

# Yields, Quality and Suitability of Four Annual Forages for Deer Pasture in North Central Alberta

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**Abstract:** Field pea (*Pisum sativum*), canola (*Brassica napus*), turnips (*Brassica rapa*) and Berseem clover (*Trifolium alexandrinum*) were grown in north central Alberta to assess their potential yield and quality and to evaluate their utilization and preference by white-tailed deer. Herbage DM yield, crude protein (CP), neutral detergent fiber (NDF), absolute and relative herbage utilization, and dietary preference were the criteria used. The four annual forages produced over 3,000 to 11,000 kg ha<sup>-1</sup> DM with canola and turnips producing higher DM yields than field pea and berseem clover. Forage CP for the four seeded forages ranged from 140 to 305 g kg<sup>-1</sup> DM with canola and turnips having higher CP concentrations than field pea and berseem clover. NDF concentrations ranged from 246 to 480 g kg<sup>-1</sup> DM and were lowest in turnips, intermediate in field pea, and highest in canola and berseem clover. Absolute herbage utilization remained similar ( $P > 0.05$ ) among the four forage species. In contrast, relative herbage utilization was greater from berseem clover (66% DM) than field pea (42% DM) or canola (22% DM) or turnips (20% DM). Differences in dietary preference occurred among the four forages (berseem clover  $\geq$  field pea  $\geq$  turnips  $\geq$  canola). These results suggest that annual forages, especially berseem clover and field pea, show promise for increasing forage yield and quality and suitability for late season grazing.

**Keywords:** Berseem clover, canola, field pea, quality, suitability, turnips, yield.

## 1. INTRODUCTION

Annual forages are commonly used in livestock production systems throughout the world and complement or provide valuable alternatives to perennial forages. Incorporating annuals in a grazing system rapidly increases short-term pasture forage options during times when perennial forages are not available. Annual forages are used on the prairies of Western Canada for silage and pasture production [1, 2]. Studies in British Columbia [3], Montana [4] and Atlantic Canada [5] have demonstrated the potential of Persian clover (*Trifolium resupinatum* L.) and berseem clover (*T. alexandrinum* L.) for high-quality forage. In Michigan, annual medics (*Medicago* spp.) and berseem clover provided an extra source of emergency forage when alfalfa (*Medicago sativa* L.) was winter killed [6]. Berseem clover, arrowhead clover (*T. vesiculosum* L.) and winter vetch (*Vicia villosa* subsp. *varia* L.) have shown promise for high N accumulation and forage production in Alaska [7]. While research on annual forage production and quality has been conducted for the cattle industry in western Canada [2, 8, 9], little research has assessed the suitability of annual forages for deer pasture. Annual forages can be utilized to provide alternative forage during perennial pasture rejuvenation on deer pastures, a frequent requirement due to the highly selective foraging behavior of deer and removal of preferred forages from pasture swards.

There is limited information on the adaptability of annual forages on deer pastures and performance of deer on annual forages in northern temperate environments such as those in north central Alberta. The objectives of this study were to evaluate the biomass production, crude protein (CP) and neutral detergent fiber (NDF) concentrations of four annual forages, including field pea (*Pisum sativum* L.), Argentine "Skyhawk" canola (*Brassica napus* L.), "Samson" turnips (*Brassica rapa* var. *rapa* L.) and berseem clover (*Trifolium alexandrinum* L.). Additional objectives were to compare the utilization and dietary preferences of white-tailed deer (*Odocoileus virginianus*) grazing these forages.

## 2. MATERIALS AND METHODS

### Experimental Procedure

Seed bed preparation was done in May 2003 using a broadcast application of glyphosate herbicide at a rate of 4.8 L ha<sup>-1</sup>, followed by extensive disking and harrowing. The predominant soil type was an Orthic Gray Luvisol of the La Corey, Plamondon and Spedden series. The seed bed was fallowed for one year and on 3 June 2004, field pea, canola, turnips and berseem clover were seeded with a 3-m wide Brillion forage seeder into plots following a randomized complete block design with two blocks. The two blocks served as two replicates of two pastures of 0.28 ha for each of the seeded forages. These pastures were fenced with 2.7 m high page wire into one large enclosure with a gate. The pastures were used to evaluate resource selection by deer. Seeding rates were 6 bushels/ha, 11, 7.6 and 13.7 kg ha<sup>-1</sup> DM for field pea, canola, turnips and berseem clover, respectively. Field pea and berseem clover were

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neither treated with fungicides and insecticides nor fertilized. Canola seeds were treated with blue coat and helix fungicide and insecticide. Turnips were treated with phosphate.

