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THE UNIVERSITY OF VERMONT EXTENSION

INFLUENCE OF CUTTING HEIGHT AND INOCULANT USE ON FORAGE PRODUCTIVITY AND SILAGE QUALITY

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Harvest management is an integral component of producing high-quality forage. Often harvest timing and speed are discussed, but equally important is the cutting height. While many grazing farmers have adopted the practice of leaving more ungrazed material in the pasture, many hay fields are still harvested as low as possible. This, in combination with frequent harvest cycles, can cause stress, leading to a decline in plant density, increases in weed pressure, and subsequent reductions in stand productivity and quality. Cutting at a higher height can help the plants recover faster and keep the ground cooler during hot and dry conditions. Increasingly erratic weather can make it difficult to properly ferment forage, the application of a silage inoculant can help speed the fermentation process and preserve dry matter and forage quality. Since the population of native bacteria can be highly variable depending on conditions, an inoculant is designed to add specific bacteria to dominate the fermentation process. Generally, these are lactic acid producing bacteria. The bacteria help to drop the silage pH quickly to reduce the growth of bacteria that could degrade the quality of the feed and even make animals ill. In 2024, the University of Vermont Extension Northwest Crops and Soils Program initiated two trials to evaluate the impacts of varying cutting heights on forage yield and quality and the use of inoculants on silage preservation and quality to better understand the cost and value of these practices.

MATERIALS AND METHODS

The trial was implemented into strips of orchardgrass and tall fescue that was established in 2022. The plot design was a randomized block design where blocks were grass species of either tall fescue or orchardgrass. Treatments within blocks were either 2-inch or 4-inch cutting height. Plots were 10’ x 125’ with five replications. On 28-Jun, plots were harvested using a New Holland discbine that was adjusted to obtain each cutting height. Yields were measured by collecting and weighing the material in a 10’ x 39” section of each plot’s swath. A small plot Carter flail forage harvester was then used to chop the swath in each plot to obtain a uniform subsample for dry matter content and quality determination. From the plots containing orchardgrass, material was bulked to use in the forage inoculant study. Thirty-two vacuum seal bags were then filled with approximately 1 lb of material and sealed. The remaining bulked material was then treated with Certi-Sile 180 WS organically approved silage inoculant at the rate of 2 grams per ton as recommended on the label. The product label outlining the species of bacteria included in the product is shown in Image 1. An additional, thirty-two bags were also filled with approximately 1 lb of the inoculated material. All sample bags were vacuum sealed and placed in enclosed plastic storage bins and stored under ambient temperature. Weekly, four bags of each treatment were removed and sent to DairyOne Forage Laboratory (Ithaca, NY) for pH analysis. After 8 weeks of ensiling, the final batch of samples were also analyzed for fermentation profile.

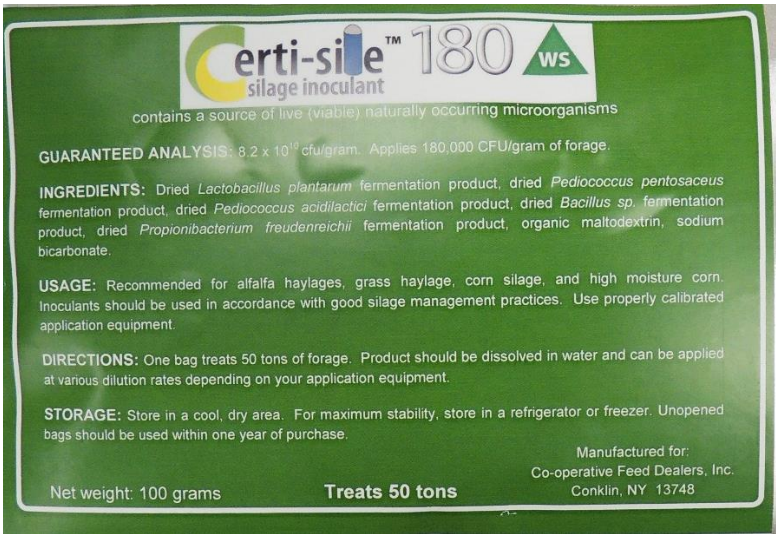

Image 1. Certi-Sile 180 WS organic silage inoculant label.
Source: https://www.cfd.coop/images/catalog/2300409.jpg

