EVALUATION OF INOCULANT-TREATED CORN SILAGES[1,2,3]

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Summary

Whole-plant corn silages treated with either Pioneer 1174® or Biotal® inoculants were preserved more efficiently than control silages. They had slightly higher dry matter (DM) recoveries; more lactic acid; higher lactic to acetic acid ratios; and less acetic acid, ethanol, and ammonia-nitrogen. Laboratory silo results showed that both inoculated silages produced lactic acid faster than control silages during the first 7 days and had more desirable fermentation profiles at the end of 90 days. Applying 5 or 10 times the recommended rate of Biotal inoculant had only a small and nonsignificant effect on rate and efficiency of fermentation.

Yearling steers fed the two inoculated corn silages gained numerically but not significantly faster and more efficiently than steers fed control silages, so inoculated silages produced about 6.1 lb more steer gain per ton of crop ensiled than controls.

(Key Words: Silage, Bacterial, Inoculants, Corn.)

Introduction

Research with bacterial inoculants and nonprotein nitrogen (NPN) silage additives using farm-scale, tower silos in Manhattan and at the Fort Hays and Southeast Kansas Agricultural Experiment Stations began over 17 years ago. Reported here are results from the last four of the 65 corn and forage sorghum silages in which fermentation characteristics, dry matter (DM) recovery, and cattle performance from inoculant and NPN silages were compared to untreated controls. A summary of the 26 trials is presented on page 101 of this report.

Experimental Procedures

Pioneer 3377 and 3379 corn hybrids were grown under irrigation in 1988, using agronomic practices similar to those on page 111 of KAES Report of Progress 592 (1990). Pioneer 3377 was harvested on August 11, and two 10 × 50 ft. concrete stave silos were filled by the alternate load method. One silo received no additive (control), and the other received the recommended rate of Pioneer 1174 Silage Inoculant, 1.9 liters per ton. The 1174 was applied at the blower and supplied 1.75×10^5 colony-forming units (cfu) of lactic acid bacteria (LAB) per gram of crop. Twelve thermocouple wires were evenly spaced in the center of each silo, and ensiling temperatures were monitored for the first 6 wks of storage.

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[1]Pioneer 1174 Silage Inoculant® is a product of Pioneer Hi-Bred International, Inc., Des Moines, Iowa.

[2]Biotal Silage Inoculant® is a product of Biotal, Inc., Eden Prairie, Minnesota.

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During the harvest, fresh forage was removed from a randomly selected load and control and treated materials were each ensiled in 14 PVC laboratory silos. Duplicate silos were opened at 6, 12, and 24 hr and 2, 3, 4, and 90 days post-filling.

Pioneer 3379 was harvested on August 15 and treated in the same manner as 3377, except that the inoculant was Biotal, applied at 1.9 liters per ton to supply 1.70×10^5 cfu of LAB per gram of crop. Two additional PVC silo treatments were Biotal applied at five and 10 times the recommended rate.

The farm-scale silos were opened on December 14, 1988 and emptied at uniform rates during the following 12 weeks. Samples were taken twice weekly for DM recovery calculations and chemical analyses. Each silage was fed to 18 yearling steers (three pens of six steers per silage) in an 84-day growing trial, which began on December 16, 1988. Rations were full-fed and contained 87.6% silage and 12.4% supplement on a DM basis. Rations were formulated to provide 12.0% crude protein (DM basis); 200 mg of Rumensin® per animal daily; required amounts of calcium and phosphorus; and vitamins A, D, and E. Supplements were top-dressed and partially mixed with the silages in the bunk.

For 3 days before the start of the growing trial, all cattle were limit-fed a forage sorghum silage ration to provide a DM intake of 1.88% of body weight. Cattle were then weighed individually on 2 consecutive days after 16 hr without feed or water. For 2 days before the final weighing, the cattle were fed their respective silage rations at a restricted DM intake of 1.88% of body weight. Individual weights then were taken on 2 consecutive days after 16 hr without feed or water.

Results and Discussion

Ensiling temperatures (Table 1) were nearly identical for the four silages; the absolute temperatures were quite high (93.3 to 107.3 F) because of hot weather at harvest.

