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Research Report

The Evaluation of Raw Milk As A Pasture Biostimulant 2012 – 2013

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The UNIVERSITY of VERMONT
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The Evaluation of Raw Milk as a Pasture Biostimulant

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INTRODUCTION

The cost to renovate poor quality, low productive pastures can be very expensive especially for organic farmers. To manage this problem, some graziers are experimenting with highly active biological compounds known as positive plant growth regulators, metabolic enhancers, and biostimulants. These compounds, which are neither fertilizers nor pesticides, promote efficient plant nutrient uptake and enhance plant growth and development through a wide variety of mechanisms. They are typically applied in very small amounts to the soil or sprayed directly onto the plant. Humic acids and seaweed extracts are well known examples.

Raw cow milk has been suggested as an effective pasture biostimulant. Raw milk has been used as a crop amendment for centuries. It contains proteins and other compounds which have been observed to suppress plant disease and enhance plant tolerance to heat stress and nutrient uptake capabilities. Furthermore, many of the bacteria ubiquitous in raw milk are established beneficial, plant growth promoting, soil microbes. In recent years, there have been anecdotal reports and claims from field observations in the Midwest that raw milk applied to pasture at rates up to 20 lbs. per acre (too low to provide a significant amount of nutrients) boosts yields, forage quality, soil porosity and grass brix measurements. However, none of these claims have been thoroughly investigated in replicated trials and there have been no studies report in the Northeast.

Our aim was to verify these reported observations in Vermont by assessing the effect of diluted raw milk on pasture production, quality, botanical composition, and soil health. It is our intent that this project will provide additional information to help farmers make informed decisions before investing their time and/or money into implementing this novel practice.

In preliminary greenhouse studies we conducted at the University of Vermont, perennial ryegrass treated with dilute raw milk tillered more rapidly than those that did not receive the treatment (Figure 2). This resulted in significantly greater above ground biomass in pots treated with milk. This only occurred in the initial growth period and the affect did not have any long lasting influence since there was no difference in tillering rate nor yield in the next growth period. Other forage growth parameters including root density, shoot elongation, and forage Brix Content, were not affected by the application of raw milk. With some positive effects, our next goal was to test milk treatments in real world situations on farms in Vermont.

Figure 1. Preliminary greenhouse study

2012 Field Trials

Field experiments were conducted on two Vermont dairy farms - Applecheek Farm, a diversified organic farm located in Hyde Park, Vermont and the Choiniere Family Farm, a family run organic dairy located in Highgate, Vermont. At both locations, existing pastures were used to test the application of raw milk compared to an untreated control. The dominate grass species were orchardgrass and

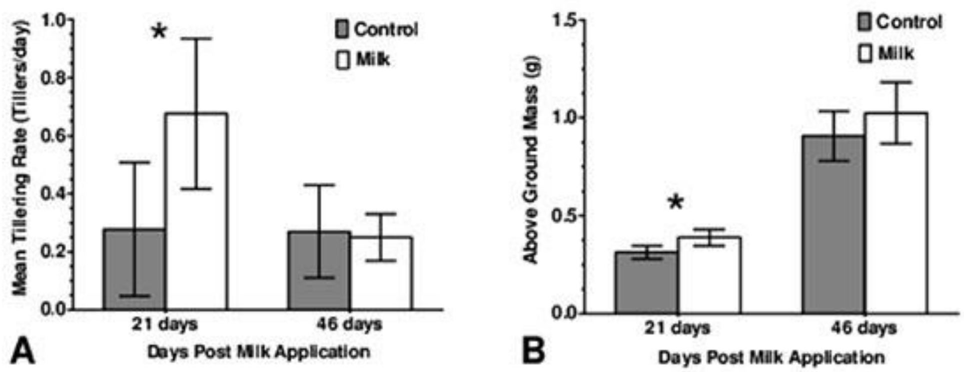

Figure 2. Preliminary greenhouse results of dilute milk applications. **A** – Mean tillering rate (tillers per day) of perennial ryegrass between 0 and 20 days and 21 and 46 days after treatment application. **B** – Average above ground yield (grams per pot) of perennial ryegrass 21 days (1^{st} cutting) and 46 days (2^{nd} cutting after regrowth) post milk application

Kentucky bluegrass at Hyde Park and Highgate, respectively. At both farms, the pastures had been subject to managed intensive grazing (MIG) methods for many years. Cows are usually moved between each milking and rest periods vary from two weeks to a month depending on growing conditions.

