Effects of Delayed Filling and H/M Inoculant® on Preservation and Quality of Corn Silage[1]

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Summary

Eight whole-plant corn silages were evaluated using laboratory silos. Treatments were: 1) control (no additive); 2) H/M Inoculant applied to the fresh crop at the forage harvester (H/M-field); and 3) H/M Inoculant applied to the fresh crop at the time of ensiling (H/M-silo). The control and H/M-field treatments were ensiled at 0, 4.5, and 12 hours post-harvest with the fresh crop remaining in the forage wagons until ensiled. The H/M-silo treatment had the inoculant applied immediately prior to ensiling at 4.5 and 12 hours post-harvest.

All eight corn silages were well preserved and underwent predominantly lactic acid fermentations. H/M Inoculant did not influence lactic acid content or 1actic:acetic and lactic:DM loss ratios. However, H/M-field silage ensiled immediately showed small improvements in quality over the control silage, as judged by lactic acid content and the two fermentation efficiency ratios. H/M Inoculant did not effect DM recovery at any ensiling time. However, when averaged across inoculant treatment, silages made at 4.5 hours post-harvest had the highest DM recoveries; silages at 12 hours, the lowest. All 4.5 and 12 hour post-harvest silages had less lactic and total acids than those made at harvest. The silages made as soon as possible after harvest had a faster accumulation of lactic and total fermentation acids than the same fresh crop ensiled 12 hours post-harvest.

Introduction

Our primary objective was to determine the efficacy of H/M Inoculant for whole-plant corn silage. A secondary objective was to document the effects of time of inoculation and time of silo filling on silage quality.

Experimental Procedures

Silages were made from whole-plant corn, harvested on September 1, 1983 in the late-dent stage at 62 to 64% moisture. The corn was grown under irrigation near Manhattan and had a grain yield of 128 bu per acre. The following three additive treatments were used: 1) control (no additive); 2) H/M Inoculant applied to the fresh crop at the forage harvester (H/M-field); and 3) H/M Inoculant applied to

[1] H/M Inoculant® contains Streptococcus faecium, Lactobacillus plantarum, and Pediococcus fermentation products and is marketed by Triple "F" Feeds, Des Moines, IA.

the fresh crop at the silage blower (H/M-silo). The control and H/M-field treatments were ensiled at 0, 4.5, and 12 hours post-harvesting. Harvested crop remained in the forage wagons until ensiled. Fresh crop for the H/M-silo treatments had the inoculant applied immediately prior to ensiling at 4.5 and 12 hours post-harvesting. The temperature of the pre-ensiled, fresh crop in the forage wagons was monitored from 0 to 12 hours post-harvesting with four thermocouples. The incomplete factorial experimental design is summarized in Table 21.1.

All silages were. made in 5-gallon capacity plastic laboratory silos using a hydraulic press to fill all silos to the same density. Five silos for each of the eight treatments were opened at 56 days post-filling. In addition, ensiling dynamics were measured for control and HM-field treatments ensiled at 0 and 12 hours post-harvesting by opening three silos per treatment at 0.5, 1, 2, 4, and 7 days post-filling.

Chemical analyses of all samples included dry matter (DM) total nitrogen, hot water insoluble-nitrogen, pH, lactic acid, and volatile fatty acids. Aerobic stability of the eight end-product, 56-day silages was determined using procedures described on page 60 of this Report.

Results and Discussion

56-Day Silages. All eight corn silages were well preserved and there were no obvious visual differences among them (Table 21.2). H/M lnoculant did not affect DM recovery at any ensiling time. However, H/M Inoculant applied at the silo 12 hours post-harvest gave a higher ($P<.05$) DM recovery than H/M Inoculant applied in the field and ensiled 12 hours post-harvest. When averaged across inoculant treatment, silages made at 4.5 hours post-harvest tended to have the highest DM recoveries; silages at 12 hours, the lowest.

All silages underwent predominantly lactic acid fermentations, as evidenced by low pHs (range of 3.76 to 3.86), high lactic acids (range of 5.18 to 6.46%), and low acetic acids (range 1.26 to 1.56%). H/M Inoculant did not influence the lactic acid content or lactic:acetic or lactic:DM loss efficiency ratios. However, H/M Inoculant silage made immediately after harvest showed small improvements in quality over the control silage, as judged by lactic acid content and the two fermentation efficiency ratios. In general, all silages made at 4.5 and 12 hours post-harvest had less lactic and total acids than those made at harvest. Preservation of plant protein, as determined by hot water insoluble-nitrogen (HWIN), was influenced by ensiling time but not by H/M lnoculant. Surprisingly, silages made at harvest had lower HWIN than silages made at 4.5 hours and 12 hours post-harvest (0.60 vs. 0.68 and 0.73%, respectively).

