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Location effects on forage production and quality among selected pioneer corn hybrids

Abstract

Six Pioneer corn hybrids were grown in Kansas and four of the six hybrids within three locations in Utah. The Utah hybrids were harvested between the one-quarter and one-half milk line stages of kernel maturity, whereas the Kansas hybrids were harvested at approximately 90% of kernel maturity. Location had a significant effect on the agronomic characteristics and chemical composition of the hybrids. Whole-plant dry matter (DM) and digestible DM yield, grain yield, and percent grain were higher in the Kansas-grown corn. The greater yield and proportion of grain were results of the excellent growth conditions in 1992 and their advanced stage of kernel maturity at harvest. Experimental hybrid X0811 yielded the highest whole-plant DM, grain, stover, and digestible DM among the Kansas corns. Hybrid X0811 also had the highest whole-plant and stover in vitro DM digestibility (IVDMD), the highest whole-plant and stover crude protein (CP), and the lowest whole-plant and stover neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents among the Kansas corns. Hybrid X0811 had the highest stover and digestible DM yields, whole-plant CP and IVDMD, and stover IVDMD and the lowest stover NDF and ADF contents among the Utah hybrids. The high digestible DM yields of hybrid X0811 emphasize the contribution of the stover fraction, in addition to the proportion of grain, to the quality of the whole-plant forage.

Keywords

Cattlemen's Day, 1994; Kansas Agricultural Experiment Station contribution; no. 94-373-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 704; Beef; Corn; Hybrid; Kansas; Utah

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LOCATION EFFECTS ON FORAGE PRODUCTION AND QUALITY AMONG SELECTED PIONEER CORN HYBRIDS

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Summary

Six Pioneer corn hybrids were grown in Kansas and four of the six hybrids within three locations in Utah. The Utah hybrids were harvested between the one-quarter and one-half milk line stages of kernel maturity, whereas the Kansas hybrids were harvested at approximately 90% of kernel maturity. Location had a significant effect on the agronomic characteristics and chemical composition of the hybrids. Whole-plant dry matter (DM) and digestible DM yield, grain yield, and percent grain were higher in the Kansas-grown corn. The greater yield and proportion of grain were results of the excellent growth conditions in 1992 and their advanced stage of kernel maturity at harvest. Experimental hybrid X0811 yielded the highest whole-plant DM, grain, stover, and digestible DM among the Kansas corns. Hybrid X0811 also had the highest whole-plant and stover *in vitro* DM digestibility (IVDMD), the highest whole-plant and stover crude protein (CP), and the lowest whole-plant and stover neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents among the Kansas corns. Hybrid X0811 had the highest stover and digestible DM yields, whole-plant CP and IVDMD, and stover IVDMD and the lowest stover NDF and ADF contents among the Utah hybrids. The high digestible DM yields of hybrid X0811 emphasize the contribution of the stover fraction, in addition to the proportion

of grain, to the quality of the whole-plant forage.

(Key Words: Corn, Hybrid, Kansas, Utah.)

Introduction

The goal of an efficient corn silage production system oriented towards producing beef is to consistently maximize beef yield per acre. Therefore, corn silage producers strive for excellent silage management practices and search for corn hybrids with superior performance (i.e. high digestible energy yields per acre). To better accommodate corn silage producers, seed companies and universities are providing information not only on forage and grain yields, but also on plant part proportions (percent grain, stover, and cob) and digestibilities (whole-plant and stover).

However, limited information exists on the relative quality of superior forage corn hybrids grown with various fertility and irrigation practices and environmental conditions.

As a result of the corn hybrid evaluation trial in 1990 (KAES Report of Progress 592), a cooperative research project was organized between Utah State and Kansas State Universities and Pioneer Hybrid Inc. to determine not only the forage yield and quality of several corn hybrids, but also the

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influence of production conditions on the forage yield and quality of the respective hybrids.

Experimental Procedures

Six mid-maturing, Pioneer, corn hybrids were grown in 1992. The corn hybrids selected by Pioneer for evaluation consisted of experimental (X0811, X1814, XC951) and currently marketed (3215, 3299, 3377) hybrids. The hybrids X0811, X1814, 3215, and 3377 were grown at three locations in Utah, and the hybrids X0811, X1814, XC951, 3215, 3299, and 3377 were grown in Kansas at a single location. All hybrids were grown under irrigated conditions. The corn hybrids were organized into randomized complete blocks with three replications at each location.

The locations in northern Utah were Hooper, Ellwood, and Bear River City. The hybrid plots in Utah were planted in 30 in. rows at plant populations of approximately 28,000 plants/acre.

The hybrids at Hooper were planted on April 25 in a Syracuse loamy fine sand soil that had been previously planted to alfalfa and heavily manured. Seventy-five lb per acre of N as ammonium nitrate was applied side-dress at furrow-making to meet soil requirements (N, P, and K). The hybrids were harvested on August 31.

