

EVALUATION OF BRASSICAS FOR FALL FORAGE

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ABSTRACT

Various species and varieties of brassicas were evaluated for their potential to extend the grazing season and provide forage through late-fall and early winter in Colorado. The species and varieties evaluated included: rapes (Bonar, Winfred, and Barnopoli), turnips (Appin, Barkant, and Purple Top), kale (Kestral), turnip x rape hybrid (Pasja), swede (Major Plus), and radish (Groundhog). Each species/variety combination was established on two different planting dates (mid-July and mid-August) with four replicates. In order to assess the potential of the brassicas as a source of forage during the fall and early winter, the varieties were sampled at two different times (mid-October and mid-November) for their yield and nutritional value (crude protein, neutral detergent fiber, and in-vitro dry matter digestibility). The second planting date yielded less biomass compared to the first. Crude protein content of the brassicas was high for most varieties (16 to 28%); whereas the fiber content was lower compared to grasses (20 to 35%); and as a result of this, the digestibility was also high (80 to 94%). Delaying the establishment date can constrain the dry matter yield of brassicas which reduces their potential to supply forage during the fall and early winter. The information obtained from this project has enabled us to pick four brassica varieties (Barnopoli rape, Pasja hybrid, Barkant turnip, and Groundhog radish) with potential to be included in forage systems with cool-season grasses and legumes.

INTRODUCTION

Beef managers in the western US must produce or buy supplemental feeds as hay or silage to support their livestock through the late-fall and winter months which significantly increases their costs. A longer grazing season in the western US can decrease overall direct costs (Janovick et al. 2004). New grazing management systems can be applied in order to reduce costs during harsh winter seasons while still maintaining livestock body condition (Hitz and Rusell 1998). Stockpiling is a technique that has been used with cool-season grasses in order to offer dry matter to grazing livestock in the winter. The quality of the grass is reduced, but it has been shown to be better than utilizing crop residues or hay to maintain body condition in beef cattle (Hitz and Rusell 1998). There are alternatives available for cultivated forages such as small grains (rye, wheat, triticale, and barley), legumes (peas and vetch), and brassicas (rapes, turnips, kale, and swedes) that have the potential to be stockpiled and extend the grazing season (Undersander 2013).

Brassicas as forage crops

Forage brassicas are members of the Brassicaceae family, which includes radish, turnip, swedes, broccoli, brussel sprouts, cauliflower, and cabbage (Ayres and Clements 2002). Brassicas

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function well over a wide range of temperatures, in particular, their tolerance of and growth at temperatures below freezing gives them an advantage over most grasses and legumes (Smith and Collins 2003). Brassicas are known for their rapid fall growth, high biomass production, and nutrient scavenging ability (Clark 2012). They are commonly sown in spring and late summer, in both northern and southern temperate areas, to provide high quality feed in summer and early-fall when pasture quality is low, or late-fall and early winter when pasture quantity is limited (Ballard 2003; Ayres and Clements 2002; Hall and Jung 2008). Brassica forages can extend the grazing season (late fall and early winter) by up to 12 weeks, providing high yields of digestible nutrients to livestock (Reid et al. 1994). Forage brassicas can be divided into 5 main types, namely: rapes (*Brassica napus*), leafy turnips or forage brassica hybrids (*Brassica campestris* spp.), kale or Chou Moellier (*Brassica oleracea*), turnips (*Brassica rapa*), and swedes (*Brassica napobrassica*) (Fig.1) (Ayres and Clements 2002).



Fig. 1. Varieties of forage brassicas: Appin, Barkant and Purple Top Turnips (1-3); Barnopoli, Bonar, Winfred and Dwarf Essex Rapes (4-7); Groundhog Radish (8); Major Plus Swede (9); and Pasja Hybrid (10).

The overall goal of this project was to evaluate the adaptation and performance of ten varieties of brassicas with potential to extend the grazing season into the fall and early-winter.