Aerobic stability, as measured by day of initial temperature rise, was not affected by inoculant treatment or ensiling time. All eight silages were only moderately stable. The average initial temperature rise occurred on day 4, approximately 86 hours after the silos were opened.

Ensiling Dynamics. The results for fermentation dynamics of the control and H/M-field silages made at 0 and 12 hours post-harvest are shown in Table 21.3 and 21.4. There were only small differences among control and H/M Inoculant silages at any of the six post-filling times. The silages made at harvest fermented very

rapidly and had lactic acid contents of near 4.0% by 24 hours and pH values below 4.0 after 48 hours. In the 12-hour post-harvest silages, some fermentation occurred while the crop was in the forage wagons, as evidenced by the pH (about 5.1) and amount of total acids in the material at silo-filling (about 1.0%). Since the material was not tightly packed in the wagons, considerable plant cell respiration likely took place, which elevated the crop temperatures from about 30 C at harvest to over 45 C after 12 hours. The crop DM loss in the wagons was estimated (using buried nylon bags) to be 1.0 to 1.5 percent. H/M lnoculant did not affect the temperature or DM loss during the 12 hours and both control and H/M-field silages underwent rapid lactic acid fermentations after ensiling.

Table 21.1. Corn Silage Treatments and the Number of Laboratory Silos per Treatment

Additive Treatment	Time of Ensiling (hrs Post-Harvesting)		
	0	4.5	12
Control	20	5	20
H/M-Field	20	5	20
H/M-Silo	--	5	5

Table 21.2. Dry Matter Recoveries, Chemical Analyses, and Aerobic Stabilities of the Eight End-product Corn Silages

	0 hrs Post-Harvest		4.5 hrs Post-Harvest			12 hrs Post-Harvest		
Item	Control	H/M-Field	Control	H/M-Field	H/M-Silo	Control	H/M-Field	H/M-Silo
Silage DM, %	35.3	35.1	35.1	35.3	36.1	37.0	34.7	37.0
	% of the DM Ensiled							
DM Recovery	93.96^{bc}	94.04^{bc}	94.33^{ab}	95.85^{a}	94.43^{ab}	93.10^{bc}	92.48^{c}	94.47^{ab}
	% of the Silage DM							
Lactic Acid	6.21^{ab}	6.46^{a}	5.89^{bc}	5.60^{cd}	5.18^{d}	5.86^{bc}	5.96^{abc}	5.70^{c}
Acetic Acid	1.36^{ab}	1.30^{a}	1.35^{ab}	1.45^{ab}	1.35^{ab}	1.26^{a}	1.32^{ab}	1.56^{b}
Total Fermentation Acids	7.56^{ab}	7.75^{a}	7.23^{ab}	7.05^{bc}	6.53^{c}	7.11^{bc}	7.28^{ab}	7.25^{ab}
Efficiency Ratios:								
Lactic:Acetic	4.6^{ab}	5.0^{a}	4.4^{bc}	3.9^{cd}	3.8^{d}	4.7^{ab}	4.5^{ab}	3.8^{d}
Lactic:DM Loss[1]	1.0^{b}	1.2^{ab}	1.1^{b}	1.5^{a}	.9^{b}	.9^{b}	.8^{b}	1.1^{b}
pH: At Ensiling	5.74	5.85	5.22	5.40	5.32	5.11	5.06	5.25
Silage	3.82^{bc}	3.79^{ab}	3.76^{a}	3.79^{ab}	3.80^{ab}	3.79^{ab}	3.79^{ab}	3.86^{c}
Aerobic Stability: Day of Initial Temp. Rise After Exposure to Air	3.8	4.0	4.1	3.2	4.3	3.0	3.4	2.9

^{abcd} Values in the same row with different superscripts differ P<.05.

[1] Percent lactic acid: Percent of the DM lost.

Table 21.3. Chemical Analyses and Dry Matter Recoveries over Time for the Control and H/M-Field Silages Made at Harvest.

