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Enhancing Forages with Nutrient Dense Sprays 2012 Trials

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The UNIVERSITY of VERMONT EXTENSION

ENHANCING FORAGES WITH NUTRIENT DENSE SPRAYS, 2012 TRIALS

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INTRODUCTION

The nutrient dense study was initiated at two locations in Vermont to test the efficacy of amending forages with foliar sprays. The nutrient spray program was developed by Advancing Eco-Agriculture and consisted of five foliar sprays for the Vermont farms in this study. The recommended spray program included applications of Rejuvenate in the early spring and late fall, and a combination of PhotoMag, Phosphorus, Potassium and MicroPak applied in the spring and after each cut of hay or graze (Table 1). This study was conducted based on farmer interest in enhancing nutrient density of forages through foliar sprays and was funded by the Lattner Foundation. Any reference to commercial products, trade names or brand names is for information only, and no endorsement or approval is intended.

Table 1. Information on Advancing Eco-Agriculture nutrient dense sprays.[1]

Spray	What is it?	What does it do?
Rejuvenate	humic substance, carbohydrates, sea minerals	stimulates soil microbial life
PhotoMag	magnesium, sulfur, boron, cobalt	promotes chlorophyll and sugar production
Phosphorus	mined phosphate	improves photosynthesis and plant root vigor
Potassium	mined potassium sulfate	improves storability
MicroPak	boron, zinc, manganese, copper, cobalt, molybdenum, sulfur	enhances sugar translocation, root strength, and plant immunity

[1]Information gathered from the Advancing Eco-Agriculture website: growbetterfood.com.

MATERIALS AND METHODS

In 2012, forages were amended with nutrient dense sprays at two locations: Shelburne Farms in Shelburne, VT and Butterworks Farm in Westfield, VT. Both hayfields had been in native grass/legume mixture for many years. The nutrient recommendations from Advancing Eco-Agriculture are listed in Table 2. In order to understand what may cause a response, if any, we compared the recommended spray regime (‘All’) to individual components, as well as a control of water. The experimental design was a randomized complete block with four replications.

Table 2. Timing and amount of Nutrient Dense Sprays used.

Timing	Recommendations (per acre)
Early Spring	3 tons compost, 20 lb. Borate (10%), and 5 lbs. Zinc sulfate, 2 gallons Rejuvenate
After Each Cut	1 gallon PhotoMag, 1 gallon Phosphorus, 1 quart Potassium, 2 quarts MicroPak
Fall, post harvest	6 quarts Rejuvenate, 2-3 tons compost

Six by ten foot plots were established in existing hay fields. Harvest and spray dates for each location are presented in Table 3. Plots were harvested with a BCS sickle bar mower (Portland, OR), raked by hand, gathered and weighed on a platform scale. A subsample was dried at 40^{o} C and weighed to determine dry matter. Oven dry samples were coarsely ground with a Wiley mill (Thomas Scientific, Swedesboro, NJ) and sent to Cumberland Valley Analytical Services, Inc. (Hagerstown, MD) for quality analysis. Results were analyzed with an analysis of variance in SAS (Cary, NC).

Table 3. Harvest and spray dates at each location.

Treatment	Butterworks Farm	Shelburne Farms
Spray Rejuvenate	18-Apr	19-Apr
Spray All Treatments	16-May	24-Apr (B, Zn only)
1st Cut	31-May	17-May
Spray All Treatments	12-Jun	29-May
2nd Cut	9-Jul	21-Jun
Spray All Treatments	18-Jul	5-Jul
3rd Cut	21-Aug	27-Jul
Spray All Treatments	28-Aug	7-Aug
Spray Rejuvenate	9-Oct	9-Oct

SILAGE QUALITY

Silage quality was analyzed by Cumberland Valley Analytical Forage Laboratory in Hagerstown, Maryland. Plot samples were dried, ground and analyzed for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF) and various other nutrients. The Nonstructural Carbohydrates (NSC) and Total Digestible Nutrients (TDN) were calculated from forage analysis data. Performance indices such as Net Energy for Lactation (NEL) were calculated to determine forage value. Mixtures of true proteins, composed of amino acids and nonprotein 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). Chemically, this fraction includes cellulose, hemicellulose and lignin. Recently, forage testing laboratories have begun to evaluate forages for NDF digestibility. Evaluation of forages and other feedstuffs for NDF digestibility is being conducted to aid prediction of feed energy content and animal performance. Research has demonstrated that lactating dairy cows will eat more dry matter and produce more milk when fed forages with optimum NDF digestibility. Forages with increased NDF digestibility (dNDF) will result in higher energy values, and perhaps more importantly, increased forage intakes. Forage NDF digestibility can range from 20 – 80%. The NSC or non-fiber carbohydrates (NFC) include starch, sugars and pectins.