PROCEDURES

Ten varieties of brassicas were evaluated during the fall of 2012 at the Colorado State University Agricultural Research, Development and Education Center (ARDEC) located about 9 miles northeast of Fort Collins, Colorado, which has an elevation (5100 feet) and weather typical for the northeastern area of the state (USDA-ARS 2012). Two plantings (mid-July and mid-August) were established using a no-till drill (Model 3P605NT, Great Plains Mfg., Inc., Salina, KS) fitted with a cone-seeder attachment (Kincaid Equipment Manufacturing, Haven, KS) and set at a 7.5 inch row spacing. Plots were 6 ft x 42 ft and seeded at a rate of 5 lbs/acre for all varieties except the Groundhog radish for which the rate was 8 lbs/acre due to the larger size seeds (Fig. 2). The

ten varieties of brassicas were randomly assigned within a complete block design with four replications and harvested in mid-October and mid-November to assess their dry matter yield (DMY), crude protein (CP) (AOAC 1990), neutral detergent fiber (NDF), and in-vitro dry matter digestibility (IVDMD) (Van Soest and Robertson 1985). For the first planting, we also assessed yield and quality of the bulbs for the turnips, Groundhog radish, and Major Plus swede on both harvest dates.



Fig. 2. Plantings of brassicas established in (1) mid-July and (2) mid-August.

RESULTS

Dry matter yield and adaptation: Dry matter yield (DMY) of the ten brassica varieties was higher on the first seeding date than the second. This trend was consistent for both harvests (Fig. 3, 4). Seeding dates have been shown to be a critical factor for successful establishment and productivity of brassicas because of differences in growth rates among species and varieties (Jung and Shafer 1995, Hall and Jung 2008). DMY is considered, to some extent, a measure of adaptation of brassicas. Kestral kale had the lowest yield in both plantings. Varieties and types of this brassica species differ in winter hardiness, rate of establishment, stem development, and time required to reach maturity (Lemus 2009). There are stemless-type kales that require at least 90 days to reach maturity whereas varieties that develop stems (e.g. Kestral kale) require 150 to 180 days to attain maximum production (Hall and Jung 2008). The stemmed-type kales definitely do not fit the need for a rapidly maturing forage species, especially for double-cropping systems. If it were necessary to delay planting until after mid-August, the turnip varieties had quicker establishment which enhanced their productivity prior to the onset of freezing temperatures in the fall (Ballard 2003). In general, there is a narrow planting window (early-July to mid-August) where most varieties had the potential to provide enough forage during late-fall and early-winter to meet the carrying capacity needs of livestock operations.

