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NORTHWEST CROPS & SOILS PROGRAM

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THE UNIVERSITY OF VERMONT EXTENSION

2018 COOL SEASON ANNUAL FORAGE MIXTURES TRIAL

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In 2018, the University of Vermont Extension Northwest Crops and Soils Program evaluated yield and quality of cool season annuals planted in mixtures an in monoculture 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. It can be challenging for these grasses to rebound after the summer slump period and maintain high yield and quality into the fall when diseases can become prevalent. Adding 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 in mixtures to maximize yield and quality. We compared twelve annual forage species planted in monocultures as well as two- and three-way 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 2018, 18 cool season annual forage treatments, both monocultures and mixtures, were evaluated at Borderview Research Farm in Alburgh, VT (Table 1). The plot design was a randomized complete block with three replications. Forage species and mixture information as well as seeding rates (lbs ac^{-1}) are summarized in Table 2.

Table 1. Annual forage trial management, Alburgh, VT, 2018.

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)	18
Replications	3
Plot size (ft)	5 x 20
Planting date	24-Aug
Harvest date	12-Oct

The soil type at the Alburgh location was a Benson rocky silt loam. 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 3 times. The trial was planted with a cone seeder on 24-Aug. Plots were harvested on 12-Oct using a Carter flail forage harvester in a 3’ x 20’ area in each plot. The material was hand collected and weighed to determine yield. An approximate 1 lb subsample of the harvested material was collected and dried to determine dry matter content and calculate dry matter yield. The samples were then ground using

a Wiley mill to a 2mm particle size and then to 1mm using a laboratory cyclone mill from the UDY Corporation. These samples were then sent to Dairy One Forage Laboratory (Ithaca, NY) for quality analysis via Near Infrared Reflectance Spectroscopy (NIR) techniques. Parameters measured include crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), non-fiber carbohydrates (NFC), relative feed value (RFV), net energy of lactation (NE_L), and total digestible nutrients (TDN).

Table 2. Forage mixture composition and seeding rates, 2018.

Treatment	Species/Variety	Rate (lbs ac^{-1})	Treatment	Species/Variety	Rate (lbs ac^{-1})
Enhancer	Annual Ryegrass	30	Oat/Pea	Everleaf Forage Oat	100
Kodiak	Annual Ryegrass	30		40-10 Forage pea	50
Tetraprime	Annual Ryegrass	30	Trit/Pea	Trical 815 Triticale	100
40-10	Forage Pea	60		40-10 Forage pea	50
Everleaf	Forage Oat	125	T/P/O	Trical 815 Triticale	75
Barkant	Turnip	6		40-10 Forage pea	40
Dwarf Essex	Rape	6		Everleaf Forage oat	50
Fridge	Triticale	100	O/P/T	Everleaf Forage oat	50
NE426GT	Triticale	100		40-10 Forage pea	30
Hyoctane	Triticale	100		Barkant Turnip	3
Trical 815	Triticale	100	O/C/R	Shelby oats	60
Aroostook	Winter rye	100		Dixie crimson clover	10
Rye/Turnip	Enhancer Annual Ryegrass	25		Eco-till radish	4
	Barkant Turnip	3			

Mixtures of true proteins, composed of amino acids, and non-protein nitrogen make up the 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 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

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

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.

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 3). From August through October there were an accumulated 1859 Growing Degree Days (GDDs), at a base temperature of 41° F. This is 186 GDDs more than the long term average.

Table 3. Weather data for Alburgh, VT, 2018.

	August	September	October
Average temperature (°F)	72.8	63.4	45.8
Departure from normal	3.96	2.76	-2.36
Precipitation (inches)	2.96	3.48	3.53
Departure from normal	-0.95	-0.16	-0.07
Growing Degree Days (base 41°F)	974	671	214
Departure from normal	112	83	-9

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.

Temperatures were above normal for August and September but below average in October. Rainfall continued to be slightly below average throughout this time, however as the season progressed, rainfall accumulated was closer to normal. Conditions continued to be favorable for growth of these species following harvest. Regrowth of some of the cool season annuals was considerable and could have allowed for a second harvest of the forage. However, due to inclement weather, a second harvest of these forages was not completed.

