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Effects of Corn Hybrid, Plant Density, and Harvest Time on Yield and Quality of Corn Plants

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Summary

Corn plants were collected to determine the effects of hybrid and season length, plant density, and harvest timing on grain and whole corn plant DM yield and nutritive value. Although whole corn plant DM yield decreased with delayed harvest timing, whole corn plant TDN increased linearly due to increasing grain concentration. Increasing plant density improved yields of grain and whole corn plant DM. This experiment suggests that hybrid and season length selection, planting density, and harvest timing affect whole corn plant DM yield and quality characteristics.

Introduction

Interest in the use of corn silage has increased due to the high price of corn grain and roughages. Current research (2013 Nebraska Beef Cattle Report, pp. 74-75) has reported that corn silage inclusion in finishing diets is economical, with more incentive in times of high priced corn and in diets containing distillers grains. With rising land costs and costs of production, corn silage production by farmer/feeders must be accomplished to optimize both yield and nutritive value; but have the flexibility for corn grain harvest with or without stover harvest if market conditions dictate. Therefore the objectives of this experiment were to determine the effects of hybrid and season length, plant density, and harvest timing on whole corn plant DM yield as well as plant part yield and nutritive value.

Procedure

Corn plants were harvested from an irrigated research plot near York, NE. Five moderately early maturity corn hybrids (MEM; 107 to 111 day maturity; Hoegemeyer Hybrids) and five moderately late maturity corn hybrids (MLM; 112 to 117 day maturity; 1, Pioneer; 4, Hoegemeyer Hybrids) were planted at 4 populations (20,000, 26,000, 32,000, and 38,000 plants/acre) in a split plot design with 3 replications per hybrid X population combination. Five competitive corn plants were cut 6 inches above ground level and collected at three harvest dates (September 1, early harvest, EH; September 15, late harvest, LH; September 29, grain harvest, GH). Grain, husk, and cob fractions were separated and weighed at time of harvest. The remaining plant parts (stem, leaf, and shank) were ground through a wood chipper, collected into one sample, and weighed at time of harvest. A subsample from the stem, leaf, and shank sample, as well as grain, husk, and cob samples were dried in a 105°F forced-air oven and weighed for DM determination and yield/acre calculations. Another subsample of the stem, leaf, and shank sample was freeze dried and ground through a 2-mm screen for laboratory analysis. Oven-dried husk and cob were also ground through a 2-mm screen for laboratory analysis. Concentration of NDF and in situ NDF digestibility (28 hour incubation; NDFd) was analyzed for husk, cob, and the stem, leaf, and shank freeze-dried sample.

A value for plant residue digestible NDF was calculated using DM percentage, NDF, and NDFd for husk, cob, and the stem, leaf, and shank sample. Total plant residue cell soluble concentration was determined summing (1-NDF) for husk, cob, and the

stem, leaf, and shank sample. Addition of plant residue digestible NDF and total plant residue cell soluble concentration resulted in a value for true digestibility, with TDN of residue calculated from this true digestibility – 12% (metabolic loss assumption). Percentage TDN of plant residue multiplied by the DM percentage of residue (sum of all plant residue components or 1 – percent corn grain) resulted in a value for digestible plant residue. Digestible grain content was calculated as corn grain percentage multiplied by 0.9. A final TDN for each hybrid x density x harvest x repetition corn silage was calculated as digestible plant residue + digestible grain content.

Yield and nutritive value data were analyzed using the mixed procedure of SAS (SAS Inst., Inc., Cary, N.C.). The experimental unit consisted of a composite of 5 corn plants. Season length, plant density, and harvest timing were fixed effects. Orthogonal contrasts were used to test the effects of harvest timing and plant density. Statistical interactions between fixed effects, although biologically plausible, were ignored due to extent of replication and for clarity of data interpretation.

Results

Harvest dates were chosen to simulate corn silage harvest (EH and LH) and corn grain with corn stover harvest (GH). There was a quadratic response to whole corn plant DM yield ($P < 0.01$; Table 1) as harvest time was delayed until later in the season, with DM yield increasing between the first two corn silage harvest dates, but then decreasing from then to grain and stover harvest. As expected, grain percentage of the corn plant increased linearly ($P < 0.01$) with delayed harvest. There

Table 1. Effect of harvest timing on corn plant characteristics.

