NORTHWEST CROPS & SOILS PROGRAM

Enhancing Forages with Nutrient Dense Sprays 2014 Trials

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ENHANCING FORAGES WITH NUTRIENT DENSE SPRAYS, 2014 TRIALS

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The purpose of the Nutrient Dense Spray trial is to evaluate the efficacy of amending forages with foliar sprays. Twenty fourteen was the third year of the trial. The nutrient spray program was developed by Advancing Eco-Agriculture and consisted of five foliar sprays recommended for the farms participating in this study. In 2014, a sixth foliar spray, 'Sea Shield' was added to the study. The recommended spray program included applications of Rejuvenate in the early spring and late fall, and a combination of PhotoMag, Phosphorus, Potassium, MicroPak, and Sea Shield 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, sea minerals	promotes chlorophyll and sugar production
Phosphorus	mined phosphate ore	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
Sea Shield	crab and shrimp shell concentrate	enhance plant health and immune response

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

MATERIALS AND METHODS

In 2014, 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 numerous 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 gal. Rejuvenate, 1 gal. Sea Shield
After Each Cut	1 gal. PhotoMag, 1 gal. Phosphorus, 1 quart Potassium, 2 quarts MicroPak, 2 quarts Sea Shield
Fall, post harvest	6 quarts Rejuvenate, 2-3 tons compost

Six by ten foot plots were established in existing hay fields in 2012. The same plots were used in 2013 and 2014. Harvest and spray dates for each location are listed 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), finely ground with a UDY cyclone mill with a 1 mm screen (Seedburo, Des Plaines, IL) and

analyzed with an NIRS (Near Infrared Reflectance Spectroscopy) DS2500 Feed and Forage analyzer (FOSS, Eden Prairie, MN) at the University of Vermont Cereal Testing Lab (Burlington, VT). 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 Spring Treatments	8-May	7 & 9-May
1st Cut	6-Jun	27-May
Spray All Treatments	17-Jun	4-Jun
2nd Cut	3-Jul	30-Jun
Spray All Treatments	14-Jul	8-Jul
3rd Cut	6-Aug	6-Aug
4th Cut	24-Sep	None

Forage samples were dried, ground and analyzed for quality characteristics including crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF) and various other nutrients. The Nonstructural Carbohydrates (NSC) were calculated from forage analysis data. 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). 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 (NDFD) 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.

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 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.

Variety	Yield
A	6.0
B	7.5*
C	9.0*
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 in Westfield was below the 30-year average for the growing season, while precipitation was above average. There were a total of 4694 GDDs (growing degree days), which is 222 GDDs below the average. In Shelburne, monthly temperatures were above the 30-year average for every month of the growing season except April. There were a total of 5567 GDDs, 226 GDDs above average. Warmer temperatures in Shelburne contributed to the earlier harvests of hay. There was over 3 inches of precipitation above the 30-year normal for April through July. However, August and September were dry, almost 4 inches below than the 30-year normal.

Table 4. Seasonal weather data collected near Westfield and Shelburne, VT, 2014.

Westfield*	April	May	June	July	August	Sept
Average Temperature (F)	39.4	53.6	62.9	67.2	64.6	57.4
Departure from Normal	-3.2	-1.2	-0.9	-0.8	-1.5	-0.9
Precipitation (inches)	3.04	5.39	4.45	5.85	4.83	2.73
Departure from Normal	0.23	1.72	0.49	1.52	0.22	-0.65
Growing Degree Days (base 32)	222	670	927	1091	1012	762
Departure from Normal	-101	-40	-27	19	-45	-28

Shelburne*	April	May	June	July	August	Sept
Average Temperature (F)	44.6	58.9	68.2	71.5	69.0	62.0
Departure from Normal	-0.20	2.60	2.40	0.90	0.20	1.50
Precipitation (inches)	3.66	3.94	4.35	5.54	2.05	1.63
Departure from Normal	0.84	0.49	0.66	1.38	-1.86	-2.01
Growing Degree Days (base 32)	378	834	1085	1223	1145	902
Departure from Normal	-5	81	71	26	6	45

*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).