Mixtures of true proteins, composed of amino acids, and non-protein nitrogen make up the crude protein (CP) content of forages. The bulky characteristics of forage come from fiber. Forage feeding values are negatively associated with fiber since the less digestible portions of the plant are contained in the fiber fraction. The detergent fiber analysis system separates forages into two parts: cell contents, which include sugars, starches, proteins, non-protein nitrogen, fats and other highly digestible compounds; and the less digestible components found in the fiber fraction. The total fiber content of forage is contained in the neutral detergent fiber (NDF) which includes cellulose, hemicellulose, and lignin. This measure indicates the bulky characteristic of the forage and therefore is negatively correlated with animal dry matter intake. The portion of the NDF fraction that is estimated to be digestible after 30 hours of fermentation in rumen fluid is represented by the 30- hour NDF digestibility. For ensiled forages, pH is an indicator of fermentation success. The lactic acid bacteria present or introduced into the material utilize plant sugar to create organic acids that reduce the pH and preserve the silage. The resulting profile of acids, lactic, acetic, and butyric, produced through fermentation indicate fermentation success and silage quality.

Data were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within trials were treated as random effects, and mixtures were treated as fixed. Treatment mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$). Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among treatments is real or whether it might have occurred due to other factors in the field. At the bottom of each table an LSD value is presented for each variable (i.e. yield). Least Significant Differences (LSDs) at the 0.10 level of significance are shown. Where the difference between two treatments within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure that for 9 out of 10 times, there is a real difference between the two treatments. In this example, treatment C is significantly different from treatment A but not from treatment B as the difference between C and B is equal to 1.5, which is less than the LSD value of 2.0. This means that these treatments did not differ in yield.

Treatment	Yield
A	6.0b
B	7.5ab
C	**9.0a**
LSD	2.0

RESULTS

Weather data was recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 1). The 2024 growing season began wetter than normal with 1.4 inches of precipitation above normal being accumulated. However, temperatures rose and precipitation was 1.5 inches below normal in May. Rain returned in June with more than 2 inches above normal being accumulated which was accompanied by slightly above normal temperatures. Overall, a total of 1,688 Growing Degree Days (GDDs) were accumulated during the trial period. This equated to 140 more than normal. In general, the wet conditions were very conducive to the growth of the perennial cool season forages utilized in this trial.

Table 1. 2024 weather data for Alburgh, VT.

	Apr	May	Jun
Average temperature (°F)	45.7	61.9	68.5
Departure from normal	0.13	3.47	0.95
Precipitation (inches)	4.47	2.27	6.65
Departure from normal	1.40	-1.49	2.39
Growing Degree Days (base 41°F)	226	647	815
Departure from normal	11	108	21

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
Historical averages are for 30 years of NOAA data (1990-2021) from Burlington, VT.

Evaluation of cutting height on grass yield and quality

Overall, we saw no statistical differences in yield or forage quality between cutting at 2 inches or 4 inches (Tables 2 and 3). While the 4 inch cutting height had numerically higher forage quality, these were not statistically different from one another. This is contrary to what we have found in previous studies.

Table 2. Forage quality metrics by cutting height treatments, 2024.

Cutting height	CP	ADF	NDF	WSC	ESC	NEL	30-hr NDFD
			% of DM			Mcal lb^{-1}	% of NDF
2 inches	13.6	32.9	53.4	11.9	7.45	0.573	66.4
4 inches	15.1	31.7	51.5	12.7	8.14	0.582	68.2
LSD (p = 0.10)†	NS‡	NS	NS	NS	NS	NS	NS
Trial mean	14.4	32.3	52.5	12.3	7.79	0.578	67.3

†Least significant difference at p = 0.10 level.
‡NS- not statistically significant.