LEAST SIGNIFICANT DIFFERENCE (LSD)

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). Least Significant differences (LSD's) at the 10% level of probability 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 in 9 out of 10 chances that there is a real difference between the two varieties. Treatments that were not significantly lower in performance than the highest value in a particular column are indicated with an asterisk. In the example below, A is significantly different from C but not from B. The difference between A and B is equal to 1.5 which is less than the LSD value of 2.0. This means that these varieties did not differ in yield. The difference between A and C is equal to 3.0 which is greater than the LSD value

Variety	Yield
A	6.0
B	7.5*
C	9.0*

of 2.0. This means that the yields of these varieties were significantly different from one another. The asterisk indicates that B was not significantly lower than the top yielding variety.

LSD	2.0

RESULTS AND DISCUSSION

Seasonal precipitation and temperature recorded at weather stations in close proximity to Westfield and Shelburne, VT are reported in Table 4. The temperature and precipitation in Westfield was close to the 30-year average. There were a total of 5530 GDD (growing degree days), 134 GDD above average. May, August and October were warmer than average in Westfield, with less rain in July and August. In Shelburne, monthly temperatures were above the 30-year average every month of the growing season. There were a total of 6488 GDD, 639 GDD above average. Warmer temperatures in Shelburne contribute to the earlier harvests of 2nd and 3rd cut hay.

Table 4. Seasonal weather data collected near Westfield and Shelburne, VT.

Westfield*	April	May	June	July	August	Sept	Oct
Average Temperature (F)	41.8	56.7	63.0	67.9	68.1	56.9	48.8
Departure from Normal	-0.9	1.9	-0.8	-0.1	2.0	-0.6	4.0
Precipitation (inches)	3.2	3.6	4.0	3.6	2.8	6.4	4.2
Departure from Normal	0.4	0.0	0.0	-0.7	-1.8	2.9	0.2
Growing Degree Days (base 32)	336	769	928	1112	1119	747	519
Departure from Normal	4	64	-25	-4	63	-41	73

Shelburne*	April	May	June	July	August	Sept	Oct
Average Temperature (F)	46.1	61.6	67.8	73.0	72.0	61.9	52.9
Departure from Normal	1.3	5.2	2.0	2.4	3.2	1.4	4.8
Precipitation (inches)	2.8	4.4	3.2	3.8	2.9	5.36	5.04
Departure from Normal	0.0	0.9	-0.5	-0.4	-1.0	1.72	1.44
Growing Degree Days (base 32)	435	917	1072	1271	1241	925	627
Departure from Normal	51	161	58	73	102	68	126

*Data compiled from Northeast Regional Climate Center data from weather stations in Newport, VT and Burlington, VT. Historical averages for 30 years of NOAA data (1981-2010).

At Butterworks Farm, there was no statistical difference in yield among the nutrient dense sprays for first, second or third cut hay (Tables 5-7). However, second cut yields of the treatments 'All' and PhotoMag were higher than first cut (Figure 1), whereas yields of the other treatments decreased with each cut, as more typical in Vermont. First cut crude protein of the 'All' treatment was 18.1% compared to the control of 15.1% (Table 5). Crude protein generally increased with each cut (Figure 2), except for the 'All' and PhotoMag treatments, where first cut CP was slightly higher than second cut. 'All', PhotoMag and the Phosphorus treatments had the most favorable forage quality characteristics including the lowest fiber, highest starch, total digestible nutrients, net energy for lactation and relative feed value. Starch levels for second cut hay were highest for PhotoMag and Rejuvenate treatments (Table 6). There were no significant differences between the treatments for third cut (Table 7).