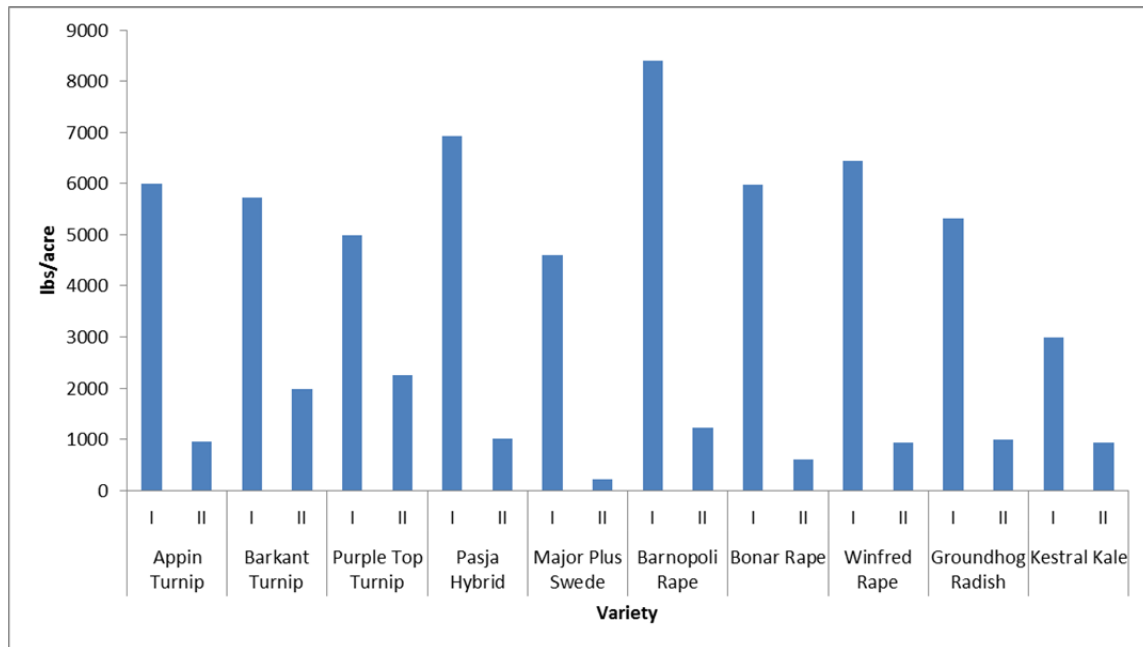


Fig. 3. Dry matter yield of ten varieties of brassicas harvested in mid-October for two planting dates (I=mid-July and II=mid-August).

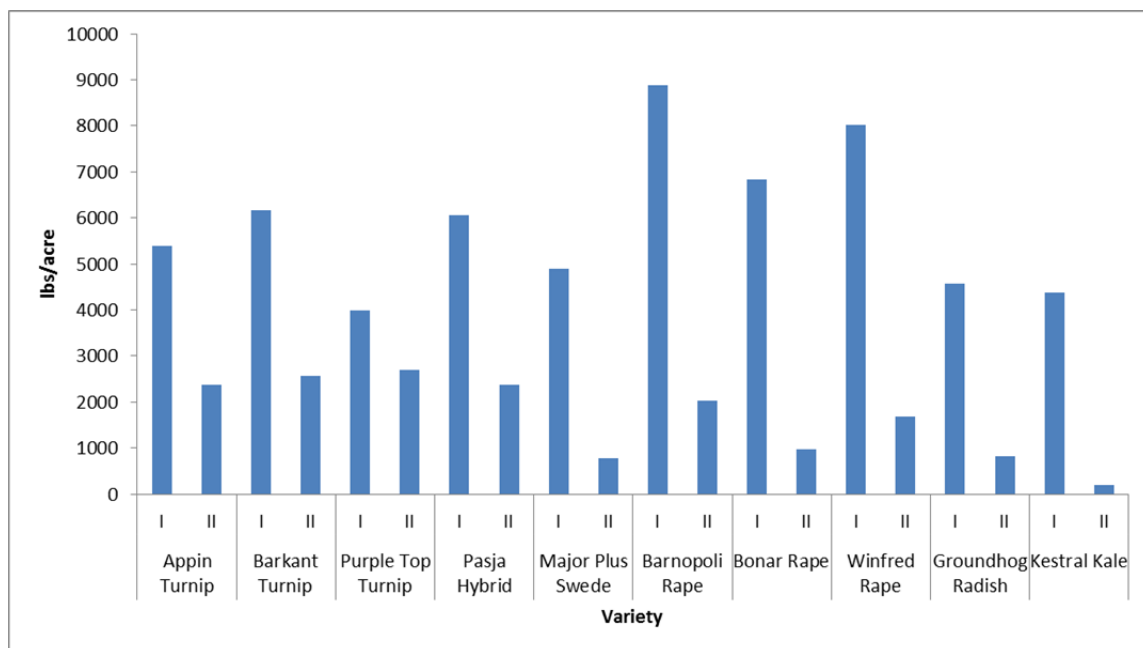


Fig. 4. Dry matter yield of ten varieties of brassicas harvested in mid-November for two planting dates (I=mid-July and II=mid-August).

Nutritional quality of brassicas: Crude protein of the brassicas was high in both plantings with values up to 28%; the second planting tended to be the one with the highest CP values (Table 1). For some of the varieties, CP was lower in the second harvest compared to the first, but their content was still sufficient to maintain rumen function and meet livestock requirements (NRC 2000). Brassica crops grown in the fall are reported to have little change in total nitrogen between 60 and 120 days after seeding (Guillard et al. 1995). Our results for CP fall into the

ranges typically expected for forage-type brassicas (Hall and Jung 2008; Ballard 2003; Lemus 2009). Caution needs to be exercised when brassicas are grazed with less than 60 days of growth, because there is a higher risk of nitrate poisoning as well as bloat (Guillard et al. 1995).

