Intercropping corn with high protein forages for potential fall/winter grazing of beef cattle

T.S. Tober[1], E.J. McGeough[1], K.H. Ominski[1], Y. Lawley[2]

[1]Department of Animal Science, [2]Department of Plant Science, Faculty of Agricultural and Food Sciences, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2

INTRODUCTION

Extending the grazing season offers an opportunity for beef cattle producers to reduce the cost of production by limiting time in confinement feeding scenarios. Although corn is a high energy and yielding crop, the crude protein concentration is low and does not meet the nutritional requirements of growing beef cattle. Intercropping corn with a high protein annual forage more closely meets the nutrient demands of growing cattle during fall and winter grazing.

OBJECTIVE

The objective of this study was to identify high protein annual forage species to intercrop with corn for fall/winter grazing of beef cattle in Manitoba.

It was hypothesized that intercropping corn with a high protein annual forage would increase the overall crude protein (CP) available for grazing cattle when compared to non-intercropped corn.

MATERIALS & METHODS

- The experimental design was a randomized complete block design with four replicates, at two sites in Manitoba (Carman and Glenlea) in 2022 and 2023. A total of seven treatments were evaluated in the small plot experiment at each site (Table 1).

Table 1. Seven corn treatments consisting of five intercropped with high protein annual forage species and two non-intercropped controls.

Treatment	Description	Row spacing
1	Control standard (std)	76 cm
2	Control wide	152 cm
3	Corn + Crimson clover	152 cm
4	Corn + Fall rye	152 cm
5	Corn + Hairy vetch	152 cm
6	Corn + Italian ryegrass	152 cm
7	Corn + Radish	152 cm

- Corn was seeded between May 17th to June 20th of 2022 and 2023, followed by intercrop annual forages seeded at V4 stage of corn between June 12th to July 13th of 2022 and 2023.
- Five intercrop forage rows were seeded between the 152 cm-spaced corn rows.
- Biomass samples of corn and intercrop annual forages were harvested in early November to determine biomass yield and chemical composition.
- Chemical composition analyses was conducted for CP, total digestible nutrients (TDN), and total nitrates.
- Statistical analysis was conducted using the Proc Glimmix procedure of SAS 9.4 with fixed effects (treatment, location, year) and random effects (rep).

RESULTS

- Biomass yield (kg DM/ha) was influenced by annual forage intercrop species treatment and year (p-value= 0.0405, Figure 1). In 2023, no intercrop treatment (control wide) had equivalent biomass to the no intercrop control on standard row spacing while in 2022, three intercrop treatments had equivalent biomass.
- CP yield (CP kg DM/ha; Figure 2) was influenced by treatment and location (p-value= 0.0011). At Carman, the radish treatment had the highest combined CP yield, while at Glenlea the hairy vetch treatment was highest.
- There was a three-way interaction for intercrop CP (p-value= <0.0001, Table 3). Glenlea 2022 had the highest CP (% DM) across all treatments.
- Intercrop TDN (p-value= 0.0011, Table 4) was highest at Glenlea in 2023 for all intercropped treatments.
- Intercrop nitrates (p-value= <0.0001, Table 5) for the radish treatment were significantly higher when compared to the other intercrop treatments and exceeded the safe threshold of 0.05% DM.

RESULTS

Table 2. Analysis of variance for the effect of treatment, location and year on biomass yield and chemical composition of corn and intercropped annual forages by p-values, with p<0.05 statistically significant.

Parameter	Treatment*	Location†	Year§	Treatment x Location	Treatment x Year	Location x Year	Treatment x Location x Year
Yield (kg DM/ha)							
Combined biomass yield	<0.0001	<0.0001	<0.0001	0.093	0.0405	<0.0001	0.242
Combined CP yield	<0.0001	<0.0001	0.0131	0.0011	0.0019	<0.0001	0.1014
Chemical composition (%DM)							
Intercrop CP	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Intercrop TDN	<0.0001	<0.0001	0.0009	0.0009	0.0065	<0.0001	0.0011
Intercrop Nitrates	<0.0001	0.6453	0.5502	0.8868	0.8044	0.2926	0.941
Corn CP	<0.0001	0.0072	0.3472	0.0121	0.4624	<0.0001	0.1894
Corn TDN	0.7225	0.5979	<0.0001	0.8287	0.5930	0.0956	0.1093

* - Five intercropped forage with corn treatments (Italian ryegrass, hairy vetch, crimson clover, radish and fall rye) and two controls with only corn (control standard on 76cm and control wide on 152cm).