Table 5. First cut hay yield and quality, Westfield, VT, 31-May 2012.

Treatment	Height in.	DM Yield lbs. acre^{-1}	DM %	CP %	ADF %	NDF %	Starch %	TDN %	NEL Mcal/lb	RFV %
All	**20.7***	2234	17.9	**18.1***	**29.1***	49.2*	3.4*	64.5*	0.643*	**126***
Control	20.2*	2828	18.6	15.1	33.3	56.2	2.9	62.8	0.595	105
MicroPak	19.4*	2547	18.5	17.3*	31.1	52.7	3.1*	63.3	0.618	114
Phosphorus	19.3*	2520	17.7	17.1*	29.5*	49.7*	3.4*	**65.3***	**0.648***	124*
PhotoMag	17.3	2140	17.7	18.1*	29.8*	**48.7***	**3.7***	64.5*	0.645*	126*
Potassium	18.3	2433	18.1	16.2	32.0	53.0	2.7	62.8	0.613	113
Rejuvenate	20.6*	2523	17.4	17.1*	30.5*	52.4	3.1	64.3*	0.628*	116*
Trial Mean	19.4	2461	18.0	17.0	30.7	51.7	3.2	63.9	0.627	118
LSD	1.8302	NS	NS	1.7923	1.7188	3.4669	0.5812	1.122	0.0219	10.46

*Varieties with an asterisk indicate that it was not significantly different than the top performer in column (in **bold**).
NS - None of the varieties were significantly different from one another.

Table 6. Second cut hay yield and quality, Westfield, VT, 9-Jul 2012.

Treatment	DM Yield lbs. acre^{-1}	DM %	CP %	ADF %	NDF %	dNDF %	Starch %	TDN %	NEL Mcal/lb	NSC %
All	2288	25.3	17.8	29.3	42.8	27.8	3.35	64.3	0.665	15.7
Control	2191	26.2	17.7	28.3	42.9	28.8	3.43	65.1	0.675	15.6
MicroPak	2255	25.8	18.3	28.4	42.3	26.8	3.45	65.1	0.675	16.2*
Phosphorus	2177	25.0	17.5	29.2	43.9	28.2	3.38	64.4	0.668	15.7
PhotoMag	2391	25.5	18.1	27.9	40.8	25.6	**3.83***	65.2	0.675	16.7*
Potassium	2215	26.4	17.0	29.3	44.2	27.8	3.40	64.8	0.670	15.9
Rejuvenate	1996	24.4	18.6	27.6	40.2	25.3	3.63*	65.4	0.678	**16.9***
Trial Mean	2216	25.5	17.8	28.5	42.4	27.2	3.49	64.9	0.672	16.1
LSD	NS	NS	NS	NS	NS	NS	0.2529	NS	NS	0.8494

*Varieties with an asterisk indicate that it was not significantly different than the top performer in column (in **bold**).
NS - None of the varieties were significantly different from one another.

Table 7. Third cut hay yield and quality, Westfield, VT, 21-Aug 2012.

Treatment	DM Yield lbs. acre^{-1}	DM %	CP %	ADF %	NDF %	dNDF %	Starch %	TDN %	NEL Mcal/lb	NSC %
All	1525	19.6	20.1	29.6	42.0	62.5	3.3	63.2	0.653	13.6
Control	1453	18.8	21.1	28.3	39.4	65.6	3.6	63.5	0.655	14.0
MicroPak	1166	17.3	21.2	28.4	40.2	64.8	3.3	63.6	0.658	13.7
Phosphorus	1297	19.6	19.8	29.3	42.2	64.6	3.2	63.4	0.658	13.6
PhotoMag	1477	18.6	20.8	29.0	40.6	64.4	3.5	63.3	0.653	13.7
Potassium	1253	19.3	20.6	29.3	41.4	63.8	3.5	63.0	0.650	13.5
Rejuvenate	1614	21.7	19.9	28.8	41.5	63.7	3.4	63.7	0.660	14.1
Trial Mean	1398	19.3	20.5	28.9	41.0	64.2	3.4	63.4	0.655	13.7
LSD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

*Varieties with an asterisk indicate that it was not significantly different than the top performer in column (in **bold**).
NS - None of the varieties were significantly different from one another.

