

Paper for the Southeast Dairy Herd Management Conference, Macon, Georgia; November 16-17, 2004

**Sorghum Silage:
A Summary of 25 Years of Research at Kansas State University**

Keith K. Bolsen
Professor Emeritus, Kansas State University

Summary

Grain sorghum silage:

1. Hybrid selection is important to achieve optimized agronomic performance.
2. Whole-plant DM yields typically range from 4 to 6 tons per acre.
3. Grain sorghum silages have higher nutritive values than virtually all forage sorghums and provide 90 to 95% the energy value of normal corn silages.
4. Grain sorghums should be harvested and ensiled at the late-dough stage.
 - a. At the milk stage, expect a lower DM yield and less than 30% whole-plant DM content.
 - b. At the hard-grain stage, expect a lower DM yield and a much lower energy value.
 - c. The earlier harvest for silage compared to harvest for grain offers flexibility in crop rotations and reduces the risks associated with wet, late-fall weather.
5. Producers should never rely on grain sorghum as their only silage crop because of the risk of a drastically low whole-plant DM yield in a low-rainfall year.

Forage sorghum silage:

1. Not all forage sorghums are “created equal”.
2. There is tremendous “phenotypic” variability among cultivars, i.e., season length, plant height, grain yield, lodging score, and plant part ratios.
3. Producers should avoid selecting phenotypic extremes, and they should always plant more than one hybrid.
 - a. Most early-season hybrids have the possibility of very low silage DM yields in a low-rainfall year.
 - b. Most late-season hybrids are prone to lodging during wet fall weather and/or a very low energy value if an early-autumn freeze occurs.
4. Forage sorghums should be harvested and ensiled at the late-dough stage.
 - a. At the milk stage, expect a lower whole-plant DM yield and less than 30% whole-plant DM content.
 - b. At the hard-grain stage, expect a lower DM yield and a lower energy value.
5. Low whole-plant DM content at harvest is a major problem with most hybrids.
 - a. Forage sorghums typically contain less than 30% DM at the late-dough stage.
 - b. These low DM silages are predisposed to excessive effluent, high acetic acid and ethanol concentrations, and poor preservation efficiency (i.e., higher “in silo” losses compared to whole-plant corn or grain sorghum).

Introduction

The popularity of grain and forage sorghums for dairy and beef cattle production in several regions of the United States can be attributed to their desirable ensiling traits and potential for competitive whole-plant dry matter (DM) yields compared to corn (Bolsen, 1995). However producers must recognize that both the agronomic performance and nutritive value of grain and forage sorghums are significantly influenced by stage of maturity at harvest (Owen, 1962; Browning and Lusk, 1967; and Black et al., 1980). In addition, the phenotypic traits of forage sorghum cultivars (i.e., hybrids and varieties) vary greatly, and the wide ranges in season length, plant height, DM content, and whole-plant DM and grain yields contribute to large differences in nutritional value among cultivars (Cummins et al., 1970; Schmid et al., 1976).

This paper summarizes 25 years of sorghum research by the Silage Team in the Animal Sciences & Industry Department at Kansas State University. Results include the effects of stage of maturity, cultivar, and processing on the agronomic performance and nutritive value of grain and forage sorghums.

Stage of Maturity Effects

Results from Smith (1986) and Kirch (1989) indicated that stage of maturity affected agronomic performance and nutritive value characteristics of grain sorghum silage, but the magnitude of the differences were relatively small (Table 1). Whole-plant DM content increased from the late-milk to the hard-grain stage of maturity. Leaf senescence and lodging (i.e., broken stalks or heads disconnected from the upper portion of the stalk) resulted in the whole-plant DM yield being highest at the late-dough stage of maturity. Both grain yield and percent grain in the whole-plant DM tended to increase as stage of maturity advanced. In both studies, stage of maturity had very little influence on the nutritive value characteristics of the silages. The late-milk stage silages had the highest CP and ADF, contents, but all nine hybrids in the two studies produced silages of relatively high nutritive value at all three stages of maturity.