Results from Butterworks Farm in Westfield, VT

At Butterworks Farm in Westfield, VT, there was no statistical difference in yield among the nutrient dense sprays for first, second, third, or fourth cut forage harvest (Tables 5-8). First cut yields averaged 2323 lbs. acre^{-1}. Second cut yields were much lower than in the past, averaging just under 500 lbs acre^{-1}. This was likely because second cut was utilized as grazed feed instead of hay. Third and fourth cut averaged 909 and 1359 lbs acre respectively (Figure 1). Crude protein generally increased with each cut, averaging 16.0% for 1st cut, 19.2% for 2nd cut, 19.3% for 3rd cut, and down a bit to 18.2% for fourth cut. The only statistical difference in any parameter measured was in fourth cut starch levels (Table 8). Sea Shield and Micropak had higher starch levels than the other treatments. Overall, there were no differences in yield or quality of the hay harvests at Butterworks Farm from the nutrient dense sprays.

Table 5. First cut hay yield and quality, Westfield, VT, 6-Jun 2014.

Treatment	DM %	DM yield lbs. acre^{-1}	CP %	Starch %	ADF %	NDF %	NFC %	NDFD %
All	16.5	2187	15.7	2.2	31.3	53.2	27.1	54.8
Control	15.9	2083	16.3	2.1	29.9	51.2	28.0	54.0
MicroPak	17.4	2199	15.6	2.4	30.6	52.8	27.5	53.1
Phosphorus	16.9	2210	15.9	2.2	30.3	52.1	27.7	55.6
PhotoMag	17.0	2034	16.7	2.1	30.1	51.6	27.8	55.1
Potassium	16.7	2368	16.1	2.1	30.5	52.2	27.4	56.2
Rejuvenate	15.8	2671	15.6	2.0	31.3	53.5	27.1	55.2
Sea Shield	16.6	2832	16.0	2.2	30.5	51.7	27.0	54.9
Trial Mean	16.6	2323	16.0	2.2	30.6	52.3	27.5	54.9
LSD (p<0.10)	NS	NS	NS	NS	NS	NS	NS	NS

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

Table 6. Second cut hay yield and quality, Westfield, VT, 3-Jul 2014.

Treatment	DM %	DM yield lbs. acre^{-1}	CP %	Starch %	ADF %	NDF %	NFC %	NDFD %
All	23.6	324	19.0	3.3	25.8	42.3	31.6	58.7
Control	22.9	491	19.4	3.2	24.5	40.5	32.7	58.6
MicroPak	24.0	539	19.5	3.2	25.5	41.3	32.4	57.4
Phosphorus	23.1	581	19.0	3.1	26.1	42.6	31.4	57.6
PhotoMag	23.9	544	19.4	3.1	25.9	41.7	32.1	58.5
Potassium	22.7	422	20.0	2.9	25.3	40.9	32.0	59.0
Rejuvenate	23.1	580	19.2	3.0	25.7	42.8	31.2	58.9
Sea Shield	23.4	382	18.5	3.2	25.7	43.0	31.6	59.7
Trial Mean	23.3	483	19.2	3.1	25.6	41.9	31.9	58.6
LSD (p<0.10)	NS	NS	NS	NS	NS	NS	NS	NS

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

Table 7. Third cut hay yield and quality, Westfield, VT, 6-Aug 2014.

Treatment	DM %	DM yield lbs. acre^{-1}	CP %	Starch %	ADF %	NDF %	NFC %	NDFD %
All	25.9	860	19.3	2.1	26.8	45.3	29.6	57.6
Control	25.6	1008	20.1	2.9	24.7	40.6	31.5	54.8
MicroPak	27.4	775	19.5	2.7	26.4	44.1	29.7	56.2
Phosphorus	23.3	815	19.3	2.4	26.3	45.2	30.1	56.1
PhotoMag	23.5	892	18.0	2.8	27.5	45.8	29.2	57.9
Potassium	22.7	1033	19.6	2.2	26.8	45.3	28.9	54.6
Rejuvenate	24.7	988	20.3	2.6	25.9	42.8	30.4	55.7
Sea Shield	24.6	903	18.2	2.6	26.5	46.4	29.6	58.1
Trial Mean	24.7	909	19.3	2.6	26.4	44.4	29.9	56.4
LSD (p<0.10)	NS	NS	NS	NS	NS	NS	NS	NS

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

Table 8. Fourth cut hay yield and quality, Westfield, VT, 24-Sep 2014.

