2017 Cool Season Annual Forage Mixtures Trial

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In 2017, the University of Vermont Extension Northwest Crops and Soils Program evaluated yield and quality of cool season annuals and mixtures of these annuals at Borderview Research Farm in Alburgh, VT. In the Northeast, cool season perennial grasses dominate the pastures and hay meadows farmers rely on throughout the season. Often times during the fall months, the perennial pasture will decline in yield and quality. Addition of cool season annual forages into the grazing system during this time may help improve the quality and quantity of forage and potentially extend the grazing season. Recently, there has been a growing interest in utilizing multiple cool season forage species to maximize yield and quality. We compared seven varieties of five annual species alone and in three-and four-species mixtures to evaluate potential differences in forage production and quality. While the information presented can begin to describe the yield and quality performance of these forage mixtures in this region, it is important to note that the data represent results from only one season and one location.

MATERIALS AND METHODS

In 2017, 16 cool season annual forage treatments, both monocultures and mixtures, were evaluated at Borderview Research Farm in Alburgh, VT. The plot design was a randomized complete block with four replications. Forage species and mixture information as well as seeding rates (lbs ac^{-1}) are summarized in Table 2. Due to land constraints, the mixtures were composed using only one variety of peas and triticale even though multiple varieties were trialed as monocultures.

Table 1. Annual forage trial management, Alburgh, VT, 2017.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Winter barley
Tillage operations	Chisel plow, disk and spike tooth harrow
Planting equipment	Great Plains Cone seeder
Treatments (species/mixtures)	16
Replications	4
Plot size (ft)	5 x 20
Planting date	17-Aug
Harvest date	13-Oct

The soil type at the Alburgh location was a Benson rocky silt loam (Table 1). The seedbed was chisel plowed, disked, and finished with a spike tooth harrow. The previous crop was winter barley. Plots were 5’ x 20’and replicated 4 times. The trial was planted with a cone seeder on 17-Aug. Plots were harvested on 13-Oct using a BCS tractor to cut the material growing within a 3’ x 20’ area in each plot. The material was hand collected and weighed to determine yield.

Table 2. Forage mixture composition and seeding rates, 2017.

Abbreviation	Variety and Species	Seeding rate	
		Alone	In mixture
O/P/T	Everleaf Oats	125	75
	Lynx Peas	60	60
	Appin Turnip	6	5
Tr/P/T	815 Triticale	125	75
	Lynx Peas	60	60
	Appin Turnip	6	5
Rye/P/T	Kodiak Ryegrass	30	30
	Lynx Peas	60	30
	Appin Turnip	6	5
Tr/O/P/T	815 Triticale	125	50
	Everleaf Oats	125	50
	Lynx Peas	60	50
	Appin Turnip	6	5
Tr/Rye/P/T	815 Triticale	125	60
	Kodiak Ryegrass	30	20
	Lynx Peas	60	30
	Appin Turnip	6	5
	Fridge Triticale	125	-
	Hyoctane Triticale	125	-
	Austrian Winter Pea	60	-
	Frostmaster Winter Pea	60	-
	Whistler Winter Pea	60	-
	Windham Winter Pea	60	-

An approximate 1 lb subsample of the harvested material was collected, dried, ground, and then sent to Dairy One Forage Laboratory, Ithaca, NY for forage quality analysis. Dry matter yields were calculated.

Forage quality was analyzed via NIR (near infrared reflectance spectroscopy) procedures for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), relative feed value (RFV), net energy of lactation (NE_L), and total digestible nutrients (TDN).

Mixtures of true proteins, composed of amino acids, and non-protein nitrogen make up the CP content of forages. The CP content of forages is determined by measuring the amount of nitrogen and multiplying by 6.25. The bulky characteristics of forage come from fiber. Forage feeding values are negatively associated with fiber since the less digestible portions of plants 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. Because of these chemical components and their association with the bulkiness of feeds, NDF is closely related to feed intake and rumen fill in cows.