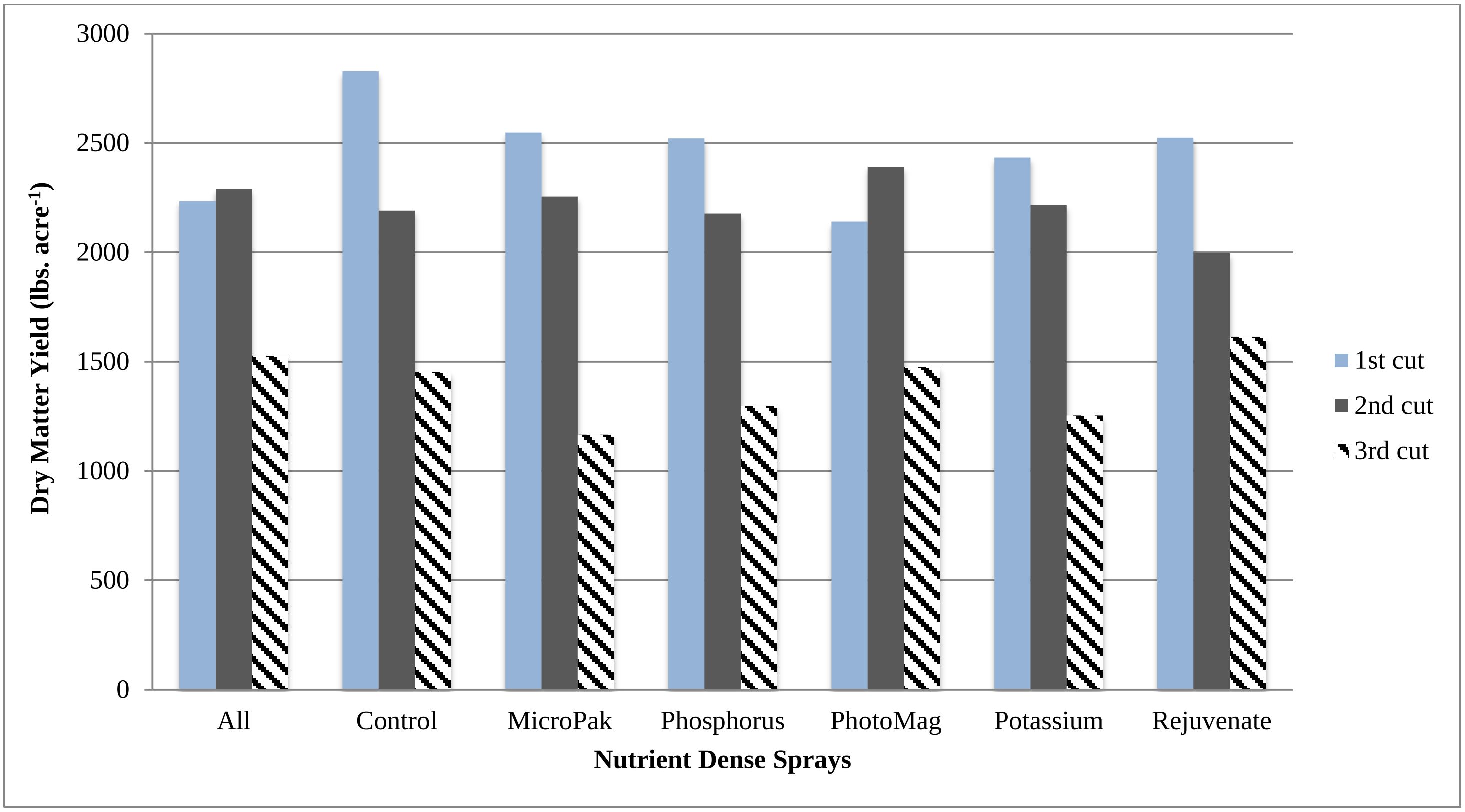

Figure 1. First, second and third cut dry matter yields, Westfield, VT.