Table 3. Forage dry matter and component yields by cutting height treatments, 2024.

Cutting height	DM yield	Predicted milk yield		Protein yield	Digestible NDF yield
	tons ac^{-1}	lbs ton^{-1}	lbs ac^{-1}	lbs ac^{-1}	
2 inches	0.862	3805	3275	236	611
4 inches	0.774	3872	2991	241	546
LSD (p = 0.10) †	NS‡	NS	NS	NS	NS
Trial mean	0.818	3839	3133	238	579

†Least significant difference at p = 0.10 level.
‡NS- not statistically significant.

However, there were species x height interactions for yield, ADF concentration, milk yield per acre, and digestible fiber yield per acre (Figures 1 and 2). While increasing cutting height of tall fescue decreased dry matter yield, which subsequently decreased milk yield per acre, and digestible fiber yield per acre, increasing cutting height of orchardgrass decreased ADF content and did not impact the other parameters. These data may suggest that orchardgrass forage, at least from this cutting at this age, was not significantly impacted by increasing cutting height to 4 inches. These data do not show impacts of repeated low or high mowing heights on yield, quality, stand persistence, or stand density.

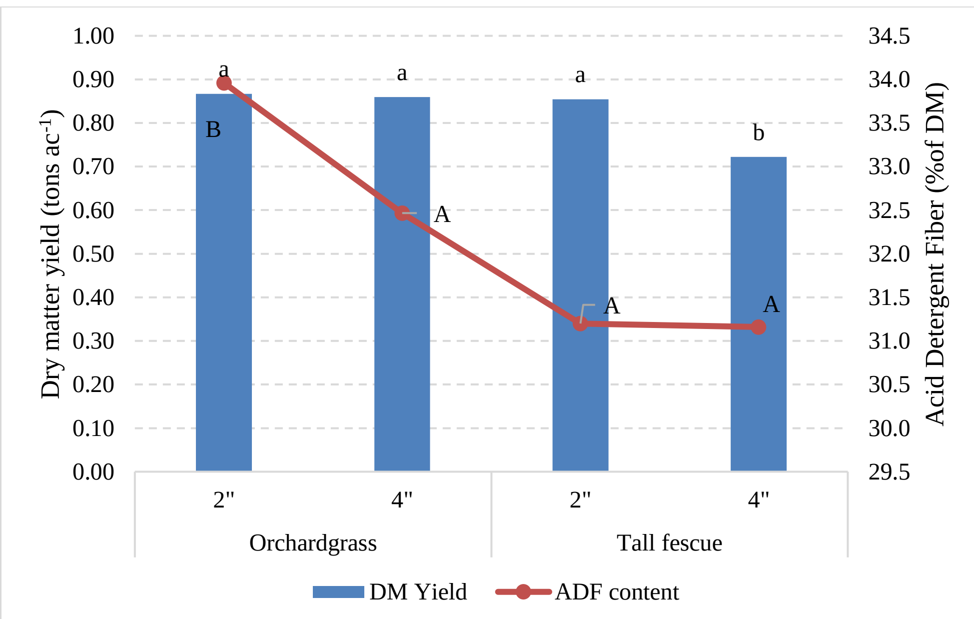

Figure 1. Species x cutting height interaction for dry matter yield and ADF content.

