

**Effects of Inoculation on
Fermentation of Silage Receiving
Liquid Dairy Manure**

**Final Report Prepared for the
Pioneer Crop Management Award Program**

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Situation

Field application of dairy manure to established alfalfa has become more common in the Northeastern US. Greater reliance on storing manure as a slurry and laws which restrict winter spreading of manure will result in continued increases in the amount of manure applied to growing crops.

There is limited information available on the effects of topdressed manure on the fermentation characteristics of alfalfa. Research in Norway on grasses concluded that coliform levels in unmanured fields are high enough that additional coliform bacteria in manure would not adversely affect fermentation. The researchers were uncertain, however, of the effects of microorganisms not normally associated with acid fermentation. There have been many reports of poor silage fermentation and reduced bunk life in the Northeast, many associated with (but not necessarily caused by) application of manure to cropland.

1994 Research Summary

A 1994 research project funded through the Pioneer Crop Management Award Program investigated the effects of the application of slurry dairy manure to an alfalfa-grass stand, including fermentation characteristics and other quality parameters. Alfalfa was treated with Pioneer 1174 or Pioneer 1177S inoculants plus an uninoculated control. There were slight increases in mineral content of manured vs unmanured alfalfa, but these differences were not economically significant. There were no significant differences in vomitoxin (DON) levels between any treatments at days 0, 45, or 48. DON levels were higher at day 0 than at days 45 or 48, although no reason is known for the decline in DON during fermentation.

Manured alfalfa had higher levels of yeast at day 0 vs unmanured alfalfa, but no differences in molds or bacteria. Silage inoculated with 1174 had higher levels of mold, Streptococci, and Lactobacilli, and silage inoculated with 1177S had higher levels of Lactobacilli. All treatments had very low levels of coliform bacteria, suggesting minimal contamination of harvested forage by topdressed manure.

By day 45, many of the differences detected at day 0 had disappeared. Mold levels were generally high, the result of air infiltration through the plastic bag enclosing the mini silos. There were no differences in pH between manured and unmanured plots, nor between inoculated and uninoculated silages. Alfalfa silage inoculated with 1174 had the lowest pH and uninoculated silage the highest pH, but these differences were not statistically significant.

Silage temperatures were measured daily for three days following opening of the silos on day 45. Although temperatures increased slightly on days 2 and 3, there were no differences among treatments.

1995 Objectives

1. Determine the effects of application of slurry dairy manure to alfalfa stubble on fermentation and other quality parameters of second cut alfalfa silage.
2. Determine if Pioneer 1174 or 1177S inoculants prevent any adverse fermentation effects resulting from manure application.
3. Evaluate manured vs unmanured and inoculated vs uninoculated alfalfa silages for molds, yeast, bacteria, and vomitoxin.

Procedures

First cut alfalfa-timothy was harvested on June 3, 1995. The stand was established in May 1993, and had not received manure since 1991. Manure slurry @10.7% solids content was applied at 4200 gallons (3730# DM)/acre on June 8, supplying 150# of N (86# organic N), 60# P₂O₅, and 108# K₂O. Manure and unmanured plots were paired, with four replications. The botanical composition at second harvest was approximately 95% “DeKalb DK122” alfalfa and 5% “Toro” timothy.

Second crop alfalfa was mowed on July 13 using a Vicon disk mower-conditioner. Within each plot were a control, Pioneer 1174, and Pioneer 1177S. The 1174 was applied in aqueous solution at the chopper, and granular 1177S was applied after chopping. Both inoculants were applied at the rates recommended by Pioneer.

Because mold levels in ensiled alfalfa were unacceptably high in the 1994 trial, minisilos made of PVC drainage pipe were used instead of five-gallon pails. These are identical to those used by Pioneer in its silage research. Chopped alfalfa forage at 34% dry matter was placed in the minisilos, packed to a uniform density of approximately 30#/cu ft and immediately sealed. Samples were taken of fresh forage from each replication and submitted to Pioneer for microbial analysis; to the Northeast DHI Forage Laboratory for nutrient analysis; and to the University of Vermont for serological analysis for vomitoxin. At day 48 the silos were opened and sampled for the same analyses as on day 0. The remaining silage was aerated and placed in open styrofoam containers at ambient air temperature, approximately 70F. Temperatures were recorded daily for eight days, at which time a final set of samples was submitted for vomitoxin analysis.

The experiment followed a split-plot design with manure application as the main treatment and inoculant application as the subplot treatment. Significant manure by inoculant interactions were tested using orthogonal contrasts. Vomitoxin analysis followed a split-split plot design with manure application as the main treatment, inoculant application as the subplot treatment and time period as the sub subplot treatment. Significant interactions were tested using pdiff on only pre-planned comparisons.

Results and Discussion

Forage analysis

There were no statistically significant differences at day 0 or day 48 in nutrient content between any treatment (Table 1). Phosphorus and potassium levels were slightly higher in manured alfalfa, which was similar to the 1994 results.

