NORTHWEST CROPS & SOILS PROGRAM

2023 Manure and Urease Inhibitors Impacts on Grass Yield and Quality

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2023 MANURE AND UREASE INHIBITORS IMPACTS ON GRASS YIELD AND QUALITY

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As fertilizer prices have been rising dramatically in the last few years, farmers have been interested in utilizing nitrogen management products to help minimize losses and ultimately reduce purchased fertilizer costs. There are three main types of nitrogen stabilizing products, urease inhibitors, nitrification inhibitors, and controlled release products. Urease inhibitors (i.e., ContaiN®, ANVOL® and Limus®) slow the transformation of urea into ammonium to avoid ammonia volatilization. Research has shown as much as 50% of fertilizer N can be lost to ammonia volatilization if conditions are right. Nitrification inhibitors (Instinct™, and N-Serve®) reduce the populations of the bacteria responsible for converting ammonium to nitrate, thereby keeping nitrogen in the ammonium form and avoiding losses to nitrous oxide or leaching. Controlled release products are coated with a physical or chemical barrier that temporarily isolates the fertilizer from the environment to slow its degradation. Approximately 50% of the nitrogen in liquid dairy manure is in the ammonium form and is subject to losses from volatilization when surface applied to hay fields. In 2023, UVM Extension initiated a replicated field trial to investigate the use of a urease inhibitor applied with liquid manure to hayfields. This report summarizes the results of those trials.

MATERIALS AND METHODS

Treatment and management information for the replicated trial are summarized in Table 1. The trial included six treatments replicated four times each. Four of the treatments utilized manure either broadcast on the surface (with and without a urease inhibitor) or injected into the sod (again with and without urease inhibitor). These were compared to applying urea treated with a urease inhibitor and a control which received no supplemental fertility. Following the first harvest, manure applications were made on 12-Jun at a rate of 6200 gal ac^{-1}. Urea treated with a urease inhibitor was applied on 12-Jun at a rate of 100 lbs ac^{-1}. The urease inhibitor ContaiN® was used for both manure and fertilizer treatments.

Table 1. N management replicated trial information, Alburgh, VT.

Location	Borderview Research Farm – Alburgh, VT
Treatments	Broadcast manure Broadcast manure with urease inhibitor Injected manure Injected manure with inhibitor Control (no fertility added) Urea fertilizer with urease inhibitor
Replications	4
Plot size (ft.)	30’ x 45’
Manure applications	12-Jun, 6200 gal ac^{-1}
Urea application	12-Jun, 100 lbs ac^{-1} treated with ContaiN®
Urease inhibitor	ContaiN®, 18 oz. ac^{-1}
Harvest date	2-Aug

Due to excessive rain and wet saturated soils, harvest was severely delayed and only one application of manure could be applied. Yields were determined by harvesting and weighing the forage using a Carter

small plot flail forage harvester equipped with scales. An approximate 1 lb subsample of the harvested material from each plot was collected and dried to calculate dry matter yield and forage quality. Samples were ground to 2mm using a Wiley sample mill and then to 1mm using a UDY cyclone mill. Samples were analyzed for quality using Near Infrared Reflectance Spectroscopy (NIR) procedures using a FOSS DS2500. Mixtures of true proteins, composed of amino acids, and non-protein nitrogen make up the crude protein (CP) content of forages. Although forage quality encompasses much more than simply protein content, this was a key metric to investigate since the addition of nitrogen can influence yield but also protein content in forages.

Yield data and stand characteristics 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 varieties is real or whether it might have occurred due to other variations in the field. At the bottom of each table a LSD value is presented for each variable (i.e. yield). 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. Treatments that were statistically similar in performance to one another share a letter. In this example, treatment C is significantly different from treatment A but not from treatment B. 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. The difference between C and A is equal to 3.0, which is greater than the LSD value of 2.0. This means that these treatments yielded significantly different from one another.

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 2). Despite a warm dry spring, conditions turned in June bringing cooler and wetter than normal weather. During July in particular, excessive rainfall was experienced over much of the region, accumulating over 6 inches above the normal rainfall for that month. Rainy conditions continued into August coupled with unseasonably cool temperatures averaging almost 4 degrees below normal. This led to approximately 84 fewer Growing Degree Days (GDDs) being accumulated during this trial period. Similar conditions were experienced across the 7 farms, although there were slight differences in total rainfall accumulations. In general, all the sites experienced excessive rainfall and cooler than normal temperatures. While cool season perennial forage grasses thrive under cool moist conditions, this excessive rainfall throughout the season negatively impacted performance with little sunlight for photosynthesis and saturated soils impacting nutrient losses and soil oxygenation.

Table 2. 2023 weather data for Alburgh, VT.

	Jun	Jul	Aug
Average temperature (°F)	65.7	72.2	67.0
Departure from normal	-1.76	-0.24	-3.73
Precipitation (inches)	4.40	10.8	6.27
Departure from normal	0.14	6.69	2.73
Growing Degree Days (base 41°F)	749	991	819
Departure from normal	-44	17	-101

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.

Impact of N Management Strategy- Replicated Trial

Dry matter yields ranged from 1.31 to 2.69 tons ac^{-1} (Table 3). While the broadcast manure with inhibitor treatment was numerically the highest, it was statistically similar to all other treatments except the control. This suggests that applying manure or fertilizer in any of the methods investigated was better than not applying any additional fertility, but that there was no advantage to any one particular method. Protein contents varied across the trial averaging around 9.5%, but did not differ statistically. The weather conditions experienced throughout the season were not conducive to ammonia volatilization. Therefore, we would not expect the urease inhibitors or injecting manure, which can protect the nitrogen from volatilizing, to have an effect under these conditions.

Table 3. Yield and quality of tall fescue managed under three fertility strategies, 2023.

N Management Treatment	DM Yield	CP	CP yield
	tons ac^{-1}	% of DM	lbs ac^{-1}
Control	1.31b†	9.64	259b
Broadcast manure	2.23a	9.69	415a
Broadcast manure + inhibitor	**2.69a**	9.52	**509a**
Injected manure	2.27a	9.70	442a
Injected manure + inhibitor	2.54a	9.04	458a
Fertilizer + inhibitor	2.15a	**9.27**‡	395a
LSD (p=0.10) ¥	0.581	NS§	134
Trial mean	2.20	9.48	413

†Treatments that share letters performed statistically similarly to one another.
‡The top performing treatment is indicated in **bold.**
§NS- not statistically significant
¥ LSD; least significant difference at the p=0.10 level.

DISCUSSION

Nitrogen is a vital but dynamic nutrient on farms. Strategies, including injecting or incorporating manure, and use of nitrogen stabilizing products are risk management tools that can help farmers retain more nitrogen under conditions that favor volatilization. However, decisions about implementing these strategies must be made well ahead of knowing if such conditions will be experienced. Previous trials have shown increased yields of approximately 1 ton ac^{-1} from the use of a urease inhibitor in manure when applied to hay crops. This year, however, with weather conditions that already did not favor nitrogen volatilization, no impact was observed. Gathering data over several sites and years can help better understand the potential impact and risks of these strategies so informed decisions about their use can be made. Therefore, additional research is needed to fully understand this risk management practice.

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