Table 1. Crude protein content (%) of ten forage-type varieties of brassicas for two planting dates (mid-July and mid-August) and two harvests (mid-October and mid-November).

Variety	1 st planting		2 nd planting	
	1 st harvest	2 nd harvest	1 st harvest	2 nd harvest
Appin Turnip	16.21	16.23	19.45	19.26
Barkant Turnip	18.33	15.87	20.43	16.82
Purple Top Turnip	22.68	16.56	23.35	19.24
Pasja Hybrid	22.89	21.11	19.66	19.90
Major Plus Swede	18.79	18.01	22.12	20.46
Barnopoli Rape	21.19	19.81	21.92	20.98
Bonar Rape	19.88	20.22	27.73	24.19
Winfred Rape	19.55	20.64	21.32	20.18
Groundhog Radish	21.15	16.39	21.01	13.75
Kestral Kale	19.54	16.28	28.03	25.86

The fiber content of the brassicas was between 20 and 35%. These values are much lower than common forages such as cool-season grasses and even dairy-quality alfalfa hay (Table 2). Even the highest values found in this study were still considered low compared to commonly cultivated forages in the western US (NRC 2000). Supplementary sources of fiber are highly recommended to ensure proper functioning of the rumen when monocultures of brassicas are grazed (Hall and Jung 2008).

Table 2. Neutral detergent fiber content (%) of ten forage-type varieties of brassicas for two planting dates (mid-July and mid-August) and two harvests (mid-October and mid-November).

Variety	1 st planting		2 nd planting	
	1 st harvest	2 nd harvest	1 st harvest	2 nd harvest
Appin Turnip	23.84	26.96	27.33	27.64
Barkant Turnip	26.27	26.72	22.87	25.52
Purple Top Turnip	27.35	29.42	23.11	28.35
Pasja Hybrid	22.00	25.00	27.62	26.09
Major Plus Swede	27.41	31.42	29.23	24.79
Barnopoli Rape	35.09	30.41	27.70	25.22
Bonar Rape	28.91	26.60	27.68	22.80
Winfred Rape	33.42	30.28	23.95	21.27
Groundhog Radish	33.31	33.20	29.19	21.97
Kestral Kale	25.82	21.20	33.51	19.76

Digestibility of the ten forage brassicas evaluated was between 80 and 94% (Table 3). Digestibility of most of the brassicas declined from the first harvest to the second in both plantings. However, the three rapes evaluated had higher digestibility in the second harvest. Perhaps because of their longer growth period (180 days), the rape varieties were still accumulating dry matter of high quality (Hall and Jung 2008). After 60 days, brassicas develop high concentrations of non-structural carbohydrates that decrease the risk of nitrate toxicosis and

excessive intake of non-protein nitrogen that can create health disorders when grazing (Guillard et al. 1995). Unlike perennial forage crops, brassicas are suitable for stockpiling because digestibility does not decrease markedly with increasing maturity (Hall and Jung 2008).

Table 3. In-vitro dry matter digestibility (%) of ten forage-type varieties of brassicas for two planting dates (mid-July and mid-August) and two harvests (mid-October and mid-November).

Variety	1 st planting		2 nd planting	
	1 st harvest	2 nd harvest	1 st harvest	2 nd harvest
Appin Turnip	92.43	89.61	86.14	86.98
Barkant Turnip	92.75	87.91	91.16	89.20
Purple Top Turnip	90.22	84.14	89.80	88.68
Pasja Hybrid	93.41	91.13	85.26	88.94
Major Plus Swede	89.90	87.84	92.95	90.22
Barnopoli Rape	84.69	87.18	83.52	91.58
Bonar Rape	91.31	90.66	83.67	94.13
Winfred Rape	88.45	87.17	85.59	93.02
Groundhog Radish	88.26	83.95	90.17	83.08
Kestral Kale	92.54	90.29	91.17	93.78