Treatments consisted of raw milk applied just after grazing compared to an untreated control. All other management practices were keep consistent and the same. Treatments were replicated at each farm using a paired-comparison design with each pair of treatments (milk supplement verses a no milk control) replicated six times for a total of 12 plots. Plot sizes were ranged from a quarter to half acre each. Within each grazing paddock, treatments were assigned to one side of the paddock or the other. In the first paddock, the treatments were randomly assigned and treatments alternated in the subsequent paddocks.

The milk treatment was applied only once at a rate of 20 gallons of milk per acre to each of the six appropriate plots in early June of 2012. Raw milk was collected from each respective farm, diluted 1:1 with tap water, and sprayed at the rate of 40 gallons of milk solution/acre using a tractor mounted boom sprayer. Treatment application occurred within five days of the pasture being grazed. Our intent was for the pasture to be relatively short to help facilitate some of the solution reaching the soil and to have at least 30 days of pasture growth between application and next grazing. However, since these were dairy cow pastures, the residual sward height at time of application was not as low as you would expect with a dry cow or beef pasture.

Figure 3. Milk sprayed on pasture in June 2012 at Applecheek Farm.

Plots were sampled twice during 2012, approximately 30 and 60 days post milk application immediately before the next two or three grazing periods. Pasture pre-grazing mass was measured just prior to grazing by collecting cut samples from 30 randomly placed 1.5 ft^2 quadrates within each plot. Each sample was placed in marked cloth bags and put in a forced air drying room located at the University of Vermont Horticultural Research and Education Center where once dried, they were weighed. Post-grazing yields were collected immediate after the animals grazed the plots using a calibrated rising plate meter. Soil samples were collected from each plot taking a 20 subsample composite and analyzed at the UVM Agricultural and Environmental Testing Lab to measure organic matter, nutrient content and moisture content. Forage grass samples were separated from the mixture and sent to Dairy One (Ithaca, NY) to be tested for ADF, NDF, and crude protein in a analysis. Forage botanical composition was determined by collecting a composite of 20 subsamples across each plot and hand separating grass, legume and weeds. BRIX measurements were determined by taking random grab samples of 6-10 leaves were collected from 30 locations in each plot. Each sample was vigorously rolled between researchers' hands for 15 seconds to form a tight ball; the sap was then extracted used a garlic press. Brix values for each batch were measured immediately using a Vee Gee Scientific STX-3 Handheld Refractometer.

Figure 4. Hand sampling pastures using electric clippers and a 6" x 36" quadrat randomly placed.

Results - Generally, we found little to no effect of the raw milk on pasture growth or productivity at either farm (Table 1). Participating farms were not able to distinguish the areas that had been treated with milk from the controls.

There were no statistical differences in pre-grazing or post-grazing yields at either farm for either growth period. We were unable to collect post-grazing for the first sampling at Applecheeck, therefore, we could not calculate consumed forage. There was a statistical difference between the milk treatment and the control for consumed forage during the second sampling at Applecheek Farm, but the numerical differences were not great. Also, there were no consumed forage differences at Choiniere farm. Since these are calculations using both pre and post grazing yields, there is more likelihood of variation.

Legume content was consistent between treatments across farms and sampling times and tended to be low at all sites. The percent of weeds in the pastures were also relatively low. The milk treatment in the second sampling at the Choiniere farm had statistically greater weed content than the control but the numerical differences were not very large (9% verses 6%). ,

There were no consistent differences in forage quality nor soil quality measurements (data not shown). Calcium content was slightly higher than the control in the first sampling at Applecheek. Since the interval between application and sampling was only 20 days and it was dry during that time period, it may be likely that the milk residue contributed to this slight increase in calcium content. There were no differences by the second sampling.

