Comparative Forage Yield and Digestibility of Winter Canola and Wheat

Udai Ram Bishnoi*, Suresh Kumar, and S. Rao Mentreddy

Natural Resources and Environmental Sciences, Alabama A&M University, Normal, AL

ABSTRACT

In Asia and South America, winter canola is extensively used as forage crop. In southeastern US, the potential of winter canola alone or in combination with wheat as winter forage crop has not been evaluated. Therefore, a field study was conducted to evaluate canola (C) cv. Jetton, and wheat (W) cv. Jackson as sole canola, sole wheat and in combination of 1W:1C, 2W:1C, 3W:1C, 2C:1W and 3C:1W ratios for two years. At grazable height of 15-18 cm, forage was harvested on three dates (Mar 9 and 23, and April 6 in 2006 and Mar 6, 27, and April 11 in 2007). During both years, canola and wheat planted in 1:1 ratio produced highest fresh forage on March 6 than all other ratios. With advanced maturity fresh forage yield varied among all ratios of both crops. It was higher than the forages from all other wheat canola ratios. Forage from canola was higher in crude protein (16.4%) and crude fiber (17.9%) than wheat and canola ratios.

INTRODUCTION

Grazed pastures are an important resource for the beef cattle industry in southeastern States. Native rangelands and introduced pastures provide the bulk of summer forages for cattle in these regions but sometimes dry seasons prevails from 6 to 8 month in a year causing shortage of quality forage (González and Hanselka. 2002). Besides this except winter cereals, there are almost no winter forage crops in the southeastern US. Winter wheat (*Triticum aestivum* L.) planted in the southern Great Plains is grown extensively for forage as well as a grain crop (Hossain et al., 2004. Ghanbari-Bonjar and Lee (2003) found that field bean intercropped with wheat led to increased forage quality (CP and NDF concentrations) compared with sole wheat, and higher WSC concentrations compared with sole bean.

Canola (*Brassica napus* L.) is used as a forage in Europe and southeast Asia but it has not been evaluated as a forage crop in the southeastern US. Protein and fiber content in canola may be same as in wheat and its forage has higher energy. Alternative forages such as of canola alone or in combination with wheat may provide quality forage for ruminants during the winter season when good quality forages are in short supply. Therefore, experiments were planted using canola and wheat as sole and inter-crops at different ratios to evaluate for whole-crop forage biomass, dry matter yield and quality of forage.

MATERIAL AND METHODS

The experiment was planted for two crop growing seasons (2006 and 2007) in Decatur silty clay loam soil with good drainage and high water holding capacity. The treatments in experiment consisted of seven canola and wheat crop combination ratios: i. 3canola rows: 3wheat rows (1C:1W), ii. 4 canola rows: 2wheat rows (2C:1W), iii. 6 canola rows: 2 wheat row (3C:1W), iv. 2 canola rows: 4 wheat rows (1C:2W), v. 2 canola row: 6 wheat rows (1C:3W), vi. Canola solo (C), and Wheat solo (W).

All plots were arranged in a RCBD with four replications. Canola cv. Jetton and Wheat cv. Jackson were planted using seed drill in plots with required number of 6 rows per plot on September 26, 2006 and on October 1, 2007. Lime, N, P, K, and herbicides were applied to crops according to the recommendations. Each forage system was harvested on three different dates (Mar 9 and 23, and April 6 in 2006 and Mar 6, 27, and April 11 in 2007) when vegetative growth was at grazable (15-18 cm) height. Each year, forage samples were clipped at 2-3 cm above ground from half-m length from center rows of each plot, excluding 1 m from each end.

Fresh and dry matter yield were recorded. The analyses of grounded samples from each treatment were carried out to determine crude protein (CP), digestible protein (DP), neutral-detergent fiber (NDF), crude fiber (CF), and total digestible nutrients (TDN) concentrations which have been reported in percentage on dry matter basis. Data were analyzed by the analysis of variance technique (SAS Inst., 9.1).

RESULTS AND DISCUSSION

Fresh forage yield

There were significant differences in forage yield between different canola wheat ratios (Table 1). In 2006, fresh forage yield was significantly higher in 1C:1W forage ratio from March 9 (27.2 Mg ha^{-1}) and March 23 (33.0 Mg ha^{-1}), and April 6 (20.9 Mg ha^{-1}) harvests than other ratios. However, in 2007, canola produced more fresh forage yield on March 27 (36.4 Mg/ha^{-1}) and April 11 (55.0 Mg/ha^{-1}) than wheat in both years.