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, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among hybrids 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 (LSDs) at the 0.10 level of significance are shown. Where the difference between two hybrids 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 hybrids. Hybrids that were not significantly lower in performance than the highest hybrid in a particular column are indicated with an asterisk. In this example, hybrid C is significantly different from hybrid A but not from hybrid 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 hybrids 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 the yields of these hybrids were significantly different from one another. The asterisk indicates that hybrid B was not significantly lower than the top yielding hybrid C, indicated in bold.

Hybrid	**Yield**
A	6.0
B	7.5*
C	**9.0**
LSD	2.0

RESULTS AND DISCUSSION

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 3). From August through October there were an accumulated 2044 Growing Degree Days (GDDs), at a base temperature of 41° F. This is 340 more than the long term average and 101 more than 2016.

Table 3. 2017 weather data for Alburgh, VT.

	August	September	October
Average temperature (°F)	67.7	64.4	57.4
Departure from normal	-1.07	3.76	9.20
Precipitation (inches)	5.50	1.80	3.30
Departure from normal	1.63	-1.80	-0.31
Growing Degree Days (base 41°F)	829	699	516
Departure from normal	-33	111	257

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

At the time of planting, temperatures were slightly below normal and 3.6 inches of rain had already been accumulated for August, much of this coming five days prior to planting in a 1.69-inch rain event. Temperatures increased after August with September and October seeing temperatures that were 3.76 and

9.20 degrees above normal respectively. Rainfall also tapered off during this time. September was particularly dry seeing only 1.8 inches of precipitation, half the normal amount for that month. Furthermore, about 90% of the total accumulated for the month of September fell during the first week of this month. October was much warmer than normal with slightly below average precipitation. The excessively warm temperatures and moderate rainfall allowed the annuals to proliferate.

Table 4. Yield and height of 16 forage species/mixtures, 2017.

Abbreviation/Treatment	DM yield	Height	Dry Matter
	lbs ac^{-1}	cm	%
O/P/T	**2.56**	58.0*	17.4*
Tr/P/T	1.41	43.3	11.2
Rye/P/T	1.64	51.1*	9.8
Tr/O/P/T	1.95*	58.1*	11.2
Tr/Rye/P/T	2.29*	52.8*	11.7
Kodiak Annual Ryegrass	1.47	30.7	15.2
Everleaf Oats	2.30*	58.0*	15.6
815 Triticale	1.09	27.9	**20.4**
Fridge Triticale	1.70	29.9	19.5*
Hyoctane Triticale	1.20	29.6	17.8*
Appin Turnip	1.64	**58.1**	8.90
Austrian Winter Pea	0.573	27.7	14.4
Frostmaster Winter Pea	0.713	36.5	14.8
Lynx Winter Pea	0.508	18.8	17.1
Whistler Winter Pea	0.685	27.4	17.3
Windham Winter Pea	0.568	21.1	17.0
LSD (p = 0.10)	0.704	8.63	3.86
Trial Mean	1.39	39.3	14.9

Treatments in **bold** are top performers for that parameter.
Treatments with asterisks* performed statistically similarly to the top performer.
Varieties in *italics* were used in the mixture treatments.

Image 1. Tr/P/T mixture at harvest, 2017.

Forage treatments (Image 1) varied significantly in terms of harvest characteristics (Table 4). Heights ranged from 18.8 cm to 58.1 cm. The shortest treatments were winter peas with the exception of the variety Frostmaster which reached heights of 36.5 cm. The tallest treatments were oats and turnips. The treatments differed greatly in dry matter content which ranged from 8.90 to 20.4%. The wettest treatments were the turnip and Rye/P/T mixture which were below 10% dry matter. The highest dry matters were produced by triticale varieties and the O/P/T mixture. Yields ranged dramatically from 0.508 tons ac^{-1} to 2.56 tons ac^{-1}. The highest yielding treatment was the O/P/T mixture. This was statistically similar to three other treatments including both four-species mixtures, and the oats treatment. These data suggest that no additional dry matter yield was gained by blending additional species in with oats compared to monoculture oats. The peas planted alone were the lowest yielding treatments.