Stage of maturity has a much greater effect on the agronomic performance and nutritive value characteristics of forage sorghum cultivars than grain sorghum hybrids (Cummins, 1981; Dickerson, 1986; and Hamma, 1987). In results from Sonon (1994) and Bolsen and Sonon (1997), 20 and 11 forage sorghum cultivars, respectively, were harvested at the late-milk, late-dough, and hard-grain stages of maturity (Table 2). Whole-plant DM content, grain yield, and percent grain in the whole-plant DM increased as stage of maturity advanced. Whole-plant DM yield was higher at the late-dough stage than the late-milk stage in both studies, and the late-milk stage silages had higher CP and ADF contents than silages at the two later stages of maturity.

Cultivar Effects

Several studies at Kansas State University documented the effects of cultivar on the nutritive value of sorghum silages (Table 3). These were unique trials because similar cultural practices were used at the same location over a period of 8 years, the cultivars represented a wide range of phenotypic traits, the hybrids were all available commercially to producers in the High Plains region, and all

harvests were made at the late-dough stage of kernel maturity. Kirch et al (1988), White (1989), and Siefers et al. (1997) found that grain sorghum silages had higher DM contents, higher nutritive values (i.e., higher CP and lower NDF and ADF percents), and less variability among hybrids than forage sorghum silages.

White et al. (1989) compared 60 forage sorghums over a two-year period and reported very large differences among cultivars for DM content and nutritive value traits. The authors also found significant year by cultivar interactions for all silage quality and agronomic performance characteristics measured. They concluded that, because of the wide range in season lengths, forage sorghums differed in their response to weather-related factors during the growing season. Early-season cultivars were prone to have a low whole-plant DM yield if there is inadequate moisture during the first half of the growing season; while late-season cultivars were inclined to have a low grain yield, a low proportion of grain in the whole-plant DM, and high NDF and ADF contents. The authors suggested that more than one forage sorghum cultivar should be planted for silage production to provide flexibility in the farming operation (i.e., scheduling of harvest dates) and to remove some of the risks that are associated with unpredictable weather during the growing season.

Processing Effects

A major concern in feeding whole-plant grain and forage sorghum is the apparent low digestibility of the grain when the kernel in the silage is in the whole form. This is thought to be due to a dense proteinaceous matrix in the peripheral endosperm layer of the sorghum kernel, which renders starch granules inaccessible for digestion in the rumen (Gutierrez et al., 1982; Acosta et al., 1983). In the past four decades, numerous researchers have attempted to improve the digestibility of the grain in the silage and subsequent animal performance by processing the kernels before (**PRE**) or after (**POST**) ensiling.

Boren et al. (1962 and 1963) reported that grinding the heads of forage sorghum before ensiling did not improve growing cattle performance. In two of the three comparisons, calves fed PRE silages actually had lower DM intakes, slower avg daily gains, and poorer feed conversions than those fed unprocessed silages. Gutierrez et al. (1982) obtained similar results when PRE processed grain sorghum silage was fed to steer calves (Table 4). The PRE silage supported a lower DM intake than the unprocessed silage, and avg daily gain and feed conversion were not affected by silage processing.

In a three-year study, Pund (1970) compared POST processed grain sorghum silage to unprocessed silage from both bird resistant and non-bird resistant hybrids. Steers fed POST silages gained an average of 8% faster than those fed unprocessed silages and feed conversions were significantly improved by processing. Fox et al. (1970) also reported a 29% increase in avg daily gain and a 19% improvement in feed conversion for steers receiving POST processed bird resistant grain sorghum silage compared to those fed unprocessed silage. However, Brethour and Duitsman (1971) and Smith et al. (1984) reported no improvement in the performance of growing cattle fed POST processed grain sorghum silages (Table 4). In both trials, the sorghums were ensiled at the late-dough stage and less than 10 percent of the kernels were cracked or broken by the forage harvester

before ensiling. The POST silages were processed through a stationary roller mill and less than 5 percent of the kernels remained in the whole form.

Brethour and Duitsman (1970) and Bolsen et al. (1983) compared POST processed grain and forage sorghum silages to unprocessed silages (Table 5). Although avg daily gains were consistently higher for calves receiving POST grain and forage silages in both trials, DM intakes were not affected by processing and feed conversions were only improved by an average of 4.7% (range, 1.4 to 8.0%).