2013 Field Trial

Since we found relatively little to no significant effects of applying raw milk to pasture in the 2012 trials, we felt it was important to conduct one more field study at another location and soil to confirm our findings. In 2013, a field trial was conducted at the Larson Farm in Wells, VT. Like the two previous farms, the Larsons practice MIG and a soil test of the study site showed high organic matter and good soil pH and nutrient levels. Dominate species included tall fescue, orchardgrass, reed canarygrass and white clover.

Table 1. The effect of raw milk applications on pasture production, utilization, composition and quality at two farms in Vermont in 2012.

Measurement	unit	First Sampling			Second Sampling		
		Milk	Control	Significance[a]	Milk	Control	Significance[a]
Site 1: (Applecheek Farm)							
Pre-grazing mass	*lbs dm/acre*	2199	2241	n.s.	1715	1805	n.s.
Post-grazing mass	*lbs dm/acre*	-	-		1050	961	n.s.
Forage consumed[b]	*lbs dm/acre*	-	-		665	844	**
Percent legume	*% of dm*	9	10	n.s.	10	9	n.s.
Percent weeds	*% of dm*	17	7	n.s.	11	10	n.s.
Quality of Grass Component							
Crude protein	*% of dm*	13.8	13.7	n.s.	17.3	17.5	n.s.
Acid detergent fiber	*% of dm*	38.4	37.9	n.s.	35.5	34.9	n.s.
Neutral detergent fiber	*% of dm*	58.9	58.8	n.s.	54.1	53.3	n.s.
Water soluble carbohydrates	*% of dm*	8.8	9.4	n.s.	9.7	10.1	n.s.
Phosphorus	*% of dm*	0.33	0.33	n.s.	0.35	0.37	n.s.
Calcium	*% of dm*	0.68	0.58	**	0.64	0.65	n.s.
Potassium	*% of dm*	2.47	2.43	n.s.	2.77	2.78	n.s.
BRIX	*% w/w*	8.56	7.70	n.s.	-	-	
Time post milk application[c]	*days*	20			72		
Site 2: (Choiniere Farm)							
Pre-grazing mass	*lbs dm/acre*	2156	2031	n.s.	1941	1947	n.s.
Post-grazing mass	*lbs dm/acre*	1356	1236	n.s.	1072	1139	n.s.
Forage consumed[b]	*lbs dm/acre*	801	796	n.s.	1090	807	n.s.
Percent legume	*% of dm*	16	15	n.s.	13	13	n.s.
Percent weeds	*% of dm*	5	5	n.s.	9	6	**
Quality of Grass Component							
Crude protein	*% of dm*	14.8	14.6	n.s.	16.8	16.9	n.s.
Acid detergent fiber	*% of dm*	36.0	36.6	n.s.	35.5	35.8	n.s.
Neutral detergent fiber	*% of dm*	57.7	56.0	n.s.	56.5	57.0	n.s.
Water soluble carbohydrates	*% of dm*	11.0	11.3	n.s.	9.1	9.0	n.s.
Phosphorus	*% of dm*	0.33	0.32	n.s.	0.37	0.37	n.s.
Calcium	*% of dm*	0.55	0.59	n.s.	0.55	0.50	n.s.
Potassium	*% of dm*	2.73	2.74	n.s.	2.74	2.79	n.s.
BRIX	*% w/w*	11.61	11.27	n.s.	-	-	
Time post milk application[c]	*days*	36			64		

[a] n.s. - not significantly different; * - significantly different; ** - very significantly different; *** - highly significantly different

[b] Forage consumed is calculated as the difference between pre and post grazing mass

[c] The first sampling was conducted during the first grazing post milk application; the second sampling was from the third grazing at Site 1 and the second grazing from Site 2.

One concern from the 2012 studies was that the 20 gallon per acre rate would be too expensive even if there was a positive response. In addition, some of the previous observations stated responses at lower rates. Therefore, we imposed two rates of milk in this study, 10 gallons and 20 gallons per acre. In addition, the Larsons were interested in also testing whey that they received from the cheese plant were they sold their milk.