Treatments also differed in forage quality parameters (Table 5). Crude protein levels ranged from 26.4% to 37.6% with the highest levels observed in the winter peas. Overall, CP concentrations would be considered very high for all treatments. The ADF levels ranged from 17.1% to 28.3%. The lowest levels were observed in the turnip monoculture which performed similarly to the Austrian winter pea, Tr/Rye/P/T, and Rye/P/T treatments. The highest levels were observed in the Everleaf oat and Fridge triticale monocultures. The mixtures that include oats therefore, have significantly higher ADF contents than the mixtures with other species. The NDF content followed similar trends with the lowest levels produced by the turnip monoculture as well as the Tr/Rye/P/T and Rye/P/T mixtures. The highest level was produced by the oat monoculture as well as two triticale varieties Trical815 and Fridge. The influence of oats on mixture NDF is demonstrated in comparing the three-species mixtures O/P/T, Tr/P/T, and Rye/P/T which only differ in the grass species included in the mixture. The highest NDF levels are observed in the mixture with the oats, then triticale, and then annual ryegrass. A similar trend can also be seen in comparing the two four-species mixtures.

Table 5. Forage quality of 16 forage species/mixtures, 2017.

Abbreviation/Treatment	CP	ADF	NDF	TDN	NE_L	RFV
	-----------------------% of DM			---------------------	Mcal lb^{-1}	
O/P/T	27.5	25.6	42.8	61.8	0.638	151
Tr/P/T	28.7	19.3	30.9	65.8	0.705	228
Rye/P/T	29.2	18.7*	28.4*	66.5*	0.723*	245
Tr/O/P/T	27.4	22.8	39.4	63.3	0.655	169
Tr/Rye/P/T	28.5	17.3*	26.4*	67.0*	0.733*	275*
Kodiak Annual Ryegrass	27.8	24.0	44.7	61.3	0.625	147
Everleaf Oats	26.9	28.3	49.8	59.8	0.590	125
815 Triticale	26.9	24.4	46.8	60.5	0.613	140
Fridge Triticale	26.4	27.6	48.4	60.3	0.598	130
Hyoctane Triticale	29.8	24.5	45.0	61.3	0.625	145
Appin Turnip	31.0	**17.1**	**25.2**	**67.8**	**0.742**	**287**
Austrian Winter Pea	**37.6**	17.6*	32.4	65.8	0.703	218
Frostmaster Winter Pea	35.3*	21.6	36.6	64.0	0.675	186
Lynx Winter Pea	33.0*	19.6	34.8	64.5	0.685	197
Whistler Winter Pea	35.7*	19.9	33.3	65.3	0.695	206
Windham Winter Pea	34.7*	19.9	34.5	65.0	0.688	200
LSD (p = 0.10)	5.00	2.06	3.68	1.42	0.025	32.6
Trial Mean	30.4	21.7	37.4	63.7	0.668	190

Treatments in **bold** are top performers for that parameter.
Treatments with asterisks* performed statistically similarly to the top performer.
Varieties in *italics* were used in the mixture treatments.

Similar trends continue with TDN as the increased ADF and NDF levels dilute the nutrient content of these treatments. Furthermore, as RFV is calculated using ADF and NDF contents, the highest ratings are obtained by the turnip monoculture and the Tr/Rye/P/T treatments with staggering ratings of 287 and 275 respectively. In comparing the mixture treatments to one another only, RFV values ranged from 151 to

275. The Rye/P/T and Tr/P/T treatments were similar while the Tr/O/P/T treatment was significantly lower and the O/P/T treatment significantly lower still. Again, the dramatic differences between mixtures containing oats and similar mixtures containing triticale instead demonstrate the influence of those grass species in the mixtures. Overall, of the mixtures, the Tr/Rye/P/T and Rye/P/T mixtures produced the highest yields and quality (Figure 1). Adding triticale to the mixture could potentially provide additional spring forage if it survives the winter. Adding other species, such as annual ryegrass, peas, and turnips, significantly increased the quality of the forage compared to seeding oats, triticale or annual ryegrass alone.

It is important to recognize, however, that not all of these treatments could be fed/grazed in the same capacity. The nutrient dense and highly digestible nature of the forage turnips or winter peas would require additional fiber sources be fed to animal health complications. Furthermore, treatments containing triticale would overwinter in this region potentially providing both fall and early spring forage without reseeding. These additional factors should also be considered when selecting annual forages to ensure they meet your farms' needs as well as the nutritional demands of your animals.