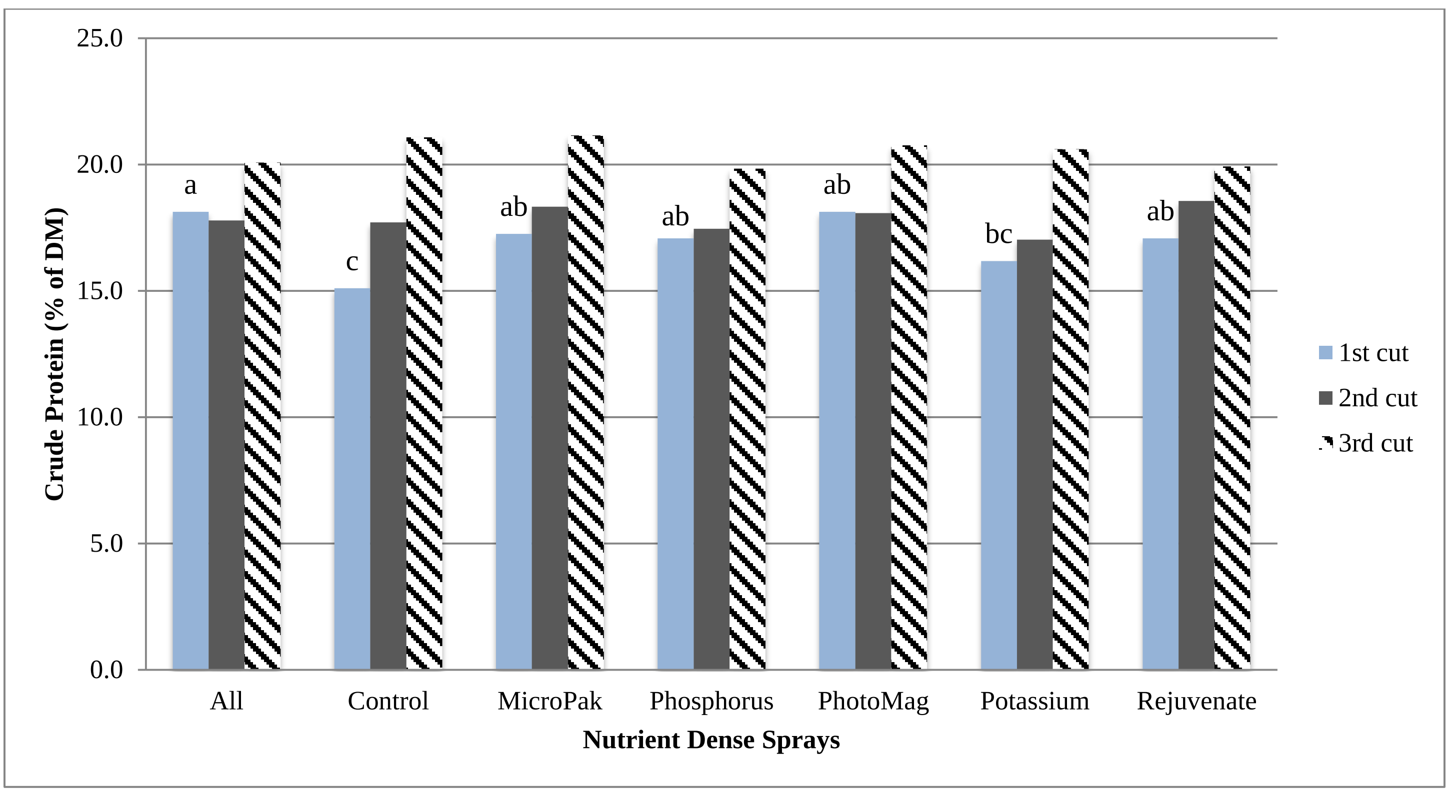

Figure 2. First, second and third cut crude protein, Westfield, VT, 2012.
Treatments with the same letter did not differ significantly from one another.

At Shelburne Farms, there were no significant differences for yield or quality between the nutrient dense spray treatments for first, second or third cut hay (Tables 8-10). The only exception to this was second cut starch levels; the Control and Phosphorus treatments had higher starch levels than the other treatments (Table 9). Dry matter yields were very high for first cut, averaging 3097 lbs acre^{-1}, and they decreased with each subsequent cut (Figure 3). Crude protein levels were also high for first cut, averaging 17.5% (Figure 4). High yield and protein levels may be attributed to the early harvest on 17-May. Above average temperatures in March, April and May provided good conditions for plant growth and soil drying to allow for the early harvest.