Table 1. Effect of various canola and wheat forage ratios and harvesting dates on Dry matter yield during two growing seasons.

Treatment†	Forage yield (Mg ha^{-1})					
	Date of harvest (2006)			Date of harvest (2007)		
	9-Mar	23-Mar	6-Apr	6-Mar	27-Mar	11-Apr
1C:1W	27.2a*	33.0a	20.9ns	26.3a	25.6b	48.6ab
2C:1W	23.3abc	23.5bc	18.2ns	23.3ab	23.5bc	45.0b
3C:1W	13.3d	24.0bc	20.5ns	15.1e	22.4bc	54.2a
1C:2W	26.0ab	21.7bc	20.0ns	22.2bc	21.7bc	45.1b
1C:3W	18.0bcd	16.4c	17.8ns	21.2cd	17.6cd	42.1b
Canola	19.9abcd	27.3ab	19.6ns	18.2cde	36.4a	55.0a
Wheat	16.1cd	15.3c	17.6ns	17.7ed	14.3d	43.1b
C.V.	**19.2**	**16.5**	**18**	**8.4**	**11**	**7.3**

*Significant at 0.05 probability levels; ns, non-significant.

Forage dry matter yield

The forage yield was significantly influenced due to canola and wheat ratios at all three dates of harvesting (Table 1). Forage harvested on 6 March from 1C:1W and 1C:2W of forage planting was significantly higher (80.0 and 70.1 Mg ha^{-1}, respectively) than 3C:1W (48.7 Mg ha^{-1}) and canola (49.6 Mg ha^{-1}). The trend in the next two harvests (27 March and 11 April) changed because of varied and reduced vegetative re-growth. However, in both these harvesting dates, canola produced significantly higher forage yield (61.4 and 108.3 Mg ha^{-1}) than all other combination of forage ratios.

Crude protein

With advancing maturity, canola gave numerically the highest CP percent (16.4, 24.2, and 24.9 % on 6 and 27 Mar, and 11 April harvest dates, respectively) over other forage ratios of canola and wheat (Table 2). Canola grown as a sole forage crop led to numerically increased forage quality in CP concentrations compared with sole wheat and any other combination of forage ratios. However, Arthington and Brown (2005) observed that early in the season, CP percent in tropical perennial grasses is quite good but it declines as the grasses mature.

Table 2. Effect of various canola and wheat forage ratios and harvesting dates on fresh forage yield (Mg ha^{-1}) and crude protein.

Treatment†	Fresh forage yield in 2006			Crude protein (%)		
	Date of harvest			Date of harvest		
	Mar. 6	27-Mar	11-Apr	6-Mar	27-Mar	11-Apr
1C:1W	80.0a*	46.0b	80.2c	13.1ns	23.5ns	22.7ns
2C:1W	67.9ab	45.8b	77.2c	15.5ns	21.0ns	18.8ns
3C:1W	48.7b	43.3b	95.2b	14.5ns	23.1ns	20.3ns
1C:2W	70.1a	44.2b	75.5c	13.5ns	21.9ns	20.6ns
1C:3W	68.0ab	38.8b	81.6c	13.9ns	21.8ns	22.5ns
Canola	49.6b	61.4a	108.3a	16.4ns	24.2ns	24.9ns
Wheat	62.9ab	33.2b	82.1c	13.7ns	21.4ns	22.1ns
C.V.	**13.5**	**13.9**	**3.9**	**6.6**	**9.9**	**9.8**

*Significant at 0.05 probability levels; ns, non-significant.

Digestible protein

Higher canola forage ratios gave numerically higher DP on 6 March (11.7 %) and 11 April (19.6 %) harvest dates (Table 3). The 3C:1W ratio gave the highest digestible protein (23.1 %) in comparison to all other forage ratios on 27 March. With advancing maturity, there was progressive numerical increase of DP percentage in 1C:3W, forage treatment than other combination of forage ratios.