The hybrids at Ellwood were planted on April 14 in a Fielding silt loam, warm soil that had been heavily manured. Eighty lb N and 60 lb P per acre were applied prior to planting to meet soil requirements (N, P, K). The hybrids were harvested on August 31.

The hybrids at Bear River City were planted on April 20 in a Fielding silt loam, warm soil that was fertilized with 175 and 75 lb per acre of N and P, respectively, to meet soil requirements (N, P, K). The hybrids were harvested on September 1.

The corn hybrid plots in Kansas were located at Manhattan. The plots were

planted in 30 in. rows at populations of approximately 22,000 plants per acre. The hybrids were planted on May 20 in a Reading silt loam soil that was fertilized with 100 lb per acre of liquid N that fulfilled soil requirements (N, P, K). The hybrids were harvested during the second week of September.

All Utah hybrids were harvested when the kernels at the center of the ear were between the one-quarter and one-half milk line stages of maturity. In each plot, 10 plants were hand-harvested and weighed, and plant parts were separated to determine yield (whole plant, stover, ear, and cob) and plant part proportions (percent grain, stover, and cob). The whole plant and stover were chopped with a Kemp chipper-shredder and subsequently sampled for chemical analysis. The remaining ears from the plants designated as stover were frozen and later hand-shelled to determine grain and cob fractions.

In Kansas, the hybrids were harvested when the milk line in the kernels at the center of the ear had progressed through approximately 90% of kernel (just prior to black layer formation). Two inner rows, within a 25-foot-long plot of six rows, were harvested for whole-plant yield, and the remaining two inner rows were used to determine plant part yields and proportions. The whole-plant and stover were harvested and weighed with a modified one-row forage chopper. Samples of the whole-plant and stover material were taken after the harvesting process for chemical analysis. The two outside rows of each plot were designated as border rows and ignored.

The husk remaining from ear separation was included in the stover fraction at all locations. The samples of all plant parts then were dried in a forced-air drying oven. Chemical analysis was performed on all samples using standard techniques.

The donor animal for the IVDMD analysis was a 4-year-old 1200 lb, lactating, crossbred, beef cow fitted with a rumen

cannula. The ration was 90% corn silage and 10% supplement on a DM basis, was formulated to 10.5% protein, and met NRC requirements for vitamins and minerals. The animal was fed ad libitum twice daily and consumed from 27 to 35 lb DM of corn silage per day. The fluid for in vitro analyses was collected immediately prior to the a.m. feeding.

Results and Discussion

The agronomic characteristics are presented in Table 1. The chemical composition of the whole plant and stover are provided in Tables 2 and 3, respectively. Because the location by corn hybrid interaction was significant, the corn hybrids are presented within their respective locations. However, to more efficiently present the Kansas results for this publication, the results of the hybrids at each location in Utah have been combined as corn hybrid averages across Utah.

Whole-plant DM yield in Utah ranged from 9.0 to 10.58 tons per acre in corn hybrids 3215 and 3377, respectively, with an average of 10.01 tons. Whole-plant DM yield in Kansas ranged from 9.78 to 11.08 tons per acre in corn hybrids 3299 and X0811, respectively, with an average of 10.43 tons. The Utah-grown corn was able to maintain whole-plant DM yields equivalent to those of the Kansas corn even though the whole-plant DM content of the Utah corn was lower (27.46 vs 34.13%). This is a result of the higher plant populations of the Utah-grown corn.

The Kansas corn had higher whole-plant DM (27.46 vs 34.13) and CP (6.04 vs 8.01) contents than the Utah corn. The higher whole-plant DM content was a result of the advanced maturity of the Kansas corn. The higher DM content of the grain (not presented) elevated the whole-plant DM when compared to the stover DM alone. The differences in CP content were predominately functions of soil fertility and factors affecting soil nutrient exchange.

Grain yields in Utah ranged from 109.7 to 158.2 bu per acre in corn hybrids 3215 and 3377, respectively, with an average of 132.7 bu. Grain yields in Kansas were higher and ranged from 191.2 to 215.8 bu per acre in corn hybrids 3215 and X0811, respectively, with an average of 205.6 bu.

Stover DM yield was not significantly different across the corn hybrids in Utah and averaged 5.92 tons per acre. In Kansas, the stover DM yields were lower and ranged from 3.89 to 5.06 tons per acre in corn hybrids 3299 and X0811, respectively, with an average of 4.64 tons.

The Kansas-grown corn contained higher proportions of grain and lower proportions of stover and cob than did the Utah corn. The higher grain yield and proportion of grain was primarily due to the excellent growth conditions in 1992 and the more advanced stage of maturity, resulting in a greater proportion of the whole-plant DM residing in the grain.

