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Influence of Corn Hybrid, Kernel Traits, and Growing Location on Digestibility

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Summary

One hundred thirty-two commercially available corn hybrids, grown in 2 field replications within three locations, were evaluated for effects of corn hybrid, kernel traits and growing location on digestibility. A significant hybrid by location interaction was observed for most kernel traits. There is potential to select hybrids for DM digestibility, but digestibility shows no consistent relationship with other kernel traits.

Introduction

Studies (*2004 Nebraska Beef Report*, pp. 54-57 and *2006 Nebraska Beef Report*, pp. 45-47) have shown that corn hybrids with a larger proportion of softer endosperm can improve feedlot performance and digestibility. Effects of location or growing environments, on kernel characteristics, feedlot performance, and digestibility have not been reported. Therefore, the objective of our experiment was to evaluate kernel traits and *in situ* digestibility of corn hybrids grown at three locations.

Procedure

Grain Production and Sampling

One hundred thirty-two commercially available corn hybrids were grown at three separate commercial research locations throughout the Corn Belt. Within the three locations (Pekin, Ill., Ames, Iowa, and Waterloo, Neb.), hybrids were grown in two similar, independent field plots. At harvest, a 5 lb corn sample was collected for analysis. A small subsample was collected and sent to a commercial (Precision Grain Analytics) laboratory for near infrared (NIR) analyses of starch, protein, and oil. The remaining sample was analyzed at the University of Nebraska Animal Science Complex.

1,000 Kernel Weights and Stenvert Hardness Test

Samples were analyzed in duplicate for both 1,000 kernel weight and Stenvert hardness test as described in previous research (*2006 Nebraska Beef Report*, pp. 43-44).

In Situ *Dry Matter Digestibility*

Thirty hybrids were chosen for *in situ* digestibility analysis in order to identify physical characteristics which could predict digestibility. Hybrids were chosen based on a range of kernel weights and hardness as well as from prior research conducted with many of the hybrids from this trial. Samples were ground through a Wiley Mill with a 6.35 mm screen to simulate a masticated dry-rolled corn sample. Once ground, a 5 g sample was placed in a 5×H10 cm Dacron bag, which was then heat sealed. Two replications of each sample were incubated in two ruminally and duodenally fistulated Holstein steers. In total, 24 individual replications, two per plot per location, were observed for each selected hybrid. Bags were incubated for 22 hours, which was based on the 75% mean retention time for a 3.44%/hour passage rate. After incubation, bags were removed, rinsed, and machine washed using five three-minute cycles and dried in a 60°C forced air oven for 48 hours.

Data analysis

Kernel traits were analyzed using the MIXED procedure of SAS (SAS Institute, Cary, N.C.), with hybrid, location, and hybrid*location interaction as fixed effects. Relationships were analyzed using the CORR procedure of SAS to obtain simple correlation coefficients.

Hybrids used in this study represent a large range in growing seasons or relative maturity (RM). The RM is a crop research tool that evaluates the length of time necessary for the corn plant to reach full maturity, in order to be grown in different geographical locations. Seven RM groups were represented within the entire group of hybrids, with three groups most consistent with Nebraska corn production. The categories were an RM of 97-103 (Group 1), which would be grown in northern and western Nebraska, an RM group of 104-107 (Group 2), which would represent northeastern Nebraska as well as northern Iowa and an RM group of 108-112 (Group 3), which would represent production in central and southeastern Nebraska.

Results

RM group 97 - 103 (Group 1)

Physical and chemical characteristics for hybrids within Group 1 are presented in Table 1. Twenty-five hybrids fell into this group, with 5 of those hybrids being evaluated for *in situ* DM digestibility (ISDMD). A significant hybrid*location interaction was observed for all kernel traits within this group. No significant relationships were observed between ISDMD and any other kernel characteristic, but we only had five hybrids evaluated for ISDMD within this group. The strongest relationships observed for Group 1 were between NIR measurements. Starch content was negatively related to both oil and protein ($r = -0.54$, and $r = -0.58$ respectively).

Table 1. Physical and chemical characteristics across hybrids within maturity group 97-103 (Group 1).