Dry matter recovery and chemical compositions are shown in Table 2. Both inoculants increased DM recovery; 1174 by 1.6 percentage units and Biotal by .8 units. Inoculated silages had more lactic acid; higher lactic to acetic acid ratios; and less acetic acid, ethanol, and ammonia nitrogen, indicating improved fermentation efficiencies. Laboratory silo results showed that both 1174- and Biotal-treated silages had faster rates of lactic acid production during the first 7 days (data not shown). At 7 and 90 days, 1174 silages had more ($P < .05$) lactic acid and less ($P < .05$) acetic acid, ethanol, and ammonia-nitrogen than control silages. Biotal silages had higher ($P < .05$) lactic acid and lower ($P < .05$) ethanol values than controls at 3, 7, and 90 days. Applying five or 10 times the recommended rate of Biotal inoculant had only a small and nonsignificant effect on rate and efficiency of fermentation.

Performance by cattle fed the four corn silage rations is presented in Table 3. Steers fed the two inoculated corn silages gained slightly but not significantly faster and more efficiently than steers fed control silages, producing an average of 6.1 lb more steer gain per ton of crop ensiled than control silages.

Table 1. Ensiling Temperatures as Change from Initial Temperature (Temp.) for the Control and Inoculated Corn Silages

Days	Pioneer 3377		Pioneer 3379	
post-filling	Control	1174	Control	Biotal
	----------Initial forage temp., F ----------			
	94.5	94.7	93.7	93.3
	---------- Change from initial temp., F ----------			
1	+ 9.1	+ 8.4	+ 8.7	+ 9.1
2	+ 11.5	+ 11.6	+ 11.9	+ 11.9
3	+ 12.5	+ 12.2	+ 12.6	+ 12.5
4	+ 12.2	+ 12.6	+ 12.5	+ 12.3
5	+ 12.3	+ 12.4	+ 12.5	+ 12.0
6	+ 12.4	+ 12.4	+ 12.8	+ 12.6
7	+ 11.9	+ 11.6	+ 12.7	+ 12.2
10	+ 10.5	+ 10.5	+ 11.2	+ 11.2
14	+ 7.6	+ 7.9	+ 10.4	+ 10.8
17	+ 6.6	+ 6.4	+ 7.6	+ 7.4
21	+ 2.4	+ 3.7	+ 7.2	+ 6.7
28	+ 1.4	+ 2.2	+ 3.7	+ 1.8

Table 2. Dry Matter Recovery and Chemical Composition[1] of the Four Corn Silages

	Pioneer 3377		Pioneer 3379	
Item	Control	1174	Control	Biotal
Dry matter, %	37.2	38.0	34.0	33.6
DM recovery[2]	91.2	92.8	88.6	89.4
pH	3.86	3.84	3.72	3.70
	---------- % of the silage DM ----------			
Lactic acid	5.8	6.4	6.8	7.1
Acetic acid	3.1	2.6	3.6	2.8
Lactic:acetic	1.9	2.4	1.8	2.5
Ethanol	.58	.46	.76	.54
NH_3-nitrogen	.145	.124	.162	.148
Crude protein	8.6	8.5	8.8	8.7
NDF[3]	51.8	51.6	53.8	53.6
ADF[3]	25.4	25.1	26.9	26.7

[1]Each value is the mean of 24 samples taken from the silos during the growing trial.
[2]Expressed as a percent of the crop DM ensiled.
[3]NDF = neutral detergent fiber and ADF = acid detergent fiber.

Table 3. Performance by Yearling Steers Fed the Four Corn Silage Rations

	Pioneer 3377		Pioneer 3379	
Item	Control	1174	Control	Biotal
No. of steers[1]	18	18	18	18
Initial wt, lb	655	658	654	654
Final wt, lb	855	863	865	872
Avg daily gain, lb	2.38[b]	2.44[ab]	2.51[a]	2.59[a]
Daily DM intake, lb[2]	17.5	17.2	17.8	17.5
Feed/lb of gain, lb[2]	7.36[b]	7.06[ab]	7.04[ab]	6.82[a]
Silage fed, lb/ton of crop ensiled[3]	1,824	1,856	1,772	1,788
Silage/lb of gain, lb[3]	18.38	17.60	17.74	16.88
Cattle gain/ton of crop ensiled, lb[3]	99.3	105.5	99.9	105.9

[1]Three pens of six steers per silage.
[2]100% DM basis.
[3]Adjusted to 35% dry matter.
[ab]Means in the same row with different superscripts differ ($P < .05$).