Abstract #: W98

Effect of Dry Matter Density on Fermentation and Nutrient Preservation in Brown Mid-Rib (BMR) Corn Silage within Bunker Silos

K. Griswold[1], P. Craig[2], J. Graybill[3], and R. Ward*[4]

[1]Kemin AgriFoods North America, Des Moines, IA; Penn State Cooperative Extension, [2]Dauphin and [3]Lancaster, PA; [4]Cumberland Valley Analytical Services, Hagerstown, MD

ABSTRACT

The objective was to determine the relationship of dry matter (DM) density to fermentation and nutrient preservation in BMR corn silage within bunker silos. Poly-weave nylon bags (36 per silo) containing chopped BMR corn were buried in 3 bunker silos during filling on the same farm in 2 successive years. Bags were blocked by depth from bunk end, 10.6 m (Front), 27.8 m (Center), and 44.9 m (Back), level from silo floor, 0.6 m (Low), 1.5 m (Middle), and 2.2 m (High), and within level, location from the east wall, 0.9 m (I), 4.7 m (II), 8.4 m (III), and 12.2 m (IV). At feed-out, all bags at a specific depth were retrieved, and silage cores for DM density at each bag position were collected with a 5.08 cm diameter stainless-steel coring tube. Corn and silage subsamples were analyzed for nutrient content and fermentation profile by NIR and wet chemistry. Data were analyzed by PROC MIXED and REG within SAS. The model included fixed effects of depth, level, location, all interactions, and random effects of silo and year. Significance was set at P<0.05, and trends at 0.05<P<0.10. There were no significant interactions. Density was affected (P < 0.0001) by depth, level, and location. Density was 221, 274, and 273 kg DM/m³ for front, center, and back, respectively. Density was 282, 265, and 221 kg DM/m³ for low, middle, and high, respectively. Density was 238 and 231 kg DM/m³ for I & IV compared to 279 and 275 kg DM/m³ for II & III, respectively. Fermentation was affected (P<0.05) by depth and level but not location. Total VFA were 9.7, 10.8, and 10.4% of DM for front, center, and back, and 11.2, 10.3 and 9.5% of DM for low, middle and high, respectively. There was a trend (P=0.059) for NDF content to be affected by level with 37.8, 38.6, and 40.4% of DM for low, middle, and high, respectively. Regression analysis showed a weak linear inverse relationship (R^2 = 0.05) between DM density and NDF content. Starch content was unaffected (P>0.10) by DM density across all positions. These results suggest that DM density of BMR corn silage may affect fermentation, but likely does not affect starch and NDF content.

INTRODUCTION

- Corn silage is the most commonly fed ensiled forage for dairy cattle in the northeastern U.S. Brown Mid-Rib (BMR) corn is being grown more widely due to its greater fiber digestibility and influence on dry matter intake in dairy diets.
- Ensiling results in a loss of dry matter (DM), often termed "shrink", that can range from < 1 to > 3.3% per month of storage (Holmes, 2006) and represents an economic loss to the dairy producer, but there is no simple on-farm method to assess DM loss.
- The DM density of silage is inversely related to DM loss. Ruppel et al. (1995) found no significant relationship between DM density and DM and NDF content of alfalfa haylage stored in bunker silos .
- Therefore, the objective of this study was to determine the relationship between DM density and fermentation and nutrient preservation in BMR corn silage in bunker silos.

MATERIALS AND METHODS

- Porous, poly-weave nylon bags (N=36) containing chopped brown midrib (BMR) corn were weighed and buried in each of three 55.5 m x 13.1 m x 2.4 m bunker silos during filling (Figure 2). Chopped corn forage subsamples were collected in plastic storage bags, sealed, and stored at -20°C until analyzed.
- Bags were blocked by depth from the end of the bunk, 10.6 m (Front), 27.8 m (Center), and 44.9 m (Back), level from the silo floor, 60 cm (Bottom), 150 cm (Middle), and 215 cm (Top), and within level, location from the east wall, 0.9 m (I), 4.7 m (II), 8.4 m (III), and 12.2 m (IV) (Figure 1).
- All silos were packed using a tractor and a loader with a combined weight of 60,327 kg. Average delivery rate of chopped corn during filling was 163 tonnes per hr. All bunks were sealed with 1 layer of 6 mil polyethylene plastic on the sidewalls and 2 layers on the top with tires covering the entire surface.
- Upon feed-out, bags at a specific depth were retrieved as a group (n = 12), weighed and subsamples were placed in plastic storage bags, sealed and stored at -20°C until analyzed.
- Silage cores for DM density determination were obtained at each bag position using a Stihl gas-powered drill and a 5.08 cm ID stainless steel probe. Cores were collected into plastic storage bags, sealed, and placed on ice until DM was determined. Core depth was measured to the closest 0.64 cm and recorded.
- Dry matter content of chopped corn and corn silage samples was determined by drying for 24 h in a forced air oven set at 50°C. All samples were run in duplicate. Core DM density was determined by dividing the total core dry weight by the core volume, and reported as kg DM/m³.
- Dry matter loss within each bag was determined as the difference in DM weight of the bagged chopped corn prior to burying and the bag of corn silage upon retrieval.
- Data were analyzed using PROC MIXED and RSREG within PC SAS v9.1 (SAS Inst. Inc., Cary, NC). The model included the fixed effects of depth, level, location, all interactions, and the random effect of bunk. Significance was set at *P*<0.05, and trends at 0.05<*P*<0.10.