Variable	Mean	Maximum	Minimum	Standard Deviation	# of hybrids[a]	*P* - value[b]
Kernel wt., g	273.7	345.8	223.1	22.8	25	<0.01
Stenvert Hardness						
Time to grind, s	6.4	8.0	5.0	0.69	25	<0.01
RPM	2428	2610	2210	75	25	<0.01
Soft ht, %	72.73	79.61	66.04	1.88	25	<0.01
Hard %	72.25	75.94	64.92	1.84	25	<0.01
Oil, %	4.32	4.94	3.65	0.30	25	<0.01
Protein, %	10.07	11.06	8.86	0.51	25	<0.01
Starch, %	71.41	72.71	68.97	0.74	25	<0.01
ISDMD[c]	32.11	41.10	23.90	4.57	5	<0.01

[a]Number of hybrids evaluated for each trait
[b]*P* - value of hybrid*location effect
[c]ISDMD = *in situ* DM digestibility

Table 2. Physical and chemical characteristics across hybrids within maturity group 104-107 (Group 2).

Variable	Mean	Maximum	Standard Minimum	# of Deviation	hybrids[a]	*P* - value[b]
Kernel wt., g	271.6	371.7	203.9	38.3	21	<0.01
Stenvert Hardness						
Time to grind, s	6.7	10.0	5.0	0.97	21	<0.01
RPM	2418	2700	2280	74	21	<0.01
Soft ht, %	72.93	78.64	68.37	1.91	21	<0.01
Hard %	72.24	78.41	64.38	2.30	21	<0.01
Oil, %	4.18	5.06	3.40	0.35	21	0.34
Protein, %	9.83	11.31	8.62	0.61	21	<0.01
Starch, %	71.67	73.51	68.93	0.83	21	0.05
ISDMD[c]	33.14	39.65	20.67	4.69	5	0.22

[a]Number of hybrids evaluated for each trait
[b]*P* - value of hybrid*location effect
[c]ISDMD = *in situ* DM digestibility

Table 3. Physical and chemical characteristics across hybrids within maturity group 108-112 (Group 3).

Variable	Mean	Maximum	Standard Minimum	# of Deviation	hybrids[a]	*P* - value[b]
Kernel wt., g	287.3	381.1	202.2	31.2	36	<0.01
Stenvert Hardness						
Time to grind, s	6.7	9.0	5.0	0.91	36	<0.01
RPM	2417	2640	2250	75	36	<0.01
Soft ht, %	72.59	79.13	67.62	1.78	36	<0.01
Hard %	72.44	76.93	66.19	1.86	36	<0.01
Oil, %	4.39	5.28	3.41	0.32	36	0.02
Protein, %	9.55	11.04	7.84	0.62	36	<0.01
Starch, %	71.47	72.90	69.46	0.75	36	0.66
ISDMD[c]	33.38	41.12	22.47	4.52	7	0.08

[a]Number of hybrids evaluated for each trait
[b]*P* - value of hybrid*location effect
[c]ISDMD = *in situ* DM digestibility

RM group 104 - 107 (Group 2)

Table 2 contains the physical and chemical kernel characteristics for Group 2. Within this group, 21 hybrids were represented for kernel analysis. A significant interaction between hybrid and location was observed for all kernel traits except oil, starch, and ISDMD. Starch content was only affected by hybrid ($P < 0.01$), while both oil and ISDMD were affected by hybrid ($P < 0.03$) and location ($P < 0.03$). Similar to Group 1, no significant relationships between ISDMD and other kernel traits were observed, though soft height percentage was approaching significance ($P = 0.08$, $r = 0.32$). Also similar to Group 1, the NIR measurements showed the strongest relationships, with starch content being negatively correlated with both oil and protein ($r = -0.48$, and $r = -0.47$ respectively).

RM group 108 - 112 (Group 3)

Physical and chemical kernel characteristics for Group 3 are presented in Table 3. In this group, 36 hybrids were evaluated, with seven of these evaluated for ISDMD. Similar to Group 2, significant interactions were observed for all kernel traits except starch and ISDMD. Location was not significant for either trait ($P < 0.20$), though both were affected by hybrid ($P < 0.02$). Similar to both previous RM groups, no significant relationships were observed between ISDMD and other kernel characteristics. Again, the NIR measurements were observed to have the strongest relationships between each other. Starch content was negatively correlated to both oil and protein ($r = -0.57$, and $r = -0.41$ respectively). Oil content was also positively correlated to 1,000 kernel weight ($r = 0.41$) indicating that heavier kernels contain more oil.

The results of this trial suggest that a hybrid*location interaction exists for most kernel traits no matter what RM group they are in. The results also show that a wide range in kernel traits exist and that these ranges are observed throughout all RM groups. We were unable to detect significant relationships between ISDMD and other chemical or physical kernel traits, though within most RM groups no interaction between hybrid and location was observed. Grind time had a negative correlation, though not significant, with ISDMD within almost all RM groups, which would suggest that harder kernels are less digestible.

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