### Forage Evaluation

Aboveground forage quality was evaluated on 20 June 2004, 17 days after planting (DAP), 4 August 2004 (73 DAP) and on 15 August 2004 (84 DAP) to determine seasonal changes in annual forage crude protein (CP) and neutral detergent fiber (NDF) concentrations. Plant parts (leaf and stem) quality was also evaluated on 4 August 2004 to emulate deer forage selectivity during late summer. Forage dry matter yield was evaluated on 15 August 2004. All data were collected by sampling four, 0.5 x 0.1 m randomly placed quadrats within each plot. All samples were dried at 60°C to constant weight and ground to pass a 1-mm screen using a Wiley Mill. CP concentration was determined from nitrogen levels (CP = 6.25 X N) using a LECO FP-528 nitrogen auto-analyzer [10]. NDF concentration was determined using the ANKOM filter bag technique [11].

### Resource Selection

The single enclosure containing the two replicates of two pastures of 0.28 ha field pea, canola, turnips and berseem clover was stocked with seven adult white-tailed bucks with mean initial live weight ( $\pm$  SD) of 50.5 ( $\pm$  3.7) kg from 4 August to 15 August, 2004, to determine the time spent grazing in each forage type and to quantify actual forage removals. Deer were observed in 3 trial periods (Early - days 3 to 6; Mid - days 7 to 9; and Late - days 10 to 12).

During daily observation periods of 75 minutes, the number of actively foraging deer on each plot and forage type were recorded 15 times at 5 minute intervals. These frequency data were then summed within each forage type across the 15, 5 minute interval scans and divided by the total number of deer observed grazing to calculate the proportion of total deer foraging within each of the 8 forage plots. These estimates were compared among forage types within each trial period and across the entire trial and used as index of forage preference.

Forage biomass availability (kg ha<sup>-1</sup> DM) and absolute utilization (kg ha<sup>-1</sup> DM) were measured by clipping 0.5 m x 1.0 m quadrats inside and outside each of 3 grazing enclosures (1.5 x 1.5 m) within each of the 2 plots for each forage type. Absolute forage utilization at each enclosure was determined as the difference between grazed and ungrazed quadrats for the seeded forage within each forage type. Moreover, relative forage utilization (%) was calculated as the proportion of dry matter removed in each forage type. Bork *et al.* [12] suggest information on both absolute and relative forage utilization are important, as these parameters emphasize grazing impacts from the perspective of the grazing animal and plant community, respectively. The research protocol (2003A061) was approved by the animal policy and welfare committee, Faculty of Agricultural, Life and Environmental Sciences at the University of Alberta following guidelines of the Canadian Council on Animal Care.

### Data Analysis

Data were subjected to analysis of variance (ANOVA) using PROC Mixed of SAS [13], where seeded forage type

was a fixed factor. Measured response variables in this study included DM yield, herbage quality (CP and NDF) and foraging responses (utilization and foraging time). Post-hoc mean comparisons were done on all significant treatment means using Tukey's method ( $p \leq 0.05$ ).