Treatment	DM %	DM yield lbs. acre^{-1}	CP %	Starch %	ADF %	NDF %	NFC %	NDFD %
All	29.9	1327	18.2	2.9	26.7	45.8	29.5	56.1
Control	28.3	1384	17.9	3.4	26.4	44.2	31.4	54.5
MicroPak	30.0	1717	17.0	3.9*	28.9	48.0	29.3	52.3
Phosphorus	26.7	1459	18.9	3.0	26.4	44.2	30.4	55.3
PhotoMag	28.7	1154	18.4	3.3	27.0	45.4	29.6	54.6
Potassium	25.6	1432	18.5	3.3	25.9	43.7	31.2	55.3
Rejuvenate	29.7	1311	19.3	2.9	26.4	43.6	31.0	54.4
Sea Shield	29.0	1092	17.6	**4.2***	27.1	45.9	30.6	53.7
Trial Mean	28.5	1359	18.2	3.4	26.9	45.1	30.4	54.5
LSD (p<0.10)	NS	NS	NS	0.79	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.

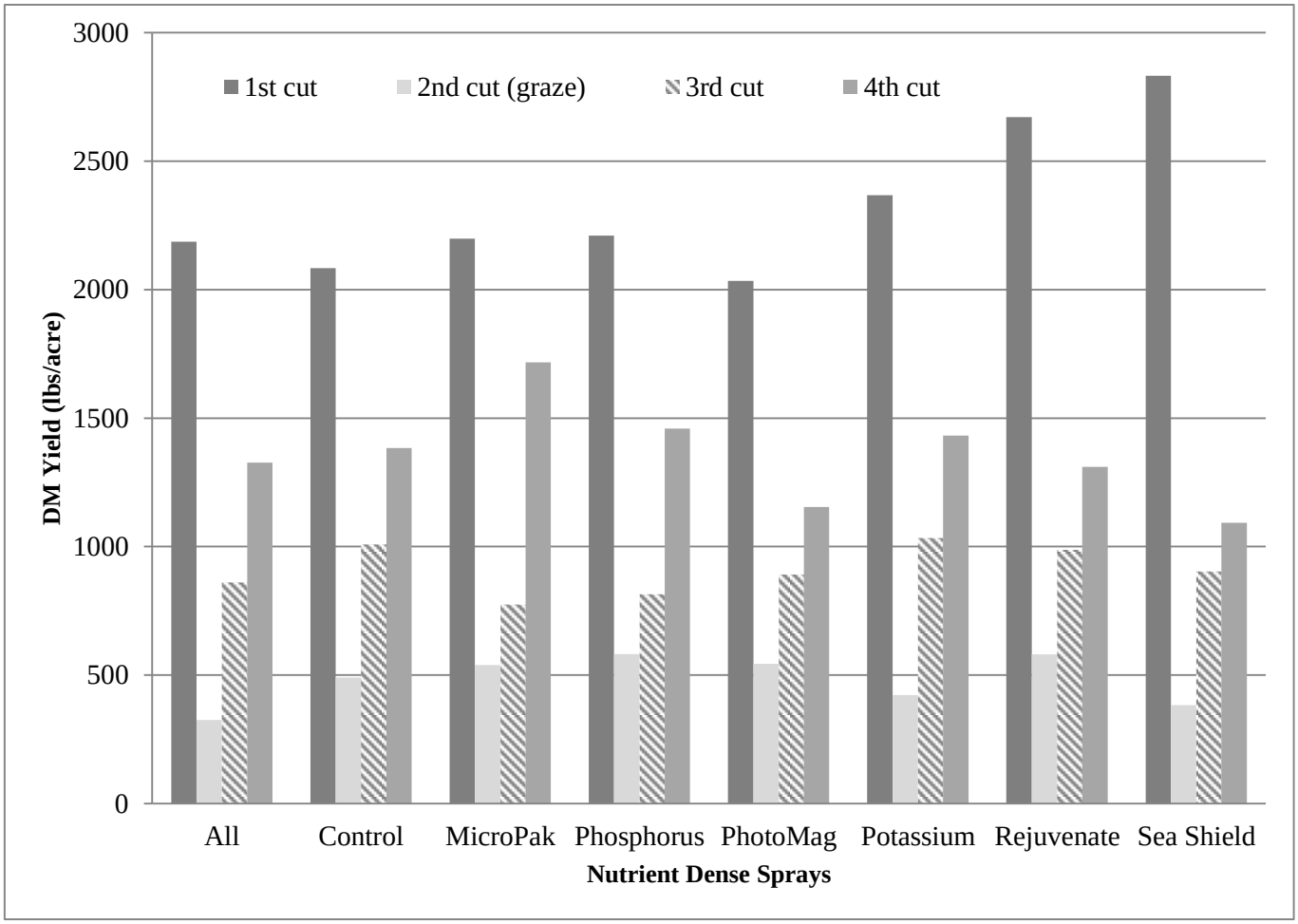

Figure 1. Dry matter yields of hay and grazing, Westfield, VT, 2014.

Results from Shelburne Farms in Shelburne, VT

Similarly, at Shelburne Farms, there were no significant differences for yield or quality for first, second or third cut hay from the nutrient dense sprays (Tables 9-11). The only exceptions to this were first cut NDF and NFC; the Control and Potassium treatments had the lowest neutral detergent fiber (NDF) and the Control had the highest NFC, (Table 9). Dry

matter yields were highest for first cut, averaging 2270 lbs acre^{-1} (Figure 2). Second and third cut yields averaged 1505 and 1827 lbs acre^{-1}, respectively. Average crude protein levels were highest for second cut, averaging 18.1%.