Yield and nutritional quality of bulbs: The bulbs of brassicas are also an important feed resource to be considered. The five varieties evaluated in our study increased their bulb yield from mid-October to mid-November (Table 4). Jung and Shaffer (1995) found a linear trend in root mass increase with advance in fall harvest from September to December for three turnips and a spinach x mustard hybrid. The bulbs of brassicas are high quality feeds with CP values between 12 and 18%, low NDF values (12 to 20%), and highly digestible tissues (95 to 98%). The bulbs of some varieties grow aboveground or are easily pulled out by livestock when grazing if the soil is not yet frozen. Even though one cannot guarantee that animals will eat the bulbs, consumption of such edible roots would help to decrease total nitrate intake because they are lower in nitrate (Guillard et al. 1995).

Table 4. Yield and nutritional quality of bulbs from five forage-type varieties of brassicas for two harvests (mid-October and mid-November).

Variety	1 st planting				
	Harvest	DMY (lb/acre)	CP (%)	NDF (%)	IVDMD (%)
Appin Turnip	I	2183	13.46	18.31	95.84
	II	4836	14.87	16.39	96.27
Barkant Turnip	I	5819	14.93	15.96	97.78
	II	8256	12.90	13.84	95.08
Purple Top Turnip	I	7036	18.52	14.71	95.48
	II	11662	17.02	14.92	95.83
Groundhog Radish	I	2284	15.18	17.25	95.95
	II	3820	17.38	20.40	97.46
Major Plus Swede	I	1786	12.03	15.78	98.09
	II	7659	12.78	12.61	96.98

Forage systems with brassicas to extend the grazing season: Forage brassicas can be grazed as a monoculture crop (Fig. 5) or can be mixed with small grains (oats, rye, triticale, or winter wheat), warm-season annual grasses (sorghum, sudangrass, sorghum-sudangrass hybrids, or millet) or other brassicas and legumes (Clark 2012). With complex mixtures, the seeding rates of the small grains are usually between 50 and 90 lbs/acre due to the competitiveness and rapid growth of brassicas (Ballard 2003). Some feeding concerns regarding the utilization of brassicas for grazing arise from their high digestibility and low fiber, which makes them almost a “concentrate” rather than a forage with regards to nutritional management (Hall and Jung 2008). In order to avoid health disorders when livestock start grazing brassicas, three management rules are recommended: 1) animals should be gradually introduced to the brassicas (do not turn hungry animals into the field), 2) supplement with some kind of roughage material (hay, corn stalks, or wheat straw), and 3) provide access to plentiful water to ensure animal’s appetite is not suppressed and their metabolic requirements are met (Ayres and Clements 2002). With the establishment of complex mixtures, you might not need to supplement with fiber because of the preferences of livestock towards grasses. However, they will graze the brassicas more intensively after 2-3 days of acclimation. The utilization of brassica crops is also variable during grazing; animals will readily consume the entire plant, but in some instances, certain plant parts, such as thick stems, are less acceptable than others, resulting in lower intakes of that fraction (Guillard et al. 1995).



Fig. 5. Steers and heifers strip-grazing a mixture of four brassicas (Barnopoli Rape, Pasja Hybrid, Barkant Turnip, and Groundhog Radish).

Brassicas can be utilized through rotational or strip grazing systems; the latter seems to be the most efficient to get higher and more uniform levels of pasture utilization (Lemus 2009; Ayres and Clements 2002) while reducing trampling and waste (Fig.5).

CONCLUSION

Brassicas are high yielding crops with potential to extend the grazing season in the western US. The decision of what species and varieties of brassicas to establish must be based on a knowledge of the period that feed supplies become limited on livestock operations. Differences in the growth periods of brassicas make them suitable to be mixed with other forages and/or other brassicas to fulfill the dry matter requirements of livestock. In order to provide significant amounts of forage during late-fall and early winter, brassica crops should be seeded from early-July to mid-August. Brassicas are high quality forage crops that can be strip grazed, and in combination with a source of fiber, can enhance livestock performance into the fall and winter.

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