Figure 5. Milk sprayed by boom sprayer at Larson Farm, Wells, VT

Since there were four treatments – two milk rates, whey applied at a rate typical of the farm, and the untreated control – the study was set up as a randomized block design with six replications and the plots were small (12' x 30') all contained in one grazing paddock. The treatments were applied July 17 after the third grazing. The raw milk was collected from the farm and diluted 1:1 with the farm's tap water and applied with the same boom sprayer used in 2012 except it was calibrated for the two rates of application. The whey was applied at a rate that the farm had been using. We estimated the whey was applied at a rate of approximately 1500 to 2000 gallons per acre.

Figure 6. Whey applied at the Larson Farm

Pre-grazing mass was measured on all treatment plots on August 14 just before the cows were turned out on the pasture. Ten falling plate heights were collected from each plot. Hand samples were collected from each plot to determine forage quality evaluation. On August 16, post-grazing mass was measured in the same manner taking 10 falling plate heights per plot.

Figure 7. Measuring pasture mass

To calibrate the falling plate, 12 samples ranging in mass from low to high were collected across the study area. At each site, the rising plate height was documented and a quadrat of the same dimensions as the falling plate was used to collect all the forage down to the ground surface. The material was placed in a cloth bag, dried and weighed to determine dry matter yield. Regression analysis showed that a quadratic equation was the best fit to develop a prediction equation. The model used was $y = -4.5508x^2 + 290.62x$, where y is yield in lbs dm per acre and x is height in centimeters.

Results - There were no significant differences in pre-grazing or post-grazing yields or forage consumption for any of the treatments (Table 2). At the time of collecting pre-grazing pasture mass, there were no observable differences as well (Figure 7). Forage quality was also not different amongst treatments. The pasture residue at time of application was relatively high and this may have interfered with any movement of the milk to the soil. However, the residue was not atypical of dairy pasture managed for high milk production. The soil quality of this site, like the other two farms, was quite good, having high organic matter, soil pH at about 6.5 or greater, and soil nutrient levels adequate to high. Therefore, growth rate was already good and could mask any subtle benefits from a biostimulant.

Table 2. The effect of raw milk and whey on pasture production, utilization, and forage quality sampled 28 days after application, the Larson Farm, Wells, VT, 2013.

Measurement	unit	Treatments				Significance[a]
		Milk 1X	Milk 2X	Whey	Control	
Application Rate	*gallons/acre*	10	20	c		
Pre-grazing mass	*lbs dm/acre*	3900	3825	3837	3887	n.s.
Post-grazing mass	*lbs dm/acre*	2139	2203	2444	2388	n.s.
Forage consumed[b]	*lbs dm/acre*	1760	1622	1393	1499	n.s.
Quality of Grass Component						
Crude protein	*% of dm*	-	16.0	14.7	16.0	n.s.
Acid detergent fiber	*% of dm*	-	29.8	30.9	29.5	n.s.
Neutral detergent fiber	*% of dm*	-	61.9	64.4	62.6	n.s.
Non-fiber carbohydrate	*% of dm*	-	24.0	23.1	23.0	n.s.
Phosphorus	*% of dm*	-	0.37	0.37	0.37	n.s.
Calcium	*% of dm*	-	0.47	0.38	0.44	n.s.
Potassium	*% of dm*	-	3.22	3.18	3.20	n.s.

[a] n.s. - not significantly different; # - significant at a 10% level of probability; means with the same letter not significant
[b] Forage consumed is calculated as the difference between pre and post grazing mass
[c] Estimated application rate of whey was at 1,500 to 2,000 gallons per acre

Conclusions

The results of the greenhouse experiment allude to the possibly that minute applications of raw milk may positively influence forage growth. However, there may be too many environmental variables in the field for the slight benefits we found in the controlled environment of the greenhouse to be expressed and be biologically or economically significant. Therefore, the merits of milk in the field setting have yet to be demonstrated. The results of these experiments indicate that the application of raw milk onto pasture is not an economical means of enhancing forage production or forage and soil quality at least for well managed dairy pasture. Although we cannot state with complete certainty that the application of raw milk on pasture will never have a benefit, it is not likely to benefit well-managed dairy pasture.

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