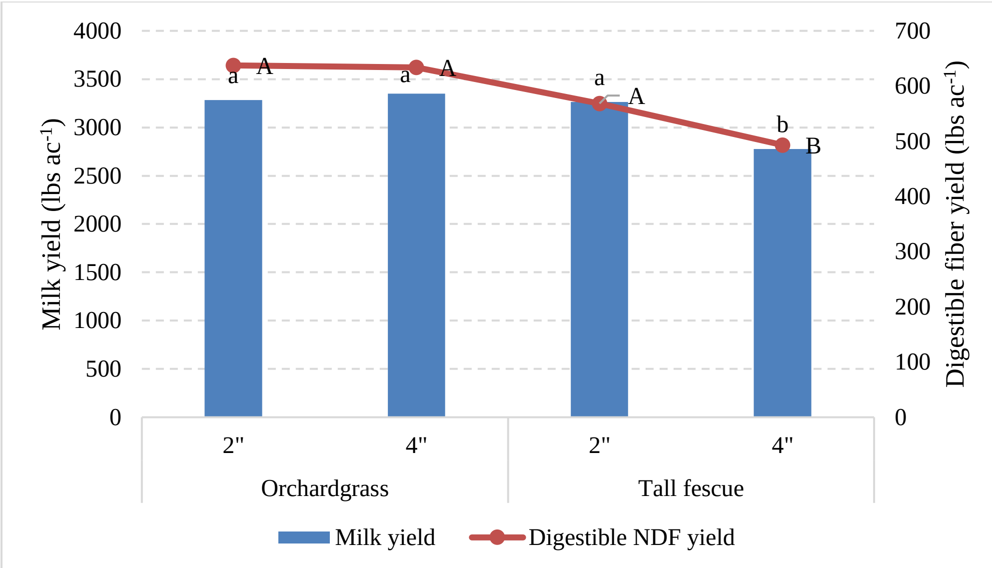

Figure 2. Species x cutting height interaction for milk and digestible fiber yield per acre.

Evaluation of forage inoculant on grass fermentation

Inoculated forage had a significantly lower pH compared to the control after just one week of ensiling and remained significantly lower across all 8 weeks (Figure 3). The control forage barely reached 4.5 pH after 8 weeks of ensiling while inoculated forage was just under a pH of 4.0 at 8 weeks of ensiling. The inoculated forage was considered well-preserved even after just one week of ensiling, while the control forage took an extra week to reach safe preservation levels (Figure 4). Grass silage typically has a pH between 4.0 and 4.8 with the lower pH indicating better fermentation.

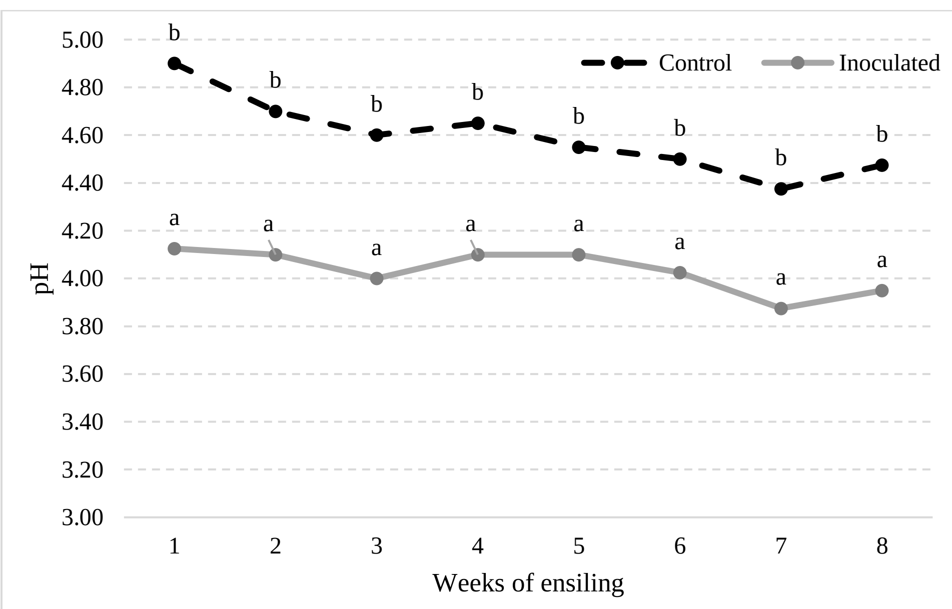

Figure 3. Silage pH of inoculated and uninoculated material over 8 weeks.