Treatments differed statistically in dry matter yield and all forage quality parameters (Table 4). Yield ranged dramatically from only 266 lbs ac^{-1}, from 40-10 forage pea planted in monoculture, to 2110 lbs ac^{-1} from the Everleaf oats planted in monoculture. The Oat/Pea/Turnip and Oat/Crimson clover/Radish mixtures yielded similarly to the oat monoculture producing 1991 and 1745 lbs ac^{-1}, respectively. Four other treatments also produced over 1500 lbs ac^{-1} including Barkant turnip planted in monoculture, the Ryegrass/Turnip mixture, Dwarf Essex Rape planted in monoculture, and the Oat/Pea mixture. Interestingly, mixing the oats with forage peas decreased the yield by approximately 500 lbs ac^{-1} while adding in peas and turnip produced approximately the same yield as oats planted alone. The quality also

increased more with the addition of turnips than peas to the oats. The lowest yielding treatments included forage peas planted in monoculture, triticale planted in monoculture, and annual ryegrass planted in monoculture. However, within the annual ryegrass varieties, Kodiak produced almost twice the yield of Enhancer and almost four times the yield of Tetraprime. With the triticale and winter rye, it is important to note that these species will overwinter in this region and have the potential to produce spring forage as well. Investigating the spring yield potential of these treatments is beyond the scope of this trial.

Table 4. Yield and forage quality 18 forage species/mixtures, 2018.

Abbreviation/Treatment	DM yield	CP	ADF	NDF	NFC	TDN	NE_L	RFV
	lbs ac^{-1}	----------% of DM----------					Mcal lb^{-1}	
Oat/Pea	1616	37.7	30.1	39.2	12.3	66.7	0.693	156
Rye/Turnip	1647	37.0	**21.4**	26.9*	**25.4**	70.0*	0.763*	**251**
Trit/Pea	511	38.5*	25.1*	31.9	18.8	68.3	0.740	205
O/C/R	1745*	36.0	28.6	33.8	19.5	67.7	0.727	184
O/P/T	1991*	37.5	26.3	31.9	19.8	68.3	0.737	200
T/P/O	1007	38.4*	28.0	35.7	15.1	67.7	0.717	175
Enhancer Annual Ryegrass	656	38.3*	30.2	41.5	9.5	65.7	0.683	149
Kodiak Annual Ryegrass	1136	38.3*	31.4	42.1	8.8	65.3	0.677	145
Tetraprime Annual Ryegrass	294	**39.6**	27.6	34.3	15.3	68.0	0.723	184
40-10 Forage Pea	266	37.1	24.6*	29.0*	23.1*	69.3*	0.753*	226*
Everleaf Oats	**2110**	37.4	29.0	39.7	12.2	66.3	0.690	156
Dwarf Essex Rape	1628	37.9	24.2*	27.7*	23.6*	70.0*	0.763*	241*
Fridge Triticale	561	38.3*	24.4*	35.3	15.5	67.3	0.720	184
NE426GT Triticale	455	38.0	26.1	33.1	18.1	68.0	0.733	193
Hyoctane Triticale	629	38.8*	24.6*	35.1	15.3	67.7	0.720	185
Trical 815 Triticale	287	37.9	23.7*	31.6	19.6	68.7	0.740	208
Barkant Turnip	1661	37.7	22.2*	**26.7**	24.8*	**70.3**	**0.770**	250*
Aroostook Winter Rye	602	36.9	26.6	34.3	18.0	67.7	0.723	186
LSD (p = 0.10)	378	1.51	3.54	4.07	3.58	1.26	0.025	29.5
Trial Mean	1045	37.9	26.3	33.9	17.5	67.9	0.726	193

Treatments with an asterisk* performed similarly to the top performer in **bold**.
Varieties in *italics* were used in the mixture treatments.

Treatments also differed significantly in all forage quality parameters. Crude protein levels overall were very high ranging from 36.0 to 39.6%. The treatments with the highest protein content included Tetraprime, Kodiak, and Enhancer annual ryegrass varieties in monoculture as well as Fridge and Hyoctane triticale varieties. The ADF values ranged from 21.4 to 30.1%. The lowest ADF content was found in the Rye/Turnip mixture, which was statistically similar to seven other treatments. The NDF values ranged from 26.7 to 42.1%. The lowest NDF content was found in the Barkant turnip monoculture treatment, which was statistically similar to three other treatments including the Rye/Turnip mixture, the Dwarf Essex rape monoculture, and the 40-10 forage pea monoculture. This is to be expected as these plants have growth habits that produce more leaf material low in structural fiber compared to grasses such as oats or annual ryegrass. Overall, all of the treatments had ADF and NDF values that would typically characterize them as high quality forages. Treatments also differed in NFC content. This measure represents the non-fiber

carbohydrate fraction, which includes soluble fiber, sugars, and starches. Therefore, it is negatively correlated with NDF content and positively correlated with TDN. The NFC ranged from 8.80 to 25.4%. The highest NFC content was found in the Rye/Turnip mixture which was statistically similar to three other treatments including Barkant turnip monoculture, Dwarf Essex rape monoculture, and 40-10 forage pea monoculture. These same treatments had the highest TDN, NE_L, and RFV values as well. The TDN is an estimate of the proportion of the forage that contains digestible nutrients. This ranged from 65.7 to 70.3%. The NE_L is an estimate of the energy available from the forage for lactation and is expressed in Mcal lb^{-1}. The NE_L of the cool season annuals ranged from 0.677 to 0.770 Mcal lb^{-1}. The annual ryegrass varieties Kodiak and Enhancer had the lowest NE_L values. Interestingly, the annual ryegrass variety Tetraprime had significantly higher NE_L than the other two varieties. This again was likely due to its lower fiber and higher NFC content. These further impacted RFV which is an estimate of overall feed value. A rating of 150 represents high quality alfalfa. The annual ryegrasses scored just under this target while seven treatments scored over 200.