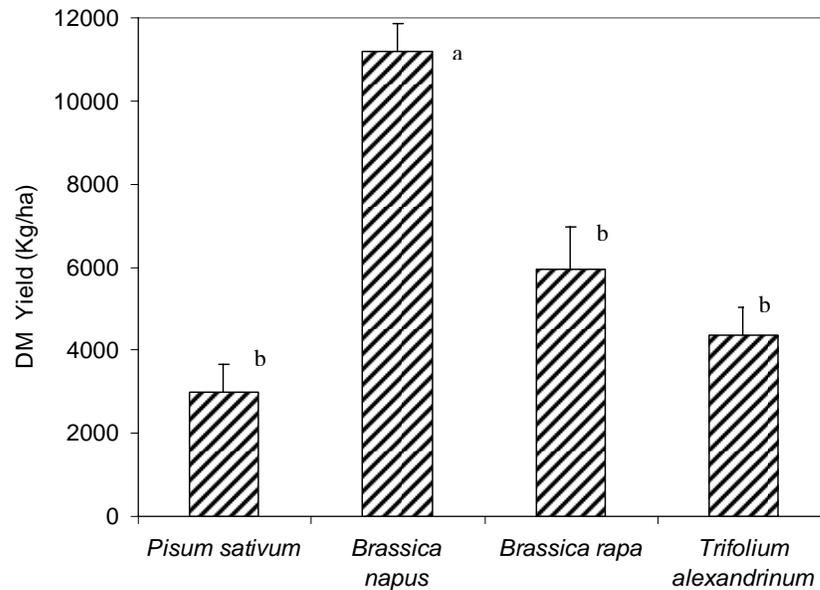
## 3. RESULTS AND DISCUSSION

### Forage Dry Matter Yield

Dry matter yields were the highest for canola (11,196 kg ha<sup>-1</sup> DM), and were significantly ( $P < 0.05$ ) higher than turnips (5959 kg ha<sup>-1</sup> DM), berseem clover (4368 kg ha<sup>-1</sup> DM) and field pea (3001 kg ha<sup>-1</sup> DM) (Fig. 1). Of the four forages, berseem clover seems to be the one that has been evaluated by most researchers. The dry matter yield for berseem clover (4368 kg ha<sup>-1</sup> DM) at 84 DAP in the current research was lower than results obtained for berseem clover biomass (6000 kg ha<sup>-1</sup> DM) at 76 DAP in a study in Edmonton, Alberta by Ross *et al.* [9], and those obtained by Brink *et al.* [14] for berseem clover at 61 DAP in Mississippi. However, the results of the current study compare favorably with berseem clover in late-May in Italy which yielded 3000-5000 kg ha<sup>-1</sup> DM [15] and berseem clover sown in northern USA which yielded 4000 kg ha<sup>-1</sup> DM at 90 DAP [6]. Our field pea yields (3001 kg ha<sup>-1</sup> DM) were also well below those obtained in a study from southern Alberta (5452 kg ha<sup>-1</sup> DM) in a study by Fraser *et al.* [2]. However, the latter study was conducted under intensively managed and irrigated conditions on Dark Brown Chernozem soils, conditions markedly different from the northern temperate Boreal environments examined in the current study. Differences in the observed forage yields can be attributed to variation in soil quality and growing season length, together with agronomic practices of heavy fertilization and irrigation.