RESULTS

Figure 1. Relative positions of chopped corn filled bags at burial in bunker silos

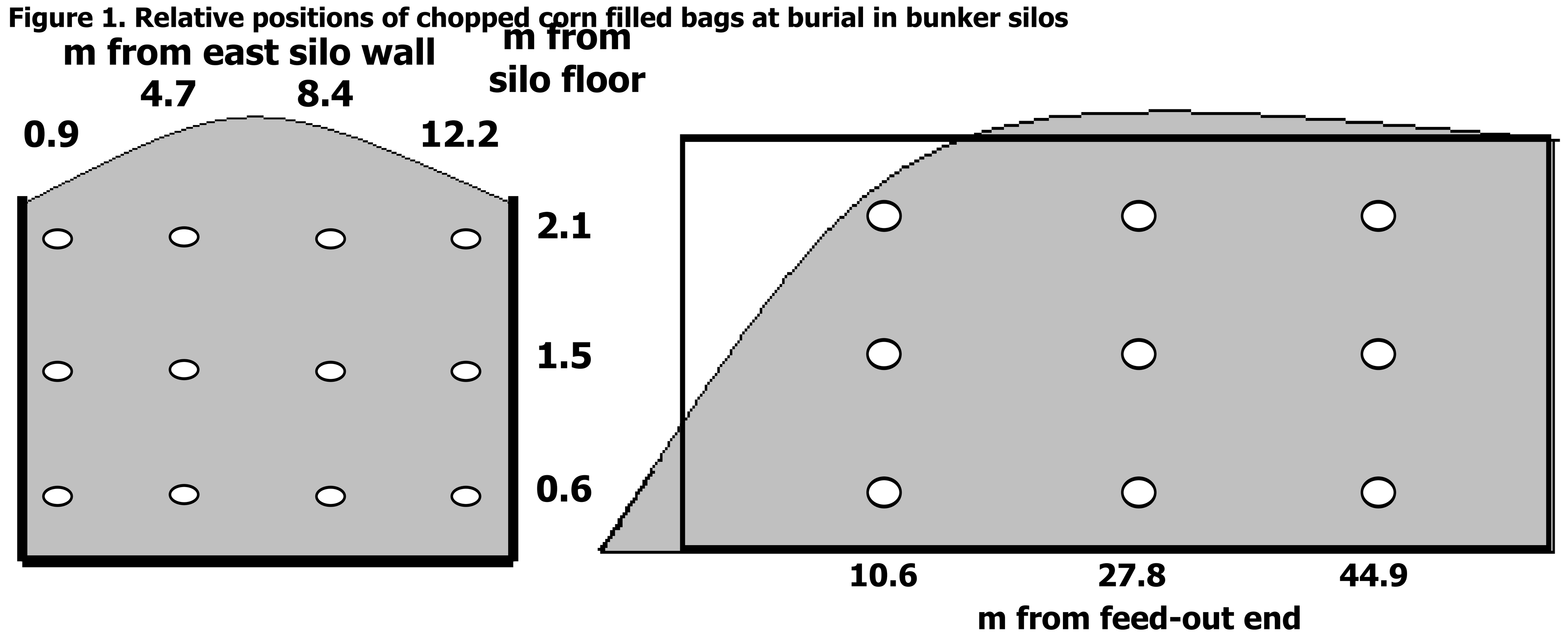


Figure 2. Chopped corn filled bag during placement for burial.

Tables 1, 2, & 3. Effects of depth, level and location within bunker silo on DM density, fermentation, and nutrient preservation.

Table 1.