DISCUSSION

In comparing mixtures to their monoculture components, it is clear that the forage peas performed poorly and therefore did not significantly increase, and in some cases decreased, yield and quality. As dry conditions persisted through planting some of this poor performance may be explained by poor germination and establishment. These data suggest that adding peas into a mixture with oats or triticale did not sufficiently increase yield or quality to outweigh the cost compared to seeding these grasses in monoculture. A larger benefit was observed when forage turnip was added into a mixture with these grasses. For example, yield increased by approximately 400 lbs ac^{-1} and RFV increased by almost 50 when turnips were added to the Oat/Pea mixture (Figure 1). Although some of these monocultures produced high yield and quality (Figure 2), it is important to recognize 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 forage peas in monoculture would require additional fiber sources be fed to animal health complications. Furthermore, as mentioned previously, triticale and winter rye 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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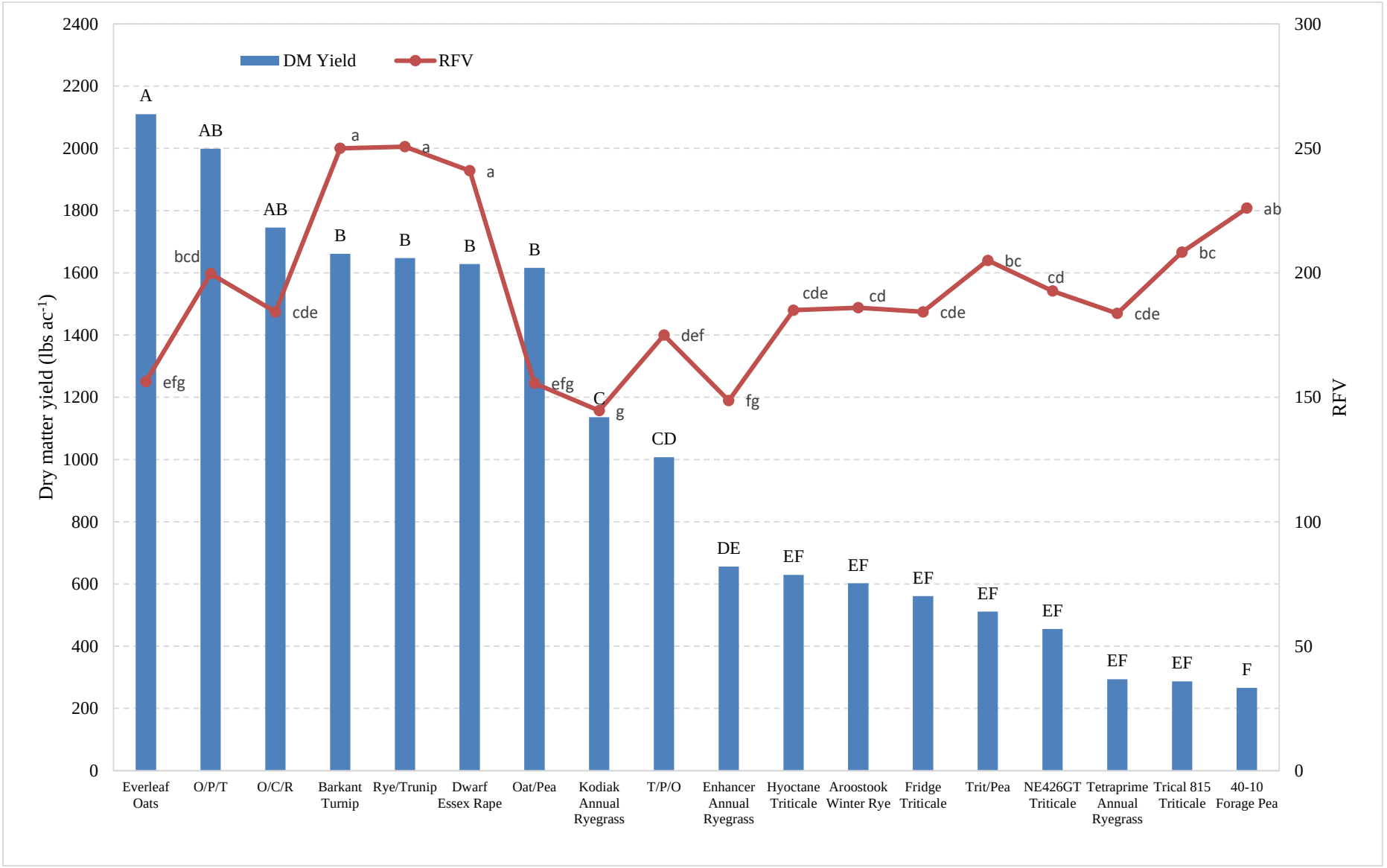