Table 1. The effect of manure and inoculant application on nutrient composition of alfalfa silage after 48 days ensiling.

Manure	Inoculant	CP%	ADF%	NDF%	P%	K%
no	None	21.7	32	42.5	0.27	2.14
no	1174	21.6	34.1	41.4	0.27	1.77
no	1177S	22.1	34.8	43.8	0.27	1.84
yes	None	21.6	34.8	42.9	0.28	2.29
yes	1174	22.6	31.7	39.7	0.28	2.3
yes	1177S	21.5	35.3	41.4	0.28	2.17

pH level

Table 2 shows there was no significant difference in pH at day 48 among treatments. pH averaged 4.4 which was lower than in 1994, an indication that the minisilos provided a better environment for fermentation than the five-gallon pails.

Table 2. The effect of manure and inoculant application on silage quality parameters.

Manure	Inoculant	pH	DON Day0 ppm	DON Day48 ppm	DON Day55 ppm
no	None	4.34	1.63	3.13	3.33
no	1174	4.27	2.7	1.6	1.7 ^A
no	1177S	4.32	2.1	2.89	2.67
yes	None	4.46	2.27	2	3.13
yes	1174	4.42	1.8	1.23	4.1 ^B
yes	1177S	4.41	0.57	2.13	2.43

Different letters significant at $p < .05$

Vomitoxin

Overall, average vomitoxin (DON) levels increased over time from 1.84 ppm on Day 0 to 2.19 ppm on Day 48. (Table 2) DON levels increased significantly ($p < .001$) when ensiled contents were aerated for eight days. Manure application did not significantly effect overall DON levels over time. Alfalfa silage treated with inoculant 1174 had significantly lower levels of DON than the other two inoculant treatments after 48 days ($p < .05$). However, there was no difference in DON levels among inoculant treatments after aerating silage for eight days. A significant manure by inoculant by day interaction showed unmanured alfalfa inoculated with 1174 had

lower DON levels after 8 days of aerating samples ($p < .05$) than manured alfalfa inoculated with 1174. Because there was no difference between manure/inoculant treatments at Day 48, it is difficult to interpret the effects manure application might have on effectiveness of inoculant after being aerated. DON levels were actually lower after aeration for uninoculated manured samples compared with manured/1174.

Microbiological analysis

Forage from manured plots had higher bacilli counts at day 0 ($p < .001$). No other significant differences were observed for other treatments and parameters at day 0 (Table 3). There were no significant differences in any parameters at day 48 (Table 4). As previously noted, the PVC minisilos were a considerable improvement over the five-gallon pails used in 1994, and mold levels at day 48 were much lower than last year. Mold levels were below detectable limits in all but 3 of the 18 minisilos. While the differences were not statistically significant ($p < .10$), it is noteworthy that all three minisilos containing silage with detectable mold levels were uninoculated treatments.

Table 3. The effect of manure and inoculant application on microbiological profile of fresh cut alfalfa prior to ensiling.

Manure	Inoculant	Bacilli x1000	Lacto x10 ⁶	Cocci x10000	Molds x1	Coliform x10000	Yeast x1000
no	None	12	317	377	9500	49	65
no	1174	64	323	223	6667	73	390
no	1177S	29	280	173	20500	33	40
yes	None	292	330	343	20000	50	40
yes	1174	597	267	330	55667	13	91
yes	1177S	833	343	307	91000	57	392

Table 4. The effect of manure and inoculant application on microbiological profile of alfalfa silage after 48 days ensiling.

Manure	Inoculant	Bacilli x1000	Lacto x10000	Cocci x10000	Molds x1
no	None	79	593	4667	1333
no	1174	81	518	102	0
no	1177S	2185	350	547	0
yes	None	1450	3437	223	833
yes	1174	445	3437	390	0
yes	1177S	455	487	377	0

1994-95 Summary and Conclusions

The application of dairy manure slightly increased mineral levels of alfalfa, not surprising considering that soil fertility levels were generally medium and some response to added nutrients

would be expected. With the exception of an increase in crude protein in 1994, these differences would require minimal changes in ration formulation for dairy cattle fed this forage. Previous research at Miner Institute showed modest but not statistically significant yield increases from application of slurry dairy manure to alfalfa, similar small increases in mineral levels, and no apparent adverse effects from manure. From a nutritional perspective, application of dairy manure is a viable alternative to commercial fertilizer.

In comparing alfalfa which was not inoculated with 1174 or 1177S, there were few meaningful differences in vomitoxin or microbiological levels between manured and unmanured treatments at day 0. Even these small differences had disappeared after 48 days of ensiling. Since manure apparently has little effect on alfalfa silage quality in the absence of inoculants, the decision to use an inoculant for alfalfa silage should be based on factors other than manure use. It should be noted that although this study did not find significant differences between inoculated and uninoculated forages, dry matter losses and animal performance were not evaluated.

Literature cited

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