Parameter	Unit	Depth in Silo: Front	Center	Back	SE	P-value
Density	kg DM/m³	221	274	273	5.3	< 0.0001
Dry Matter	%	29.6	30.9	31.9	1.28	< 0.0001
Crude Protein	% of DM	8.65	8.64	8.42	0.48	0.2664
Soluble Protein	% of CP	56.5	60.1	61.4	3.78	< 0.0001
Acid Detergent Fiber (ADF)	% of DM	24.0	23.9	23.9	0.58	0.8715
Neutral Detergent Fiber (NDF)	% of DM	39.6	39.2	38.8	0.95	0.3283
NDF digestibility, 30 hr in vitro	% of NDF	69.3	68.6	67.0	1.26	0.4128
Lignin	% of DM	2.36	2.30	2.87	0.49	0.7300
Soluble Fiber	% of DM	4.61	4.19	4.16	1.76	0.3903
Non-Fibrous Carbohydrates (NFC)	% of DM	45.6	46.1	46.3	1.79	0.6765
Starch	% of DM	30.3	30.4	30.4	1.18	0.9099
Ethanol Soluble CHO (Sugar)	% of DM	0.97	1.10	1.17	0.27	0.0132
Fat	% of DM	3.62	3.58	3.61	0.15	0.2877
Ash	% of DM	2.53	2.48	2.87	0.16	0.5214
pH		3.79	3.73	3.93	0.14	0.5439
Total VFA	% of DM	9.74	10.80	10.41	1.00	0.0423
Lactic Acid	% of DM	5.20	6.62	7.75	1.56	0.4180
Acetic Acid	% of DM	4.36	3.96	4.31	1.29	0.7018

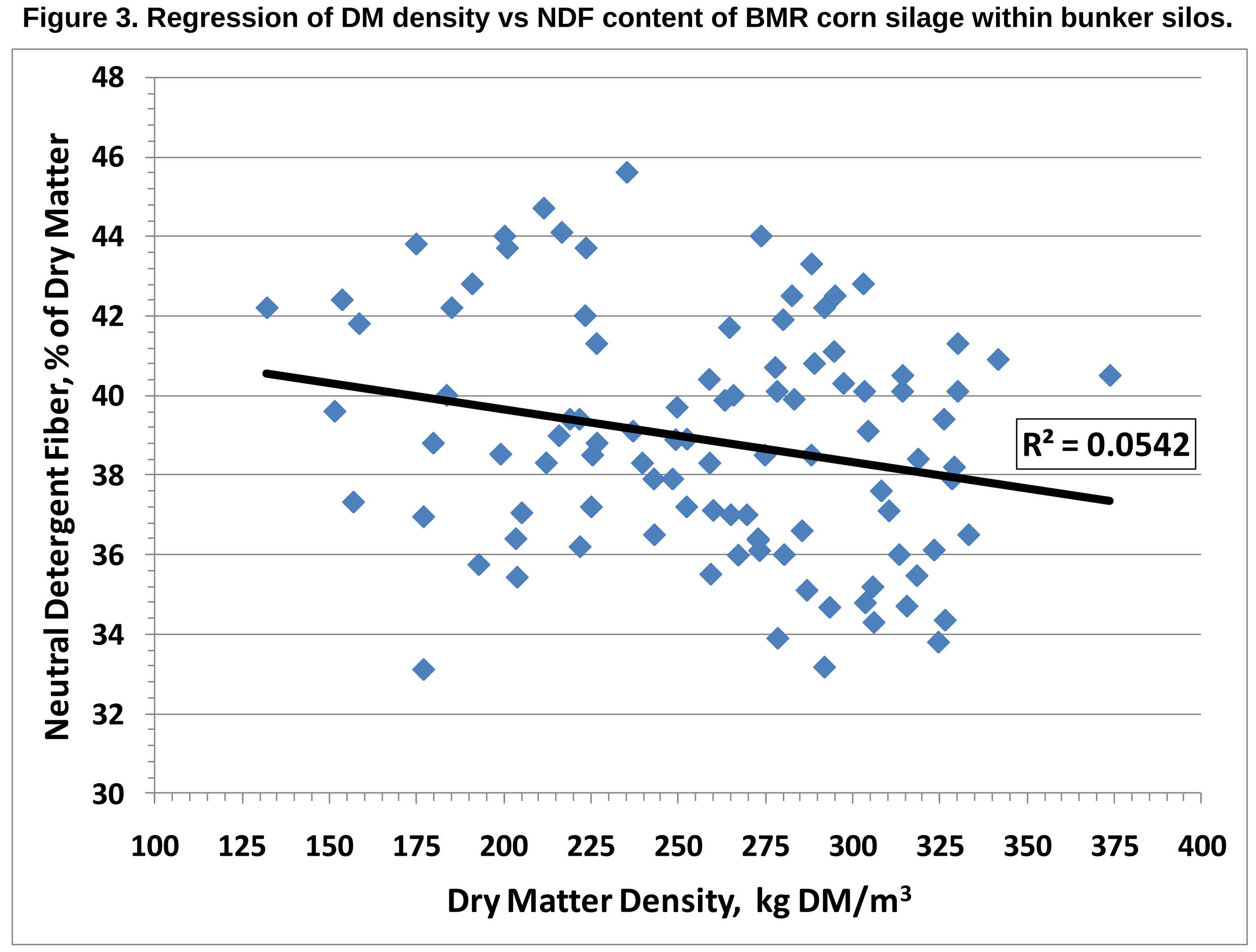
Table 3.