Figure 1. Dry matter yield and RFV of 18 annual forage mixtures/species, 2018.
Treatments that share a letter performed statistically similarly to one another.

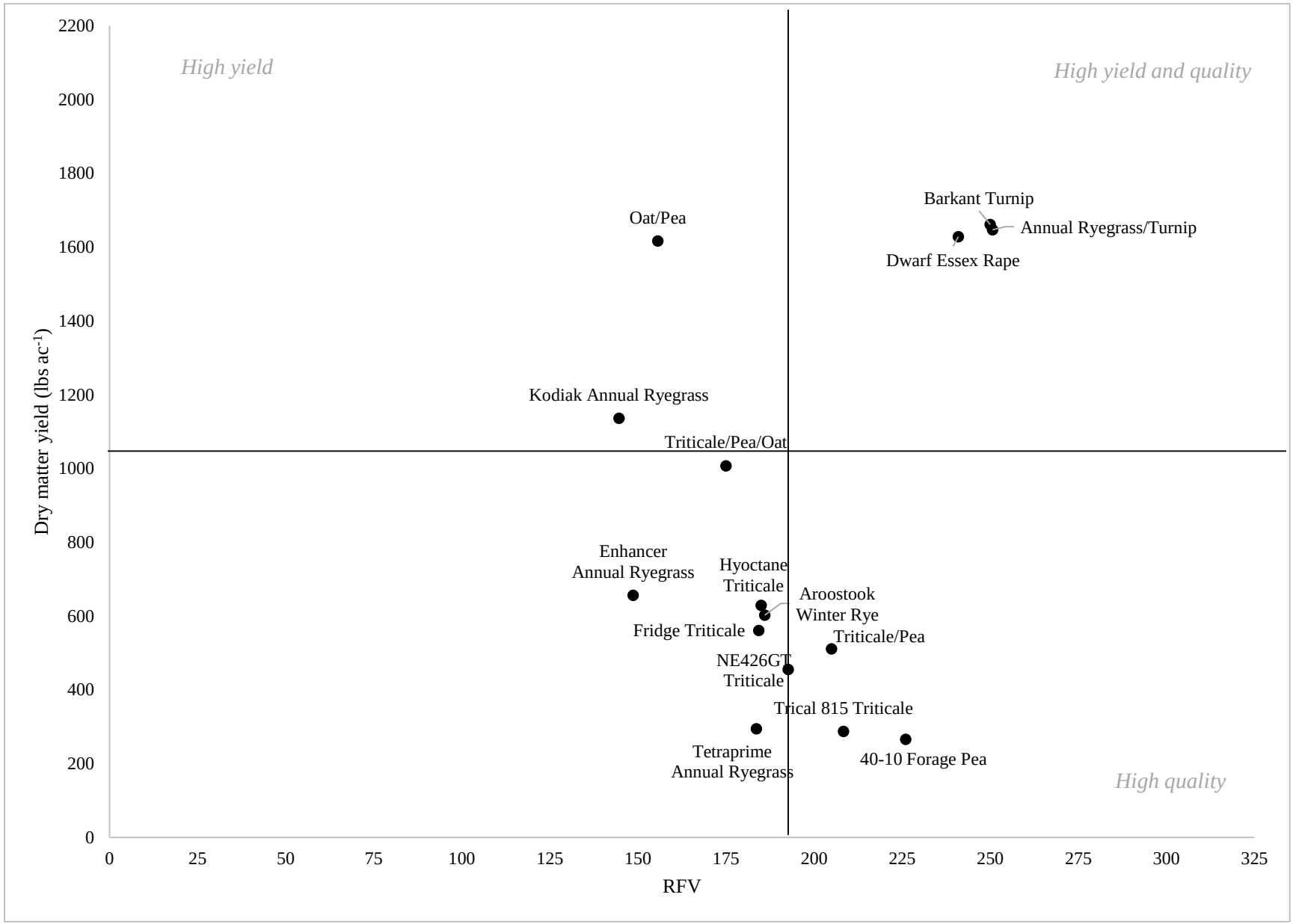

Figure 2. Yield vs quality of 18 annual forage treatments, 2018.