Table 9. First cut hay yield and quality, Shelburne, VT, 27-May 2014.

Treatment	DM %	DM yield lbs. acre^{-1}	CP %	Starch %	ADF %	NDF %	NFC %	NDFD %
All	16.7	2379	12.3	1.6	30.8	63.1	23.2	38.2
Control	15.9	2279	13.4	3.8	31.5	**55.6***	**27.2***	36.7
MicroPak	14.2	2192	13.2	1.5	29.9	60.6	24.5	37.3
Phosphorus	15.5	2183	12.6	1.9	29.9	60.8	25.0	37.3
PhotoMag	16.1	2408	13.6	1.3	31.0	61.8	24.0	36.9
Potassium	15.3	2228	14.0	1.6	29.1	58.8*	25.4	36.7
Rejuvenate	15.2	2177	12.1	1.7	30.6	63.3	23.4	39.2
Sea Shield	16.2	2318	13.3	1.7	29.6	61.0	24.5	39.2
Trial Mean	15.6	2270	13.1	1.9	30.3	60.6	24.6	37.7
LSD (p<0.10)	NS	NS	NS	NS	NS	3.97	1.70	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. Second cut hay yield and quality, Shelburne, VT, 30-Jul 2014.

Treatment	DM %	DM yield lbs. acre^{-1}	CP %	Starch %	ADF %	NDF %	NFC %	NDFD %
All	21.7	1420	18.7	1.3	30.4	49.1	24.9	57.7
Control	22.1	1528	17.7	0.7	31.2	52.3	23.1	57.2
MicroPak	21.5	1377	18.5	1.5	30.9	49.8	24.5	57.0
Phosphorus	21.7	1623	17.9	1.0	30.7	51.1	23.7	58.3
PhotoMag	21.9	1494	18.1	1.2	30.9	50.7	24.2	58.1
Potassium	21.5	1383	18.5	1.3	31.2	50.0	24.7	55.9
Rejuvenate	22.4	1718	17.7	1.2	31.5	51.9	23.3	58.0
Sea Shield	20.5	1498	18.0	1.2	31.0	51.0	24.3	56.1
Trial Mean	21.7	1505	18.1	1.2	31.0	50.7	24.1	57.3
LSD (p<0.10)	NS	NS	NS	NS	NS	NS	NS	NS

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

Table 11. Third cut hay yield and quality, Shelburne, VT, 6-Aug 2014.