### Forage Quality

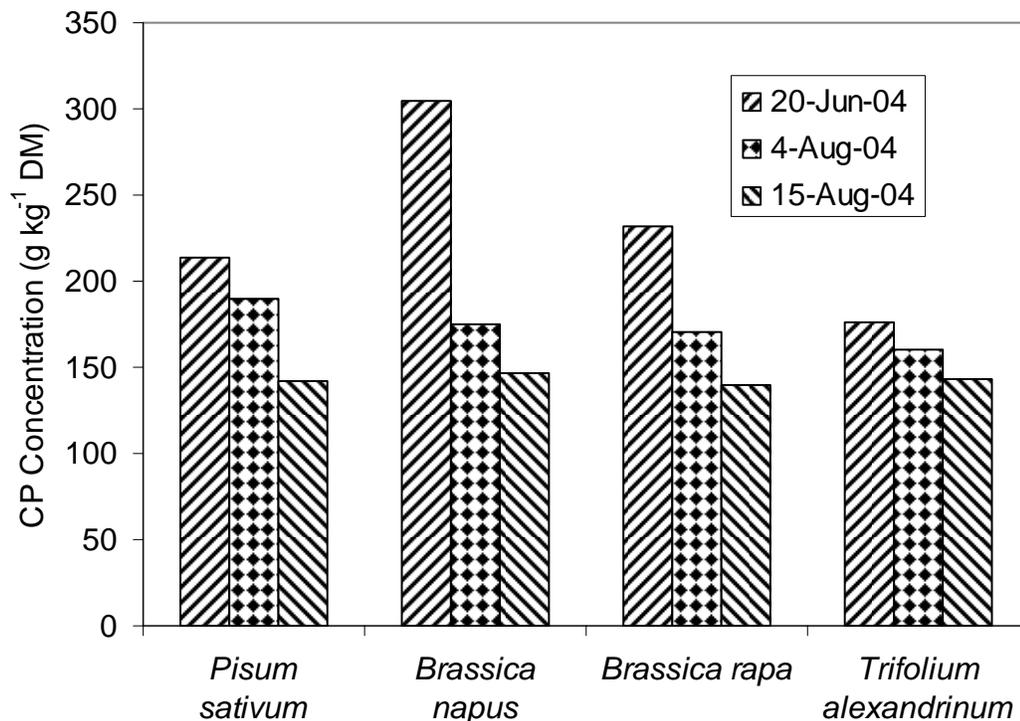
Total aboveground forage CP concentrations of the seeded forages 17 DAP ranged from 176 to 305 g kg<sup>-1</sup> DM (Fig. 2), and were highest in turnips and lowest in berseem clover. By 4 August (73 DAP) the total aboveground forage CP concentrations of the seeded forages had declined to a range of 150 to 200 g kg<sup>-1</sup> DM, and were highest in field pea and lowest in berseem clover. In contrast, total aboveground forage CP concentrations were similar ( $p > 0.05$ ) among forage types at 84 DAP, ranging from 140 to 147 g kg<sup>-1</sup> DM. Thus, between 17 and 84 DAP CP concentrations significantly decreased ( $P < 0.05$ ) in all four seeded forages (Fig. 2). The CP concentrations obtained in the current study are comparable to other studies. For example, Ross *et al.* [9] found that between 35 and 88 DAP, CP concentration of berseem clover declined from 310 to 180 g kg<sup>-1</sup> DM. The CP concentrations of berseem clover were also consistent with ranges of 180 to 270 g kg<sup>-1</sup> DM found by Duke *et al.* [16] and 180-300 g kg<sup>-1</sup> DM found by Guessous *et al.* [17] and 140 g kg<sup>-1</sup> DM after 70 DAP by [14]. The CP concentrations for the four annual forages evaluated in this study are higher than those observed by Tanciera *et al.* [7] in interior Alaska. Leaves of all seeded forages contained higher ( $P < 0.05$ ) crude protein concentrations than stems (Table 1). Crude protein concentration was particularly high in field pea and canola.



**Fig. (1).** Mean (with SE bars) dry matter yield of annual forages harvested 15 August 2004 (84 DAP). Means with different letters differ,  $p < 0.05$ .

Aboveground forage NDF concentrations of the seeded forages after 17 DAP ranged from 246 to 480 g kg<sup>-1</sup> DM and were lowest in the turnip plants, intermediate in field pea, and highest in canola and berseem clover (Fig. 3). By 73 DAP, similar trends of NDF concentrations were obtained from the four seeded forages, ranging from 280 to 470 g kg<sup>-1</sup> DM. By August 15 (84 DAP) NDF concentrations of the seeded forages remained highest in canola, intermediate in berseem clover and field pea, and lowest in turnips (a range of 420-480 g kg<sup>-1</sup> DM). NDF concentrations did not

significantly differ ( $P > 0.05$ ) from 17 and 84 DAP in all four seeded forages (Fig. 3). With the exception of turnips, all the other three forages had lower NDF concentrations in their leaves than in their stems (Table 1). NDF concentrations were lowest in pea and canola leaves. Declines in digestibility in forages have been linked to factors such as stem properties [14]. Stem accumulation has the greatest potential negative impact on the forage quality of annual forages, with digestibility of stems declining at a greater rate than that of leaves.