Results of a 2-year study by Smith et al. (1985 and 1986) suggested that growing cattle performance response to POST processing of grain sorghum silage was influenced by stage of kernel maturity at harvest (Table 6). In both studies, DM intakes were higher for cattle fed the POST processed silages compared to those fed the unprocessed silages at the hard-grain stage, but DM intakes were not affected by processing for cattle fed the late-milk or late-dough silages. POST processing did not improve either ADG or feed conversion for cattle fed the late-milk silage compared to those fed the unprocessed silage. Cattle receiving the POST processed, late-dough and hard-grain silages gained significantly faster and had lower feed/gain than those fed unprocessed silages in both studies. Avg daily gains and feed conversions were improved by an average of 15 and 10 percent, respectively, by POST processing the more mature silages. The authors reported that approximately 90-95% of the kernels were in the whole form before processing, but less than 5% were whole after processing.

The PRE and POST processing of grain sorghum head silage on performance of feedlot cattle has been investigated by Brethour and Duitsman (1975) and Bolsen et al. (1974 and 1975). In all three studies the kernels were in the late-dough to hard-grain stage at harvest and grain comprised 70-74% of the head silages on a DM basis. Brethour and Duitsman (1975) reported that cattle fed PRE processed head silage consumed 12.4% less DM and had an 11.7% lower feed/gain than those fed unprocessed silage, however these differences were not statistically significant. Bolsen et al. (1974 and 1975) obtained similar results for steers fed POST head silage. Processing to break 90-95% of the kernels did not affect avg daily gain, but in both studies steers receiving the POST processed silages consumed significantly less DM than those fed unprocessed silages. As a result, cattle fed POST processed silages had 11.3 and 13.2% better feed conversions than those fed unprocessed silages.

References

- Acosta, J. E., P. G. Lemieux, and L. M. Schake. 1983. Processing whole-plant grain sorghum silage for finishing steers. *Beef Cattle Res. in Texas.* p 65.
- Black, J. R., L. O. Ely, M. E. McCullough, and E. M. Sudweeks. 1980. Effects of stage of maturity and silage additives upon the yield of gross and digestible energy in sorghum silage. *J. Dairy Sci.* 50:617-624.
- Bolsen, K. K. 1995. Silage: Basic Principles In: R.F. Barnes, D.A. Miller, and C.J. Nelson (Eds.) *Forages, Vol. II, The Science of Grassland Agriculture (5th Ed.)*. p 163-176. Iowa State University Press, Ames, IA.
- Bolsen, K. K., J. G. Riley, K. L. Conway, and P. Henry. 1974. Corn silage, wheat head silage, and milo head silage for finishing cattle. *Kansas Agric. Exp. Sta. Rep. Progr.* 210:35-39.