Time Post-Filling and Treatment	Silage DM, %	DM Recovery[1]	pH	Fermentation Acids[2]			Efficiency Ratios	
				Lactic	Acetic	Total	Lactic: DM Loss[3]	Lactic: Acetic
Day 0 (harvest)								
Control	37.5	--	5.74	.21	.19	.4	--	--
H/M-Field	37.1	--	5.85	.19	.05	.3	--	--
SE	--	--	--	--	--	--	--	--
Day .5								
Control	37.1	98.9	5.20	1.03	.45	1.5	1.5	2.3
H/M-Field	36.9	99.3	5.22	1.27	.48	1.8	2.2	2.7
SE	.18	.48	.03	.04	.02	.06	.71	.06
Day 1								
Control	36.6	97.4	4.08	3.97	.51	4.5	1.7	8.0
H/M-Field	36.6	98.3	4.14	4.08	.71	4.8	2.5	5.7
SE	.10	.28	.01	.16	.04	.18	.28	.64
Day 2								
Control	36.4	97.0	3.97	4.42	.55	5.0	1.6	9.2
H/M-Field	36.2	97.1	3.99	4.68	.59	5.3	1.6	8.3
SE	.15	.40	.01	.51	.10	.51	.33	2.41
Day 4								
Control	36.4	96.8	3.95	5.23	.69	5.9	1.6	7.6
H/M-Field	35.8	96.0	3.97	4.85	.82	5.7	1.3	6.1
SE	.15	.40	.01	.28	.05	.25	.19	.61
Day 7								
Control	36.2	96.5	3.96	5.17	.72	5.9	1.5	7.2
H/M-Field	35.9	96.2	3.96	5.35	.82	6.2	1.4	6.6
SE	.10	.27	.01	.25	.05	.28	.10	.26
Day 56								
Control	35.3	94.0	3.82	6.21	1.36	7.6	1.1	4.6
H/M-Field	35.1	94.0	3.79	6.46	1.30	7.8	1.2	5.0
SE	.22	.60	.10	.06	.06	.14	.14	.23

[1] Percent of the DM ensiled.

[2] Percent of the silage DM.

[3] Percent lactic acid: percent of the DM lost.

Table 21.4. Chemical Analyses and Dry Matter Recoveries over Time for the Control and H/M-Field Silages Made at 12 Hours Post-harvest

Time Post-Filling and Treatment	Silage DM, %	DM Recovery [1]	pH	Fermentation Acids [2] Lactic	Acetic	Total	Efficiency Ratios Lactic: DM Loss [3]	Lactic: Acetic
Day 0 (12 hrs Post-Harvest)								
Control	39.3	--	5.11	.69	.38	1.2	--	--
H/M-Field	37.0	--	5.06	.44	.39	.9	--	--
SE	--	--	--	--	--	--	--	--
Day .5								
Control	38.6	98.1	4.37	2.09	.44	2.6	1.1	4.7
H/M-Field	36.9	99.5	4.31	2.53	.45	3.1	5.1	5.6
SE	.07	.20	.02	.09	.01	.09	.82	.14
Day 1								
Control	38.5	97.7	4.03	3.93	.60	4.6	1.9	6.9
H/M-Field	36.6	98.9	4.00	3.62	.51	4.2	3.4	7.1
SE	.12	.32	.01	.11	.07	.14	.35	.74
Day 2								
Control	38.3	97.2	3.94	4.49	.61	5.2	1.8	7.4
H/M-Field	36.4	98.1	3.92	3.24	.77	4.1	1.9	4.3
SE	.22	.54	.02	.26	.05	.25	.38	.48
Day 4								
Control	38.3	97.3	3.92	4.72	.72	5.5	1.8	6.5
H/M-Field	36.0	97.0	3.89	4.93	.90	5.9	1.7	5.6
SE	.12	.27	.01	.17	.06	.15	.15	.48
Day 7								
Control	38.3	97.1	3.91	4.43	.80	5.3	1.6	5.6
H/M-Field	36.2	96.2	3.88	5.06	.96	6.1	1.8	5.3
SE	.23	.51	.01	.27	.07	.34	.20	.14
Day 56								
Control	37.0	93.1	3.79	5.86	1.26	7.1	.9	4.7
H/M-Field	34.7	92.5	3.79	5.96	1.32	7.3	.8	4.5
SE	.19	.51	.02	.13	.05	.17	.08	.14

[1] Percent of the DM ensiled.

[2] Percent of the silge DM.

[3] Percent lactic acid: percent of the DM lost.