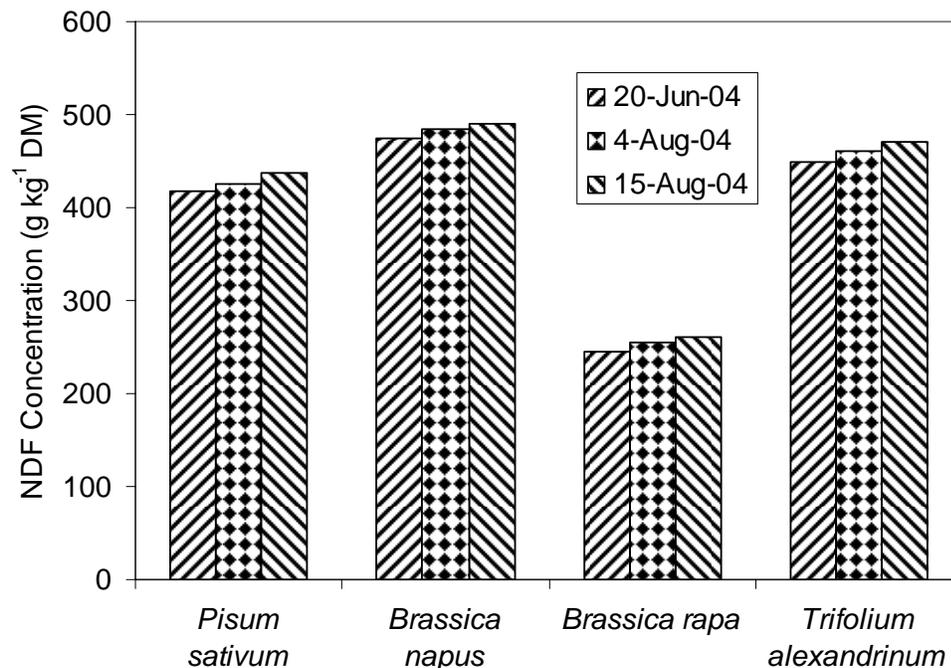


**Fig. (2).** Total aboveground forage crude protein (CP) concentrations of seeded forages sampled 20 June 2004 (17 DAP), 4 August 2004 (73 DAP) and 15 August 2004 (84 DAP).

**Table 1.** Mean (SE in Parentheses) Chemical Measures of Forage Parts in *Pisum sativum*, *Brassica napus*, *Brassica rapa*, and *Trifolium alexandrinum*, Sampled 4 August 2004 (73 DAP)

Forage Type	Crude Protein		Neutral Detergent Fiber	
	(g kg <sup>-1</sup> DM)		(g kg <sup>-1</sup> DM)	
	Leaf	Stem	Leaf	Stem
<i>Pisum sativum</i>	270 (10) a <sup>z</sup>	100 (5) b	275 (11) b	425 (13) a
<i>Brassica napus</i>	260 (8) a	80 (4.5) b	280 (12) b	480 (15) a
<i>Brassica rapa</i>	230 (8) a	130 (6.1) b	300 (12) a	300 (13) a
<i>Trifolium alexandrinum</i>	240 (9) a	80 (5.5) b	350 (13) b	480 (14) a

<sup>z</sup> Within a column, means with different letters differ, p<0.05.

**Fig. (3).** Total aboveground forage neutral detergent fiber (NDF) concentrations of seeded forages sampled 20 June 2004 (17 DAP), 4 August 2004 (73 DAP) and 15 August 204 (84 DAP).

Legumes are generally superior to grasses on pastures in terms of protein and mineral concentration and their nutritive quality values decline less with age. The CP and NDF for the forages in this study were higher than 140 g kg<sup>-1</sup> DM and less than 500 g kg<sup>-1</sup> DM, respectively, which provides a relative nutritive value index of > 140 [18] and would be able to meet the nutritive requirements of deer [19].