Item	Harvest ¹			SEM	P-value ²	
	1	2	3		Lin.	Quad.
Grain Yield ³	195.0	195.0	195.0			
Corn Plant Yield ⁴	11.00	12.18	10.25	0.10	<0.01	<0.01
Grain, %	51.36	52.40	62.23	0.23	<0.01	<0.01
Residue NDF, %	65.42	62.51	66.65	0.30	<0.01	<0.01
Residue TDN, %	49.29	50.22	41.74	0.31	<0.01	<0.01
Corn Plant TDN, %	70.22	71.10	71.75	0.15	<0.01	0.52

^{abc}Means with different superscripts differ ($P < 0.05$)

¹Harvest dates: 1= September 1, 2011; 2=September 15, 2011; 3=September 29, 2011.

²Lin. = P-value for the linear response to plant density. Quad. = P-value for the quadratic response to plant density.

³Grain yield in bushels per acre.

⁴Corn plant yield in DM tons per acre.

Table 2. Effect of plant density on corn plant characteristics.

Item	Plants per acre				SEM	P-value ¹	
	20,000	26,000	32,000	38,000		Lin.	Quad.
Grain Yield ²	166.4	198.9	203.5	211.2	3.6	<0.01	<0.01
Corn Plant Yield ³	9.84	10.93	11.67	12.14	0.12	<0.01	<0.01
Grain, %	54.25	55.71	55.94	55.42	0.26	<0.01	<0.01
Residue NDF, %	63.07	63.98	65.82	66.58	0.35	<0.01	0.84
Residue TDN, %	48.17	47.40	46.79	45.96	0.35	<0.01	0.92
Corn Plant TDN, %	71.10	71.30	71.13	70.55	0.17	0.02	0.02

¹Lin. = P-value for the linear response to plant density. Quad. = P-value for the quadratic response to plant density.

²Grain yield in bushels per acre.

³Corn plant yield in DM tons per acre.

Table 3. Effect of season length on corn plant characteristics.

Item	Season Length ¹		SEM	P-value
	MEM	MLM		
Grain Yield ²	190.7	199.3	2.5	0.02
Corn Plant Yield ³	10.95	11.34	0.08	<0.01
Grain, %	56.00	54.67	0.18	<0.01
Residue NDF, %	64.18	65.54	0.24	<0.01
Residue TDN, %	47.26	46.90	0.24	0.28
Corn Plant TDN, %	71.35	70.69	0.12	0.01

¹MEM=Moderately early maturity hybrids (107-111 day maturity), MLM=Moderately late maturity hybrids (112-117 day maturity).

²Grain yield in bushels per acre.

³Corn plant yield in DM tons per acre.

was a quadratic response ($P < 0.01$) for residue NDF due to harvest time, with NDF decreasing between the first two harvests and then increasing thereafter. There was also a quadratic response for residue TDN ($P < 0.01$) with the highest quality residue found during the midpoint harvest. Total corn plant TDN was linearly increased

($P < 0.01$) due to the added TDN from greater grain concentrations. Although there was increased TDN concentration of the whole corn plant with GH; there was 15% more total TDN yield/acre for harvesting silage at LH than harvesting the crop for corn grain and corn stover (GH harvest). Yield of grain and total DM

increased quadratically ($P < 0.01$; Table 2) with increasing plant density, with corn planted at 38,000 plants/acre yielding 44.8 more bushels of grain and 2.3 more tons DM /acre than corn planted at 20,000 plants/acre. Grain percentage slightly increased quadratically ($P < 0.01$; range of 1.69 percentage units) with increased plant density. Residue NDF content increased linearly ($P < 0.01$), while TDN content of the residue decreased linearly ($P < 0.01$) with increasing plant density. There was a quadratic response for whole corn plant TDN content due to planting density ($P = 0.02$), but only with a numerical difference of only 0.75 TDN percentage units.

Grain and whole corn plant DM yield increased 4.3% and 3.4%, respectively for MLM hybrids in comparison to the MEM hybrids ($P < 0.05$; Table 3). Grain percentage in the whole corn plant decreased with MLM hybrids ($P < 0.01$). Residue NDF concentration was slightly increased for MLM hybrids ($P < 0.01$). Residue TDN content was not different ($P = 0.28$), however overall TDN of the whole corn plant was slightly higher for the MEM hybrids ($P = 0.01$).

This experiment suggests that whole corn plant yield and nutritive value is affected by decisions made both in the spring (hybrid selection and planting density) and fall (harvest timing), with harvest timing (corn silage or corn grain with stover harvest) having the most profound impact on yield and quality characteristics. In general, as management decisions increase corn grain yield, corn plant DM yield also increases with little effect on nutritive quality.

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