Digestible DM yield was higher in Kansas than in Utah, 7.32 vs 6.93 tons per acre, which was primarily due to the higher whole-plant DM content and grain proportion in the Kansas-grown corn. The higher grain proportion in the Kansas corn reduced the ADF and NDF content of the whole-plant dry matter. Hybrid X0811 had the highest digestible DM yield across both Utah and Kansas. The high digestible DM yield of hybrid X0811 was a result of its high whole-plant IVDMD and low whole-plant NDF and ADF. The stover fraction of hybrid X0811 had the lowest NDF and ADF contents and the highest IVDMD in both Kansas and Utah. The high quality of whole-plant X0811 emphasizes the contribution of the stover fraction to the quality of the whole-plant dry matter. Therefore, experimental corn hybrid X0811 has the potential to be labeled as a superior forage hybrid because it consistently yields high proportions of grain and produces a high quality stover.

Table 1. Whole-Plant, Grain, Stover, and Digestible DM Yields, and Plant Part Proportions of the Corn Hybrids Grown in Utah and Kansas

Location and Hybrid	Whole-Plant DM Yield, tons/acre	Grain Yield, bu/acre ^a	Stover DM Yield, tons/acre	Digestible DM Yield, tons/acre	Plant Part (% DM basis)		
					Grain	Stover	Cob
<u>Utah</u> ^b	10.01	132.7	5.92	6.93	31.7	60.8	7.5
X0811	10.39	141.0	5.99	7.51	33.1	59.9	7.0
X1814	10.13	136.8	5.92	6.90	33.4	59.7	6.9
3215	9.00	109.7	5.58	6.05	28.4	63.9	7.7
3377	10.58	158.2	5.76	7.31	35.9	55.8	8.3
<u>Kansas</u> ^b	10.43	205.6	4.64	7.32	49.2	45.6	5.2
X0811	11.08	215.8	5.06	8.10	48.8	46.8	4.4
X1814	10.71	209.4	4.73	7.50	49.7	45.4	4.9
3215	10.21	191.2	4.89	7.04	46.0	49.1	4.9
3377	9.94	197.2	4.35	6.92	48.9	44.9	6.2
3299	9.78	210.7	3.89	7.03	54.0	40.9	5.1
XC951	10.83	209.4	4.89	7.32	47.8	46.8	5.4
LSD (P<.05) ^c	1.21	20.46	0.62	0.95	1.93	2.20	0.49

^aAdjusted to 14.5% moisture.

^bUtah and Kansas means, respectively.

^cThe LSD (least significant difference) is valid only among corn hybrids within Kansas.

Table 2. Chemical Composition and In Vitro Digestibility of the Whole-Plant Forage of Corn Hybrids Grown in Kansas and Utah

Location and Hybrid	Dry Matter, %	CP	NDF	ADF	IVDMD
----- % of the forage DM -----					
<u>Utah</u> ^a	27.46	6.04	48.63	28.75	69.30
X0811	26.73	6.50	47.74	27.41	72.39
X1814	27.70	5.96	48.02	29.30	68.33
3215	27.60	5.94	50.57	30.13	67.37
3377	29.85	6.11	45.91	26.14	69.19
<u>Kansas</u> ^a	34.13	8.01	41.64	24.84	70.16
X0811	34.63	8.60	39.81	23.09	73.13
X1814	35.97	8.32	39.84	23.47	69.96
3215	32.11	8.36	44.67	27.60	68.93
3377	31.25	7.70	41.69	25.27	69.58
3299	37.87	7.32	40.79	23.81	71.76
XC951	32.91	7.75	43.04	25.77	67.55
LSD (P<.05) ^b	6.26	0.46	3.98	2.62	2.34

^aUtah and Kansas means, respectively.

^bThe LSD (least significant difference) is valid only among corn hybrids within Kansas.

Table 3. Chemical Composition and In Vitro Digestibility of the Stover Fraction of Corn Hybrids Grown in Utah and Kansas

Location and Hybrid	Dry Matter, %	CP	NDF	ADF	IVDMD
----- % of the forage DM -----					
<u>Utah</u> ^a	22.30	5.38	61.87	39.75	63.71
X0811	21.23	5.53	60.90	38.25	67.10
X1814	22.48	5.30	62.40	41.86	61.45
3215	23.20	5.50	62.36	39.75	62.14
3377	23.29	5.68	60.75	38.54	64.17
<u>Kansas</u> ^a	24.01	6.38	62.04	41.14	60.11
X0811	23.61	6.60	57.52	38.38	65.47
X1814	23.50	6.17	63.36	42.29	57.63
3215	22.84	6.25	63.76	42.42	58.82
3377	21.15	7.18	62.44	40.79	61.05
3299	26.97	6.40	62.69	41.12	62.26
XC951	26.01	5.72	62.45	41.87	55.44
LSD (P<.05) ^b	2.18	0.88	2.54	2.62	4.15

^aUtah and Kansas means, respectively.

^bThe LSD (least significant difference) is valid only among corn hybrids within location.