### Forage Utilization and Feeding Preference

Biomass availability was higher ( $P < 0.05$ ) in canola and turnip than berseem clover and field pea (Table 2). Absolute herbage utilization levels did not vary significantly among the four forages (Table 2). In contrast, relative herbage utilization differed ( $P < 0.05$ ) among forage types, with berseem clover higher than field pea and field pea higher than both canola and turnip (Table 2). Thus, even though berseem clover and field pea had the lowest available biomass, deer showed greater utilization specifically of these species, indicating relatively high preferences for these species. Low NDF concentrations partially explain why deer

preferred these forages. A possible reason for turnips being the least preferred forage of the four is the presence of a moderate to strong astringent flavour when ingesting the turnips.

Forage type had a significant effect on where deer preferred to graze both within each trial period (early, mid, and late) ( $p < 0.001$ ) and during the entire trial ( $p < 0.0001$ ) (ANOVA results not shown). Across the whole trial, deer preferred to graze berseem clover, followed by field pea, turnips and canola (Table 3). Among specific trial periods the pattern of preference remained high for berseem and low in canola, with preference for field pea and turnips varying. Canola use by deer was particularly low of all the forage types and plant phenological stage. After full bloom, approximately 5-10 days prior to the start of the grazing trial, canola had started to grow pods, set seed, switching from vegetative to reproductive growth, followed by initiation of the ripening process causing a change in preference by deer. Field pea preference was equal to berseem clover until the last period of the trial, at which time preference for this

**Table 2. Comparison of Mean (SE in Parentheses) Forage Availability, Absolute and Relative Utilization White-Tailed Deer Offered 4 Seeded Annual Forages**

Forage Type	Forage DM	Absolute DM	Relative
	Availability (kg ha <sup>-1</sup> )	Utilization (kg ha <sup>-1</sup> )	Utilization (%)
<i>Pisum sativum</i>	3001 (220) b <sup>z</sup>	1873 (440)a	41.8 (6.5) b
<i>Brassica napus</i>	11196 (663) a	2435 (580) a	20.7 (5.0) c
<i>Brassica rapa</i>	9208 (663) a	2270 (540) a	22.5 (6.0) c
<i>Trifolium alexandrinum</i>	4368 (322) b	2935 (586) a	66.4 (7.3) a

<sup>z</sup> Within a column, means with different letters differ, p<0.05.

**Table 3. Proportion (%) of Total Deer Grazing Seeded Annual Forages from 3-15 August, 2004**

Grazing Period	<i>Pisum sativum</i>	<i>Brassica napus</i>	<i>Brassica rapa</i>	<i>Trifolium alexandrinum</i>
Early (days 3-6)	A <sup>z</sup> 45.5 (8.3) a <sup>y</sup>	B 2.0 (0.5) c	B 10.6 (3.8) b	A 42.0 (8.0) a
Mid (days 7-9)	A 37.2 (9.6) a	A 6.8 (2.6) c	B 17.6 (3.6) b	A 38.4 (8.6) a
Late (days 10-12)	B 9.7 (3.6) b	A 12.3 (3.3) b	A 29.9 (6.6) a	A 48.2 (9.6) a
Entire Period (days 1-12)	32.3 (5.0) b	6.5 (1.5) d	18.5 (3.5) c	42.8 (5.4) a

<sup>z</sup> Within a column, means with different uppercase letters are significantly different (P < 0.05).

<sup>y</sup> Within a row, means with different lowercase letters are significantly different (P < 0.05).

forage type sharply declined coincident with reduced biomass as a result of high utilization. Field pea and berseem clover were both high yielding and high quality; a finding that supports other research in western Canada [2, 9]. In contrast, preference for turnip increased to 29.9%, suggesting deer switched from field pea to turnips with time (Table 3).

## CONCLUSIONS

Evaluations of forages for deer pasture require several considerations including palatability, seasonal nutritional needs and forage yield. Based on this study, these conclusions can be drawn: (1) Annual forages of field pea, canola, turnips and berseem clover can provide suitable DM yield to complement those from perennial pastures. (2) The quality of these annual forages, together with associated deer preference indicates they can be excellent pasture forage for deer. (3) Inclusion of these annual forages into deer grazing system should involve careful planning and crop management to ensure they are timed with forage demand.

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