Treatment	DM yield lbs. acre^{-1}	CP %	Starch %	ADF %	NDF %	NFC %	NDFD %
All	1733	16.8	0.5	31.9	53.8	22.4	55.6
Control	1794	16.7	0.2	31.6	54.6	22.0	56.2
MicroPak	1698	16.5	0.4	32.0	53.7	22.7	55.1
Phosphorus	1721	17.0	0.6	31.4	53.6	22.7	55.3
PhotoMag	1993	16.6	0.6	32.2	54.0	23.1	55.7
Potassium	1764	16.7	0.6	31.8	54.0	22.6	55.4
Rejuvenate	1989	16.2	0.2	33.0	56.4	20.9	54.8
Sea Shield	1927	17.0	0.6	31.8	52.8	23.0	55.2
Trial Mean	1827	16.7	0.5	32.0	54.1	22.4	55.4
LSD (p<0.10)	NS	NS	NS	NS	NS	NS	NS

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

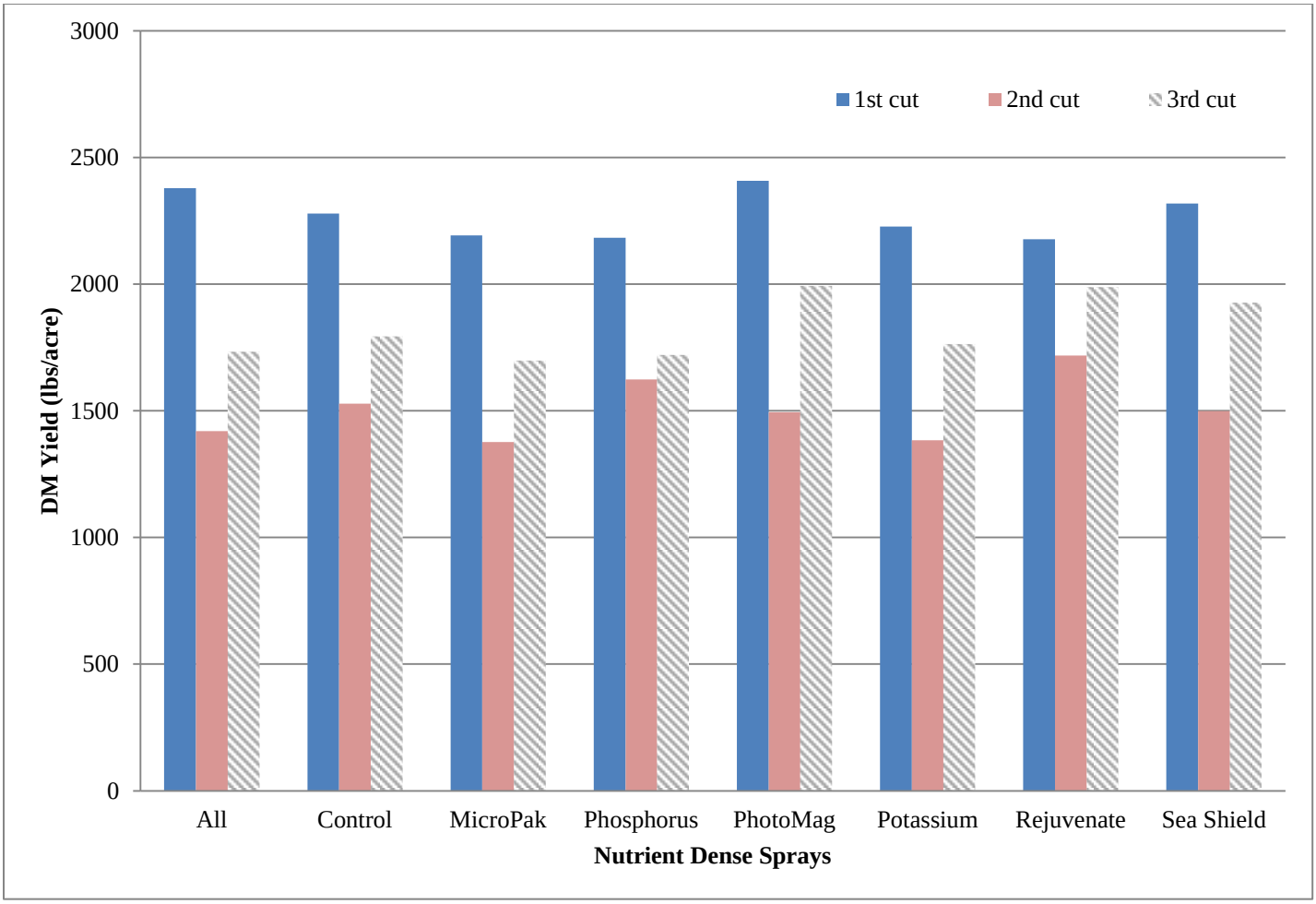

Figure 2. First, second and third cut dry matter yields, Shelburne, VT, 2014.

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