- Bolsen, K. K., J. G. Riley, and G. Fink. 1975. Milo head silage rations for finishing yearling steers. *Kansas Agric. Exp. Sta. Rep. Progr.* 230:39-43.
- Bolsen, K. K., H. Ilg, R. V. Pope, M. A. Hinds, and J. Hoover. 1983. Whole-plant forage, grain, or non-heading sorghum silages, cornlage, and feed flavor supplements for growing cattle. *Kansas Agric. Exp. Sta. Rep. Progr.* 427:46-52.
- Bolsen, K. K., and R. N. Sonon, Jr. 1997. Effects of cultivar and stage of maturity on agronomic characteristics, chemical composition, and nutritive value of forage sorghum silages. *Advances in Agric. Research.* 5(3):1-17.
- Boren, F. W., E. F. Smith, D. Richardson, D. L. Follis, and G. E. Fairbanks. 1962. Factors affecting the feeding value of sorghum silage. *Kansas Agric. Exp. Sta. Bull.* 447:10-11.
- Boren, F. W., E. F. Smith, D. Richardson, and G. E. Fairbanks. 1963. Factors affecting the feeding value of sorghum silage. *Kansas Agric. Exp. Sta. Bull.* 460:32-33.
- Brethour, J. R., and W. W. Duitsman. 1970. Processing forage or grain sorghum silage in a roller mill. *Kansas Agric. Exp. Sta. Bull.* 535:4-5.
- Brethour, J. R., and W. W. Duitsman. 1971. Grain sorghum silage (rolled or not rolled) compared with forage sorghum silage for wintering calves. *Kansas Agric. Exp. Sta. Bull.* 545:5-6.
- Brethour, J. R., and W. W. Duitsman. 1975. Milo head silage and milo whole-plant silage for finishing yearling steers. *Kansas Agric. Exp. Sta. Rep. Progr.* 236:10-12.
- Browning, C. B., and J. W. Lusk. 1967. Effect of stage of maturity at harvest on nutritive value of combine type grain sorghum silage. *J. Dairy Sci.* 50:81-85.
- Cummins, D. G., M. E. McCullough, and J. W. Dobson. 1970. Evaluation of corn and sorghum hybrids for silage. *Georgia Agric. Exp. Sta. Res. Rep.* 72.
- Cummins, D. G. 1981. Yield and quality changes with maturity of silage-type sorghum fodder. *Agron. J.* 73:988.
- Dickerson, J. T. 1986. Yield, composition, and nutritive value of forage sorghum silages: hybrid and stage of maturity effects. M. S. Thesis, Kansas State University, Manhattan.
- Fox, D. G., E. W. Klosterman, H. W. Newland, and R. R. Johnson. 1970. Net energy of corn and bird resistant grain sorghum rations for steers when fed as grain or silage. *J. Anim. Sci.* 30:302-308.
- Gutierrez, G. G., L. M. Schake, and F. M. Byers. 1982. Whole-plant grain sorghum silage processing and lasalocid effects on stocker calf performance and rumen fermentation. *J. Anim. Sci.* 54:863-868.
- Hamma, S. 1987. Effects of hybrid and harvest stage on the yield, composition, and feeding value of forage sorghum silages. M. S. Thesis, Kansas State University, Manhattan.
- Kirch, B. H. 1989. Yield, composition, and nutritive value of whole-plant grain sorghum silage: effects of hybrid, maturity, and grain addition. M. S. Thesis. Kansas State University, Manhattan.
- Kirch, B. H., S. R. Hamma, K. K. Bolsen, J. G. Riley, and J. Hoover. 1988. Whole-plant forage and grain sorghums and corn silages for growing cattle. *Kansas Agric. Exp. Sta. Rep. Progr.* 539:167-171.
- Owen, F. G. 1962. Effect of stage of maturity on the nutritive value of Atlas sorghum silage for lactating dairy cows. *J. Dairy Sci.* 45:625-631.
- Pund, W. A. 1970. Finishing yearling steers with high energy grain sorghum silage. *Mississippi Agric. Exp. Sta. Bull.* 780.

- Schake, L. M., W. C. Ellis, W. A. Suarez, and J. K. Riggs. 1982. Preservation of sorghum plant portions harvested, processed, and ensiled at ten stages of maturity. *Anim. Feed Sci. and Tech.* 7:257.
- Schmid, A. R., R. D. Goodrich, R. M. Jordan, G. C. Marten, and J. C. Meiske. 1976. Relationships among agronomic characteristics of corn and sorghum cultivars and silage quality. *Agron. J.* 68:403.
- Siefers, M. K., J. E. Turner, G. L. Huck, M. A. Young, S. A. Anderson, R. V. Pope, and K. K. Bolsen. 1997. Agronomic and silage quality traits of forage sorghum cultivars in 1995. *Kansas Agric. Exp. Sta. Rep. Progr.* 783:75-79.
- Smith, R. L. 1986. Yield, composition, and nutritive value of grain sorghum harvested as silage: stage of maturity and processing effects. M. S. Thesis. Kansas State University, Manhattan.
- Smith, R. L., K. K. Bolsen, H. Ilg, M. A. Hinds, R. V. Pope, J. T. Dickerson, and J. Hoover. 1984. Effects of sorghum type and harvest date on silage feeding value. *Kansas Agric. Exp. Sta. Rep. Progr.* 448:53-57.
- Smith, R. L., K. K. Bolsen, H. Ilg, J. Hoover, and J. T. Dickerson. 1985. Whole-plant forage, grain, or non-heading sorghum silages for growing cattle. *Kansas Agric. Exp. Sta. Rep. Progr.* 470:71-76.
- Smith, R. L., K. K. Bolsen, and J. Hoover. 1986. Whole-plant grain sorghum silages for growing cattle. *Kansas Agric. Exp. Sta. Rep. Progr.* 494:123-129.
- Sonon, R. N., Jr. 1994. Factors affecting the agronomic traits, chemical composition, and nutritive value of forage sorghum and corn silages. Ph.D. Dissertation. Kansas State University, Manhattan.
- White, J. S. 1989. Effect of plant type on the yield, quality, and nutritive value of forage sorghum silage. Ph.D. Dissertation. Kansas State University, Manhattan.
- White, J. S., B. H. Kirch, K. K. Bolsen, and L. Pfaff. 1989. Selecting forage sorghum cultivars for silage: a 3-year summary. *Kansas Agric. Exp. Sta. Rep. Progr.* 568:12-19.