† - Carman and Glenlea, Manitoba

§ - 2022 and 2023

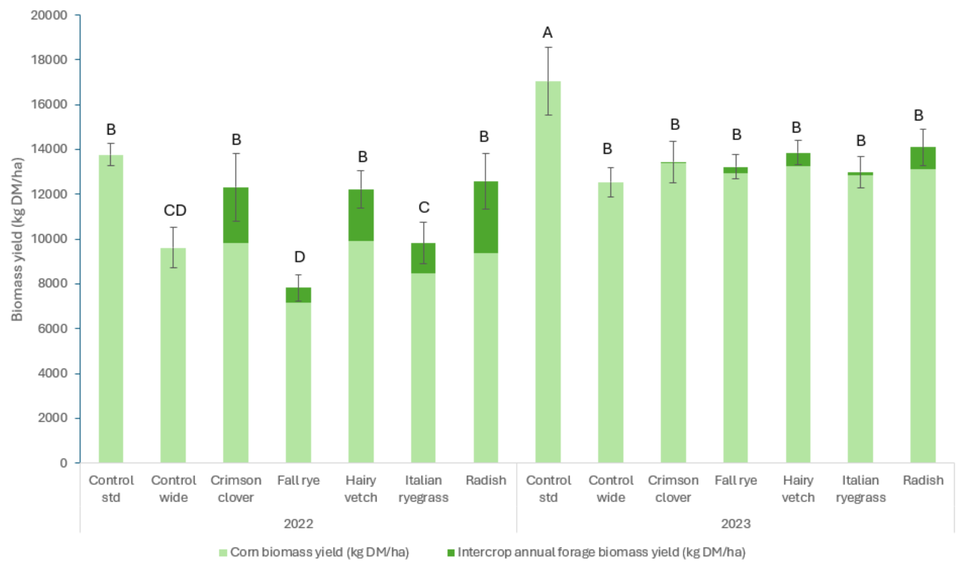

Figure 1. Biomass yield of annual forage intercrop and corn compared to no intercrop corn controls on standard (std, 76cm) and wide (152cm) row spacing in 2022 and 2023 at Carman and Glenlea. Same letters do not differ (p<0.05).

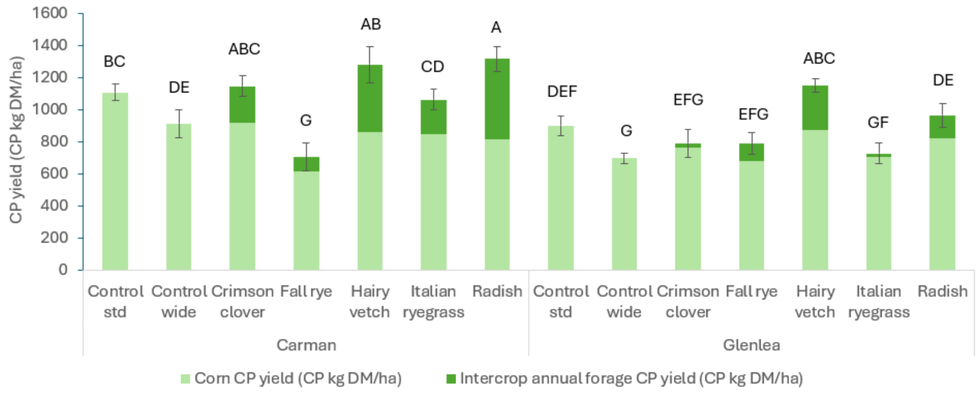

Figure 2. CP yield of annual forage intercrop and corn compared to no intercrop corn control treatments on standard (std, 76cm) and wide (152cm) row spacing at Carman and Glenlea over 2022 and 2023. Same letters do not differ (p<0.05).