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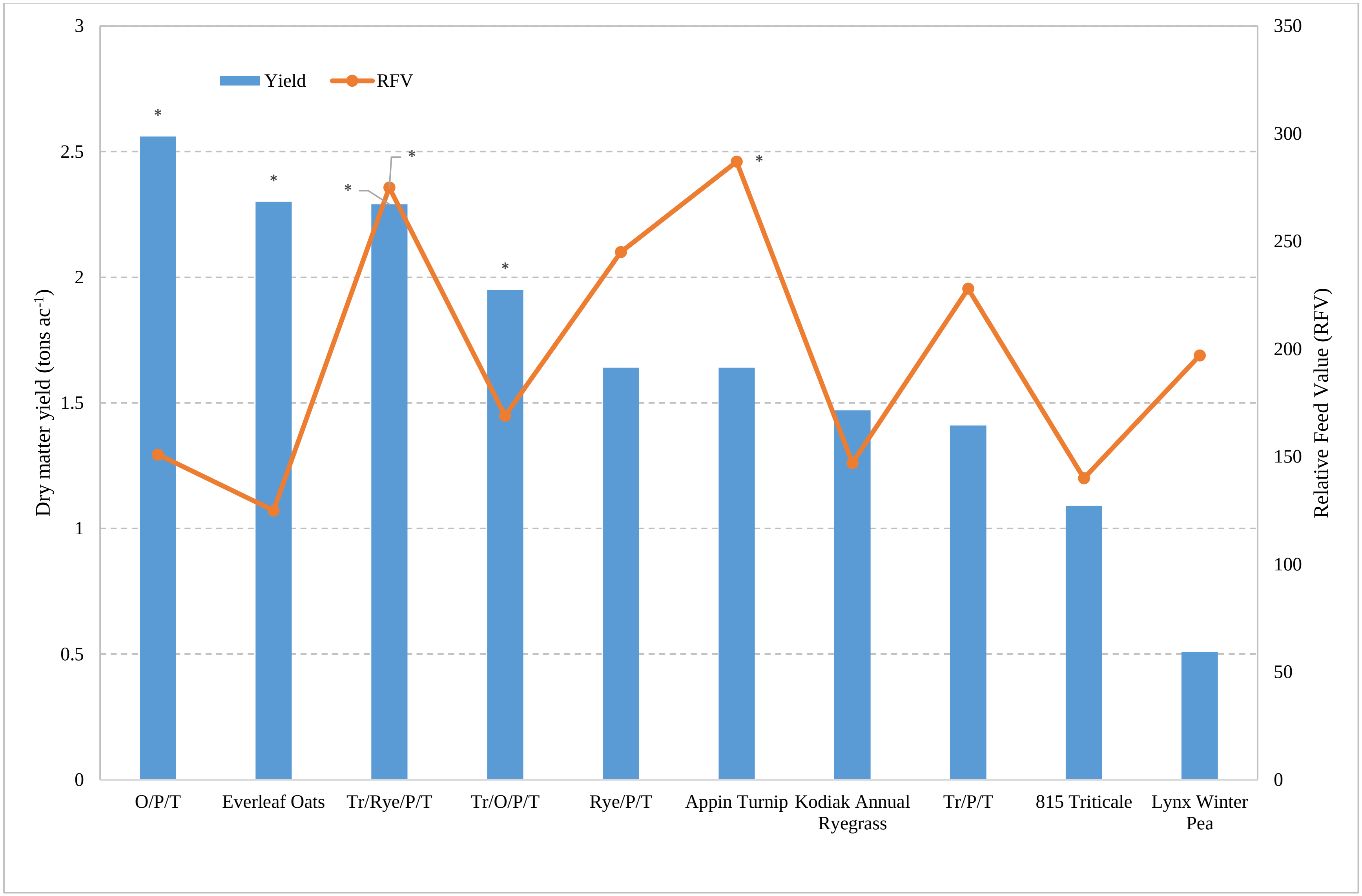

Figure 1. Dry matter yield and RFV of 5 annual forage mixtures and corresponding species monocultures, 2017.
Treatments with an asterisk* performed statistically similarly to the top performer.