Table 1. Effects of stage of maturity on the agronomic performance and nutritive value characteristics of whole-plant grain sorghum.

Reference ^a and stage of maturity	Whole-plant		Grain yield ^b tons/acre	Silage		
	DM content %	DM yield tons/acre		CP — % of the silage DM —	NDF	ADF
Smith (1986) (5)						
Late-milk	32.9 ^z	4.61 ^y	1.50 ^z (32.1 ^y)	10.5 ^x	48.8	27.8 ^x
Late-dough	41.8 ^y	5.14 ^x	2.23 ^x (43.4 ^x)	9.7 ^y	47.1	26.2 ^y
Hard-grain	51.3 ^x	4.62 ^y	2.02 ^y (44.2 ^x)	9.5 ^y	49.3	25.5 ^y
Kirch (1989) (4)						
Late-milk	28.0 ^z	4.45 ^y	1.54 ^y (34.4 ^y)	10.9 ^x	43.6	26.8 ^x
Late-dough	32.4 ^y	4.90 ^x	2.04 ^x (41.8 ^x)	10.0 ^y	44.2	25.2 ^y
Hard-grain	41.2 ^x	4.70 ^y	2.18 ^x (46.4 ^x)	9.5 ^y	43.7	24.4 ^y

^aThe number of grain sorghum hybrids in each study is shown in parenthesis.

^bThe percent of grain in the whole-plant DM is shown in parenthesis.

^{xyz}Means within a trial in the same column with no common superscript differ ($P < .05$).

Table 2. Effects of stage of maturity on the agronomic performance and nutritive value characteristics of whole-plant forage sorghum.

Reference ^a and stage of maturity	Whole-plant		Grain yield ^b tons/acre	Silage		
	DM content %	DM yield tons/acre		CP — % of the silage DM —	NDF	ADF
Sonon (1994) (20)						
Late-milk	25.6 ^z	5.26 ^y	0.93 ^z (17.6 ^z)	8.8 ^x	--	36.0 ^x
Late-dough	30.8 ^y	6.52 ^x	1.94 ^y (30.0 ^y)	7.7 ^y	--	33.8 ^y
Hard-grain	34.7 ^x	5.54 ^y	2.23 ^x (39.9 ^x)	7.6 ^y	--	34.0 ^y
Bolsen and Sonon (1997) (11)						
Late-milk	25.4 ^z	4.53 ^z	0.53 ^z (11.5 ^y)	10.2 ^x	60.2 ^x	33.7 ^x
Late-dough	30.0 ^y	4.98 ^y	1.42 ^y (28.2 ^x)	9.6 ^y	54.1 ^y	31.2 ^y
Hard-grain	38.0 ^x	5.46 ^x	1.66 ^x (30.6 ^x)	9.3 ^y	53.9 ^y	31.6 ^y

^aThe number of forage sorghum cultivars in each study is shown in parenthesis.

^bThe percent of grain in the whole-plant DM is shown in parenthesis.

^{xyz}Means within a trial in the same column with no common superscript differ ($P < .05$).

Table 3. Effects of hybrid or cultivar on the nutritive value of whole-plant grain (GSS) and forage (FSS) sorghum silages.

Reference ^a	Whole-plant DM content %	Silage		
		CP	NDF	ADF
		———— % of the silage DM ————		
Kirch et al. (1988)				
GSS (3)	40.5 (38.0-44.0) ^b	10.7 (10.3-11.5)	40.3 (36.9-43.5)	20.1 (19.1-20.4)
FSS (4)	32.0 (28.0-37.0)	8.3 (7.0-8.8)	57.0 (54.1-61.3)	33.0 (28.9-37.8)
White (1989)				
GSS (5)	34.0 (33.6-35.1)	9.1 (8.5-9.9)	43.4 (41.9-48.0)	24.5 (22.6-27.5)
FSS (7)	28.8 (23.3-34.4)	7.5 (6.7-8.3)	55.1 (47.3-60.0)	33.1 (29.6-38.5)
Siefers et al. (1997)				
GSS (3)	36.0 (34.0-40.2)	10.4 (10.1-10.8)	46.8 (42.5-49.4)	27.9 (26.0-29.3)
FSS (37)	25.4 (22.9-39.9)	8.4 (7.2-10.1)	51.9 (45.1-58.0)	29.6 (27.3-36.5)
White et al. (1989)				
FSS (60)	27.5 (23.3-35.4)	6.5 (4.5-8.1)	57.6 (48.3-71.9)	35.6 (27.1-49.4)
FSS (60)	29.2 (24.0-34.8)	6.8 (4.9-8.3)	51.6 (44.0-67.8)	30.9 (24.3-40.3)