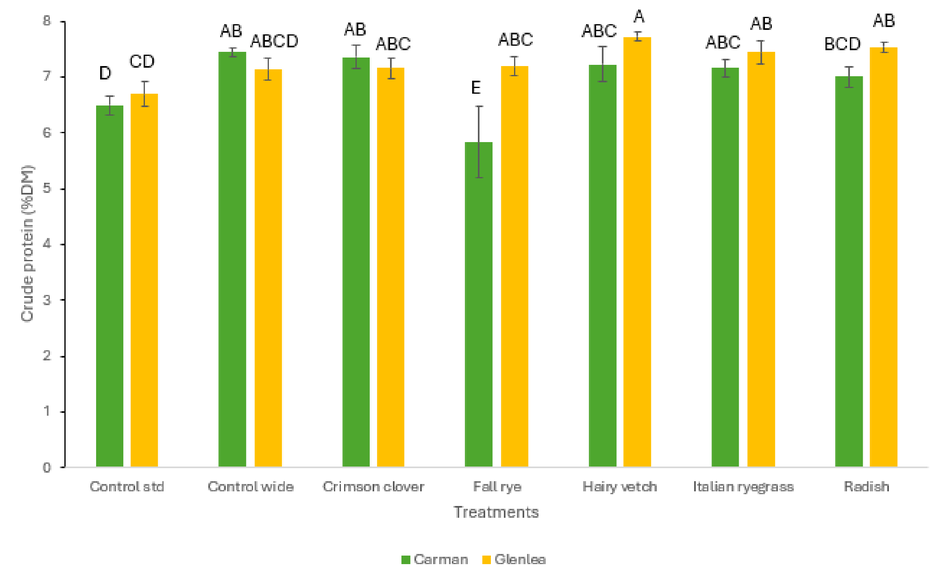

Figure 3. Crude protein concentration (% DM) of corn intercropped with high protein annual forages compared to no intercrop control treatments on standard (std, 76cm) and wide (152cm) row spacing at Carman and Glenlea averaged over 2022 and 2023. Same letters do not differ (p<0.05).

- The CP (%DM) for corn was significantly different between locations only for the fall rye treatment. Carman fall rye was lower compared to Glenlea fall rye treatment (p-value= 0.0121, Figure 3).
- TDN for corn was not statistically significant different between treatments and location (Table 2) but was higher in 2023.

Table 3. Crude protein concentration (% DM) of five annual forages intercropped individually with corn in 2022 and 2023 at Carman and Glenlea.

	Carman		Glenlea	
Treatment	2022	2023	2022	2023
Italian ryegrass	13.9hi	16.9efg	26.0a	17.2efg
Hairy vetch	22.7b	12.1ij	27.5a	15.4gh
Crimson clover	9.4k	10.7jk	19.6cd	-*
Radish	13.7hi	17.9def	27.5a	18.1def
Fall rye	18.6de	20.4c	26.9a	16.4fg

*- no sample

Means followed by the same letter do not differ (p<0.05).

Table 4. Total digestible nutrients (%DM) of five annual forages intercropped individually with corn in 2022 and 2023 at Carman and Glenlea.

	Carman		Glenlea	
Treatment	2022	2023	2022	2023
Italian ryegrass	64.7cd	48.1fg	61.3de	71.4bc
Hairy vetch	53.7ef	44.4gh	60.6de	75.2ab
Crimson clover	37.8h	38.2h	55.5e	-*
Radish	63.8e	57.4e	64.0d	80.2a
Fall rye	47.9fg	55.4e	65.6cd	75.2ab

*-no sample

Means followed by the same letter do not differ (p<0.05).

Table 5. Nitrate concentration of five annual forages intercropped individually with corn in 2022 and 2023 at Carman and Glenlea.

Treatment	Nitrate (%DM)	SEM
Italian ryegrass	0.68b	0.156
Hairy vetch	0.05b	0.006
Crimson clover	0.14	0.039
Radish	2.69a	0.393
Fall rye	0.21b	0.039

Means followed by the same letter do not differ (p<0.05).

Standard error of the mean (SEM).

CONCLUSION

- Intercropping corn with annual forages increased the CP concentration available when comparing the intercropped treatments to the no intercrop control treatments.
- However, intercropping did affect the yield and CP concentration of corn compared to the control treatments on standard (std, 76cm) and wide (152cm) row spacing.
- Annual forage species differed in their chemical composition (CP, TDN, and nitrates), however all offered the opportunity to increase the nutritive value.
- Consideration of nitrates, however, is important for feeding of annual forages.

ACKNOWLEDGEMENTS

Technicians and graduate students in the Departments of Plant and Animal Science for assistance with field experiments and sample processing. Dr. Gary Crow for assistance with statistical analysis.