Table 8. First cut hay yield and quality, Shelburne, VT, 17-May 2012.

Treatment	Height in.	DM Yield lbs. acre^{-1}	DM %	CP %	ADF %	NDF %	Starch %	TDN %	NEL Mcal/lb
All	27.9	2977	18.0	17.6	31.8	57.7	2.0	63.0	0.588
Control	33.1	3137	18.4	17.4	30.7	56.3	1.2	62.3	0.588
MicroPak	28.2	3193	17.8	16.3	32.0	57.6	1.6	62.3	0.583
Phosphorus	31.2	3030	17.0	17.4	30.8	55.4	1.3	62.3	0.595
PhotoMag	33.5	3377	16.5	17.9	32.2	58.1	1.2	61.3	0.568
Potassium	27.6	3057	17.5	17.7	31.4	55.9	1.9	62.5	0.590
Rejuvenate	32.8	2906	17.9	18.3	31.2	58.1	1.8	62.0	0.575
Trial Mean	30.6	3097	17.6	17.5	31.4	57.0	1.6	62.2	0.584
LSD	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS - None of the varieties were significantly different from one another.

Table 9. Second cut hay yield and quality, Shelburne, VT, 21-Jun 2012.

Treatment	Height in.	DM Yield lbs. acre^{-1}	DM %	CP %	ADF %	NDF %	dNDF %	Starch %	TDN %	NEL Mcal/lb	NSC %
All	17.2	2369	27.8	14.9	35.9	55.4	63.8	3.0	59.8	0.615	10.0
Control	15.8	2379	25.2	15.1	35.3	53.8	65.2	**3.3***	59.9	0.618	8.4
MicroPak	17.6	2209	26.0	14.8	36.0	56.1	64.8	3.0	59.7	0.613	9.7
Phosphorus	16.9	2253	27.0	14.6	35.8	56.0	64.8	3.1*	59.7	0.613	9.8
PhotoMag	17.3	2663	26.5	14.9	36.4	55.7	63.0	2.9	59.0	0.605	9.5
Potassium	17.6	2322	27.7	14.2	36.2	56.7	64.9	3.0	59.6	0.613	9.8
Rejuvenate	16.3	2309	28.1	14.8	36.2	55.8	64.7	2.9	59.3	0.608	9.4
Trial Mean	16.9	2358	26.9	14.7	36.0	55.6	64.5	3.0	59.5	0.612	9.5
LSD	NS	NS	NS	NS	NS	NS	NS	0.1978	NS	NS	NS

*Varieties with an asterisk indicate that it was not significantly different than the top performer in column (in **bold**).
NS - None of the varieties were significantly different from one another.

Table 10. Third cut hay yield and quality, Shelburne, VT, 27-Jul 2012.

Treatment	DM Yield lbs. acre^{-1}	DM %	CP %	ADF %	NDF %	dNDF %	Starch %	TDN %	NEL Mcal/lb	NSC %
All	1366.3	27.7	18.6	28.7	48.2	59.2	2.4	62.8	0.650	9.8
Control	1246.4	26.7	18.9	28.0	46.9	58.9	2.5	63.1	0.653	9.9
MicroPak	1365.6	27.1	18.2	29.2	49.1	60.3	2.3	62.5	0.650	9.5
Phosphorus	1297.4	27.0	18.1	29.2	49.5	60.1	2.3	62.3	0.645	9.8
PhotoMag	1518.5	25.9	19.1	28.4	47.8	60.4	2.3	62.6	0.648	9.5
Potassium	1300.6	25.9	18.7	29.2	48.5	59.5	2.0	62.3	0.645	9.6
Rejuvenate	1286.2	27.3	18.6	28.4	48.3	59.7	2.3	63.0	0.650	9.4
Trial Mean	1340.1	26.8	18.6	28.7	48.3	59.7	2.3	62.7	0.649	9.6
LSD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS - None of the varieties were significantly different from one another.