^aThe number of GSS hybrids and FSS cultivars in each study is shown in parenthesis.

^bThe minimum and maximum values among the hybrids or cultivars are shown in parenthesis.

Table 4. Effects of pre-ensiled (PRE) or post-ensiled (POST) processing of whole-plant grain sorghum silage on growing cattle performance.

Item	Gutierrez et al. (1982) (34.1%) ^a		Brethour and Duitsman (1971) (40.9%)		Smith et al. (1984) (37.5%)	
	Control	PRE	Control	POST	Control	POST
DMI, lbs/d	12.3 ^x	11.7 ^y	16.3	16.5	15.0	14.6
ADG, lbs	1.70	1.63	2.07	2.14	2.12	2.07
Feed/gain, DM basis	7.3	7.3	8.0	7.8	7.1	7.0

^aSilage DM content is shown in parenthesis.

^{xy}Means within a trial in the same row with no common superscript differ ($P < .05$).

Table 5. Effects of post-ensiled (POST) processing of whole-plant grain (GSS) and forage (FSS) sorghum silages on growing cattle performance.

Item	Brethour and Duitsman (1970)				Bolsen et al. (1983)			
	GSS (36.0%)		FSS (28.0%) ^a		GSS (37.0%)		FSS (34.9%)	
	Control	POST	Control	POST	Control	POST	Control	POST
DMI, lbs/d	17.0	17.2	14.1	14.6	15.2 ^x	15.7 ^x	11.7 ^y	11.7 ^y
ADG, lbs	2.25 ^y	2.47 ^x	1.98 ^y	2.16 ^x	2.16 ^x	2.31 ^x	1.48 ^y	1.57 ^y
Feed/gain, DM basis	7.5	6.9	7.2	6.8	6.9 ^x	6.8 ^x	7.8 ^y	7.5 ^y

^aSilage DM content is shown in parenthesis.

^{xy}Means within a trial in the same row with no common superscript differ ($P < .05$).

Table 6. Effects of stage of maturity at harvest and post-ensiled (POST) processing of whole-plant grain sorghum silage on growing cattle performance.

Item	Smith et al. (1985)			
	Late-dough (42.3%) ^a		Hard-grain (50.9%)	
	Control	POST	Control	POST
DMI, lbs/d	19.4 ^y	19.4 ^y	19.8 ^y	20.7 ^x
ADG, lbs	2.25 ^y	2.49 ^x	2.12 ^y	2.45 ^x
Feed/gain, DM basis	8.7 ^y	7.8 ^x	9.4 ^z	8.5 ^y

^aSilage DM content is shown in parenthesis.

^{xyz}Means within a trial in the same row with no common superscript differ ($P < .05$).

Table 6 (cont.). Effects of stage of maturity at harvest and post-ensiled (POST) processing of whole-plant grain sorghum silage on growing cattle performance.

Item	Smith et al. (1986)					
	Late-milk (31.9%)		Late-dough (42.3%)		Hard-grain (56.2%)	
	Control	POST	Control	POST	Control	POST
DMI, lbs/d	18.3 ^y	18.5 ^y	18.5 ^y	19.4 ^y	19.4 ^y	21.4 ^x
ADG, lbs	2.40 ^{yz}	2.51 ^{xyz}	2.38 ^{yz}	2.67 ^x	2.27 ^z	2.80 ^x
Feed/gain, DM basis	7.8 ^x	7.5 ^x	8.0 ^x	7.4 ^y	8.8 ^y	7.7 ^x

^aSilage DM content is shown in parenthesis.

^{xyz}Means within a trial in the same row with no common superscript differ ($P < .05$).