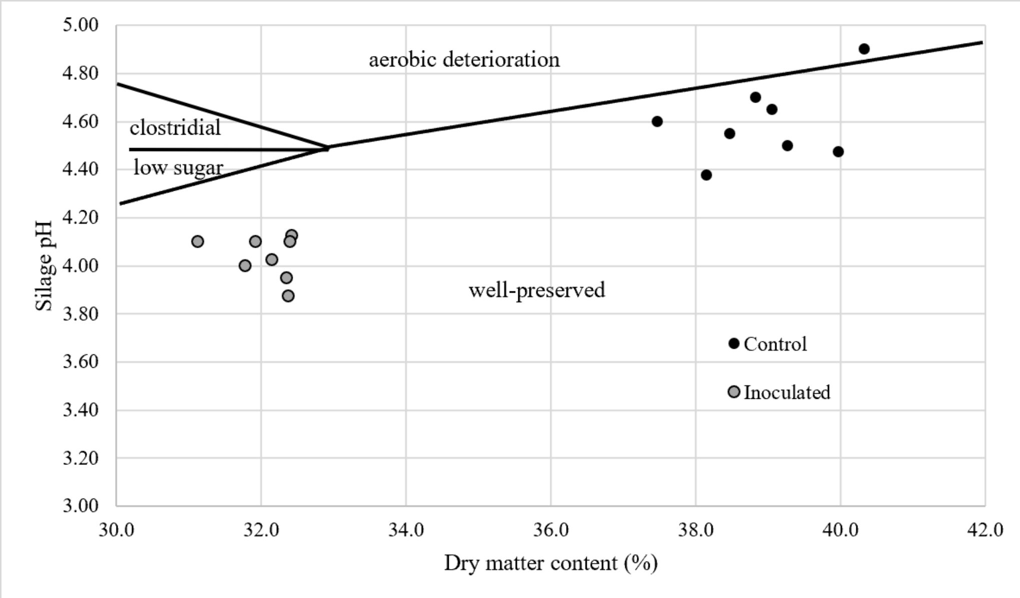

Figure 4. Silage pH vs. dry matter content indicating silage preservation quality.

The faster reduction in pH preserved more protein as evidenced by both the higher total crude protein content and lower ammonia content of the inoculated forage (Table 4). The inoculated forage was also higher in lactic acid and lower in butyric acid, which are both indicative of higher quality silage. The total silage acids and volatile fatty acids (VFAs) produced through fermentation were both higher for the inoculated forage.

Table 4. Silage quality of inoculated and uninoculated material after 8 weeks of ensiling, 2024.

Treatment	CP	Ammonia	Lactic acid	Acetic acid	Propionic acid	Butyric acid	Silage acids	Total VFA
	% of DM	% of CP			% of DM			
Control	16.0	3.90	3.74	1.02	**0.003**	0.685	5.62	7.15
Inoculated	**18.1**	**2.70**	**5.83**	**1.22**	0.000	**0.010**	**7.09**	**8.43**
LSD (p = 0.10)†	0.823	0.214	0.241	NS‡	NS	0.436	0.535	0.508
Trial mean	17.0	3.30	4.78	1.12	0.001	0.348	6.35	7.79

Top performer is in **bold.**

†Least significant difference at p = 0.10 level.

‡NS- not statistically significant.

DISCUSSION

While this single year and single harvest showed no yield or quality benefit to increasing cutting height, in past years we have seen stronger differences especially when cutting height was implemented across multiple cuttings in the growing season. In addition, the species interactions suggest that some species may be more impacted by altering cutting heights than others. These relationships need further exploration to fully understand to help farmers make management decisions about their particular forage stands.

The forage inoculant was highly beneficial to the fermentation process producing a silage with high lactic acid and low pH both indicative of successful fermentation. It cost approximately $0.92 to treat a ton of dry matter with inoculant and in each ton of treated dry matter, 42 pounds of additional protein were gained. This additional protein costs $0.02 per pound. This is significantly cheaper than buying a pound of organic soybean meal. Regardless of the exact return, for less than $1 per ton to treat, utilizing a silage inoculant to support better silage preservation appears to be a very cost-effective strategy to support higher organic grass silage quality.

ACKNOWLEDGEMENTS

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