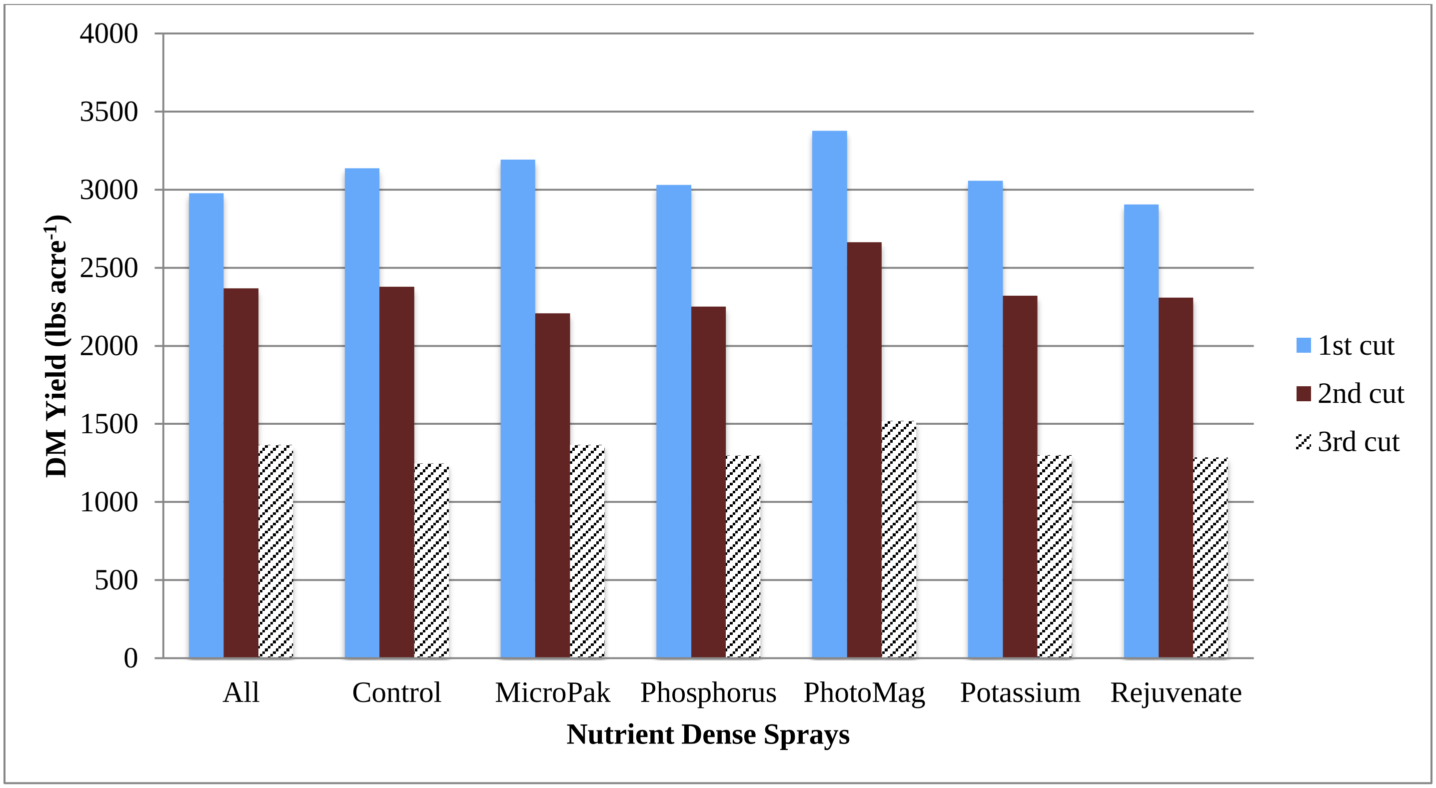

Figure 3. First, second and third cut dry matter yields, Shelburne, VT, 2012.

