05	36.06	35.24	35.33	0.02	0.99	1.00	0.66	<.01	<.01	<.01
~9 in	40.19	39.21	39.86	36.58	35.90	36.06	0.02	0.99	1.00	0.66	<.01	<.01	<.01
~14 in	41.28	40.37	42.36	37.36	37.14	37.59	0.02	0.99	1.00	0.66	<.01	<.01	<.01

<sup>1</sup>Days from black layer: -18 = Aug. 22, 2013; -13 = Aug. 27, 2013; -10 = Aug. 30, 2013; -6 = Sept. 3, 2013; -3 = Sept. 6, 2013; 3 = Sept. 12, 2013; 8 = Sept. 17, 2013. Black layer approximately Sept. 9, 2013. Short: -17 = Sept. 12, 2013; -12 = Sept. 17, 2013; -9 = Sept. 20, 2013; -5 = Sept. 23, 2013; -2 = Sept. 27, 2013; 4 = Oct. 1, 2013. Black layer approximately Sept. 29, 2013.

<sup>2</sup>Lin. = P-value for the linear response to plant maturity Quad. = P-value for the quadratic response to plant maturity

<sup>3</sup>Digestibility as percent of plant

<sup>4</sup>Sample day = P-value for effect on day of sampling cutting height = P-value for effect on plant cutting height

The upper plant had the next highest digestibility (14 inches and up). Digestibility then decreased as lower parts of the plant were added in. This means that as cutting height decreased, digestibility of the silage is decreased overall, but with an increase in silage yield.

The results from this study suggest there is a delicate balance between obtaining the greatest silage yield and the best nutrient quality of the silage. By decreasing cutting height, overall

volume of the silage produced will increase, but not have a positive impact on quality. These data also suggest that there is little change in the digestibility of the lower internodes (3-12 inches cutting height), though this digestibility is low to begin with. When faced with the challenge of needing more silage, but not wanting to sacrifice quality, it may be possible to extend harvest time in some cases to meet this need. More research is needed to determine how harvesting

at later maturity will affect the stability, fermentation, and nutritional value of the silage.

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