Parameter	Unit	Location across face: I	II	III	IV	SE	P-value
Density	kg DM/m³	238	279	275	231	5.8	< 0.0001
Dry Matter	%	30.0	31.3	31.5	30.6	1.29	0.0126
Crude Protein	% of DM	8.52	8.59	8.57	8.60	0.49	0.9690
Soluble Protein	% of CP	58.3	60.4	60.5	58.1	3.80	0.0447
Acid Detergent Fiber (ADF)	% of DM	23.9	24.0	24.0	23.9	0.60	0.9849
Neutral Detergent Fiber (NDF)	% of DM	39.5	39.1	39.3	39.0	1.07	0.9457
NDF digestibility, 30 hr in vitro	% of NDF	67.1	68.8	69.3	68.2	1.47	0.7216
Lignin	% of DM	3.06	2.32	2.33	2.34	0.52	0.9262
Soluble Fiber	% of DM	3.99	4.62	3.94	4.73	1.76	0.1350
Non-Fibrous Carbohydrates (NFC)	% of DM	45.6	46.1	45.9	46.4	1.81	0.8392
Starch	% of DM	30.1	30.4	30.2	30.6	1.21	0.8324
Ethanol Soluble CHO (Sugar)	% of DM	1.03	1.11	1.09	1.11	0.27	0.6888
Fat	% of DM	3.64	3.61	3.60	3.56	0.15	0.1542
Ash	% of DM	2.74	2.60	2.63	2.44	0.16	0.1630
pH		3.97	3.75	3.75	3.79	0.16	0.6964
Total VFA	% of DM	10.4	10.2	10.5	10.1	1.02	0.8793
Lactic Acid	% of DM	8.01	6.00	6.14	5.93	1.75	0.7335
Acetic Acid	% of DM	4.68	4.06	4.12	3.99	1.31	0.6276

Table 2.

Parameter	Density	DM	CP	SP	ADF	NDF	NDFD	Lignin	Soluble Fiber	NFC	Starch	Sugar	Fat	Ash	pH	Total VFA	Lactic Acid	Acetic Acid
Unit	kg DM/m³	%	% of DM	% of CP	% of DM	% of DM	% of NDF	% of DM	% of DM	% of DM	% of DM	% of DM	% of DM	% of DM		% of DM	% of DM	% of DM
Level within Silo: High	221	30.5	8.29	57.4	23.7	38.3	68.7	2.33	4.53	45.3	29.5	1.05	3.62	4.49	3.92	9.5	5.03	4.22
Middle	265	31.3	8.60	59.7	23.5	38.6	69.0	2.27	4.45	46.7	31.2	1.18	3.58	2.52	3.73	10.3	6.13	3.92
Low	282	30.6	8.83	60.9	24.7	38.8	67.2	2.81	3.98	45.9	30.3	1.03	3.62	2.85	3.79	11.2	8.40	4.50
SE	6.2	1.28	0.48	3.78	0.58	0.95	1.25	0.38	1.76	1.78	1.19	0.27	0.15	0.68	0.13	1.00	1.56	1.29
P-value	<0.0001	0.1195	0.0045	0.0014	0.0016	0.3215	0.5736	0.6849	0.3106	0.1966	0.7851	0.0582	0.2213	0.6087	0.6011	0.0005	0.2127	0.5472

Figure 3. Regression of DM density vs NDF content of BMR corn silage within bunker silos.



RESULTS & CONCLUSIONS

- Dry matter density was significantly affected by depth, level and location within the silo (Tables 1, 2, & 3) There were no significant interactions of depth, level, or location on DM density.
- Soluble protein (as a % of CP) was the only nutrient affected by depth, level and location within the silo (Tables 1, 2, & 3), and was lower at the front, on the top, and along the sides of the silo.
- Fermentation was affected by depth and level within the bunker silo (Tables 1, 2, & 3) as total VFA were lower at the front and top of the silo.
- There was an inverse relationship between DM density and NDF content (Figure 3), but the relationship was weak (R^2=0.05).
- Overall, these data would suggest that DM density may affect fermentation, but likely does not alter nutrient content of BMR corn silage.

REFERENCES

Muck, R. E. and B. J. Holmes. 2000. Factors affecting bunker silo densities. Appl. Engr. In Agric. 16(6):613-619.

Ruppel, K. A., R. E. Pitt, L. E. Chase, and D. M. Galton. 1995. Bunker silo management and its relationship to forage preservation on dairy farms. J. Dairy Sci. 78:141-153.