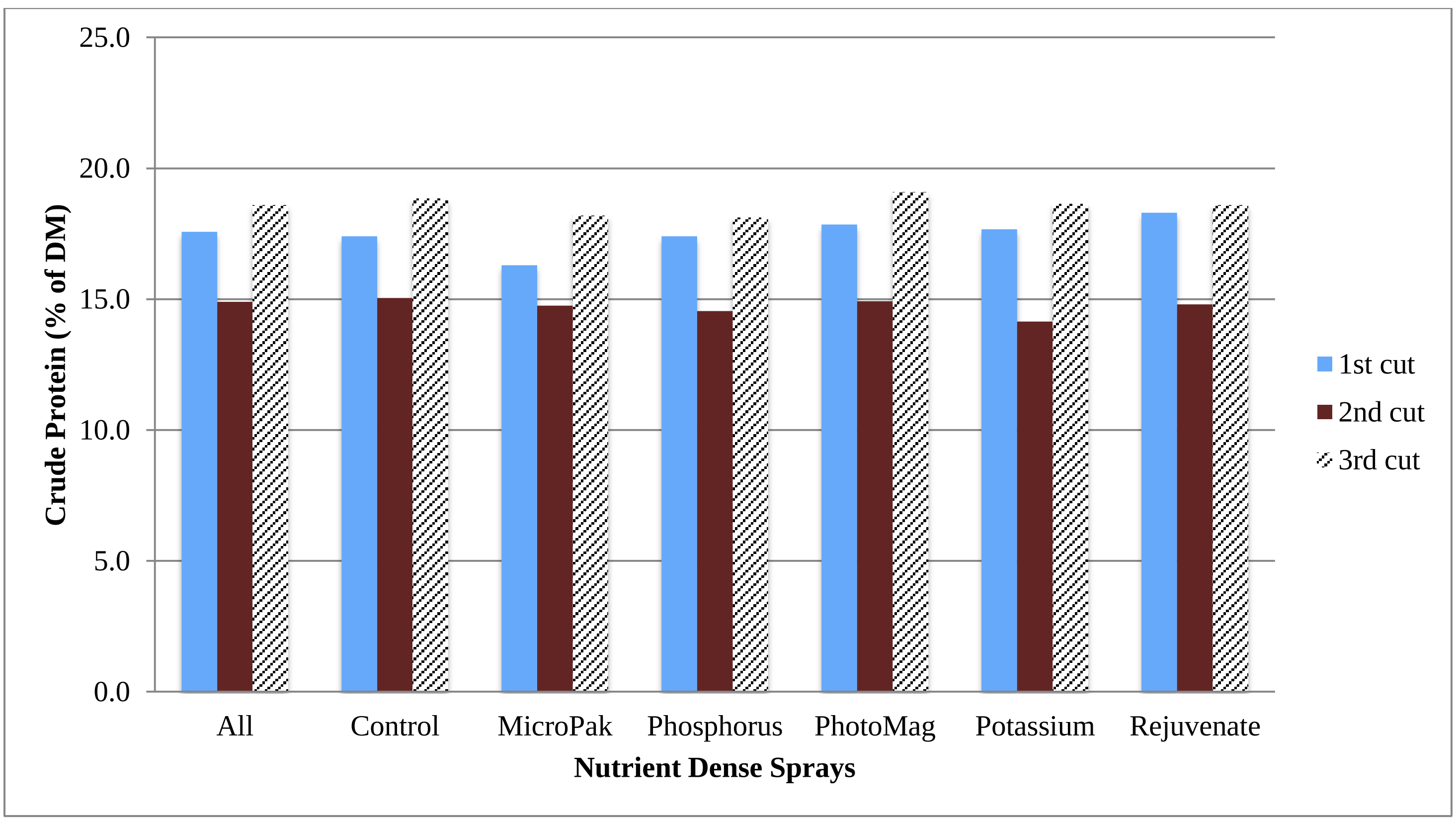

Figure 4. First, second and third cut crude protein, Shelburne, VT, 2012.

In addition, there was no significant difference among the treatments in calcium, phosphorus, magnesium, potassium or sulfur at either location (data not shown).

ACKNOWLEDGEMENTS

The UVM Extension Northwest Crops and Soils team would like to thank Butterworks Farm and Shelburne Farms for hosting these trials, and the Lattner Foundation for funding this research.

UVM Extension helps individuals and communities put research-based knowledge to work.