Neutral detergent fiber

Canola gave the lowest NDF percentage (22.5, 26.5, and 35.5 %) at all harvesting dates and among various wheat-canola ratios (Table 3). With advancing maturity, no progressive increase of NDF concentrations was observed in 1C:3W, 2C:1W and 3C:1W ratios of forage systems. Rodney and Kenneth (1994) observed that **as** soybean forage plants matures, NDF and ADF percentage increased and CP concentration decreased in leaf and stem.

Table 3. Effects of various canola and wheat forage ratios and harvesting dates on digestible protein and neutral detergent fiber.

Treatment†	Digestible protein (%)			Neutral detergent fiber (%)		
	Date of harvest			Date of harvest		
	Mar. 6	27-Mar	11-Apr	6-Mar	27-Mar	11-Apr
1C:1W	8.7ns	18.4ns	17.6ns	34.0ab*	34.0ns	38.5ab
2C:1W	11.0ns	16.0ns	14.0ns	33.5ab	30.5ns	42.5ab
3C:1W	10.0ns	23.1ns	15.3ns	26.5ab	25.5ns	40.0ab
1C:2W	9.1ns	17.1ns	15.7ns	35.5a	35.0ns	43.0ab
1C:3W	9.4ns	16.8ns	17.4ns	39.0a	35.5ns	44.0ab
Canola	11.7ns	19.0ns	19.6ns	22.5b	26.5ns	35.5b
Wheat	9.2ns	16.4ns	17.0ns	35.5a	39.5ns	47.5a
C.V.	**9.0**	**10.1**	**11.9**	**9.3**	**17.2**	**5.9**

*Significant at 0.05 probability levels; ns, non-significant.

Crude fiber

Crude fiber content was higher in sole canola, but differences tended to be similar in all ratios of canola vs. wheat (Table 4). Wheat gave the lowest CF percent (12.7, 14.3, and 17.9 %) at all harvesting dates and among all forage ratios. However, with advancement in maturity, no progressive increase of CF concentrations was observed in 3C:1W ratio.

Total digestible nutrients

The total digestible nutrients were significantly influenced by ratios of canola and wheat when harvested on 6 Mar and 11 April. Wheat as a sole forage crop gave significantly higher TDN (79.4%) on March 6 in comparison to 1C:2W (71.7 %), 1C:3W (70.00 %) and canola solo (71.7%) (Table 4); however, this difference was contrary to 1C:1W, 2C:1W, 3C:1W forage ratios when harvested on 27 March. Wheat as sole forage crop significantly gave the highest TDN percent (71.7 %) over other canola wheat and forage ratios when harvested on 11 April.

Table 4. Effects of various canola and wheat forage ratios and harvesting dates on crude fiber and total digestible nutrients.

Treatment†	Crude Fiber (%)			Total digestible nutrients (%)		
	Date of harvest			Date of harvest		
	6-Mar	27-Mar	11-Apr	6-Mar	27-Mar	11-Apr
1C:1W	17.3ab*	17.9ns	19.1ab	72.6ab	72.6ns	70.00ab
2C:1W	17.9a	17.9ns	20.9ab	71.7b	72.0ns	67.3ab
3C:1W	19.3a	17.9ns	19.7ab	69.7b	71.7ns	69.1ab
1C:2W	17.1a	17.9ns	20.7ab	72.9ab	71.7ns	67.6ab
1C:3W	14.3ab	16.1ns	19.7ab	77.0ab	74.4ns	67.6a
Canola	17.9a	19.5ns	22.7a	71.7b	69.4ns	64.7ab
Wheat	12.7b	14.3ns	17.9b	79.4a	77.0ns	71.7a
C.V.	**7.2**	**8.2**	**4.8**	**2.4**	**2.9**	**2.1**

*Significant at 0.05 probability levels; ns, non-significant.

CONCLUSION: The results of this research showed that canola planted as sole or in combination of 1C:1W ratio produced higher fresh forage and forage dry matter when harvested in March. A similar trend was observed in crude or digestible protein although statistically not significant. Wheat as sole or in combinations of 1C:2W or 1C:3W ratios tended to contain higher crude fiber and total digestible nutrients in this study. The data concludes that like wheat, winter canola can be adopted as a forage crop and their 1:1 ratio proved to be better combination forage for planting than other ratios.

REFERENCES

Arthington, J.D., and W.F. Brown. 2005. Estimation of feeding value of four tropical forage species at two stages of maturity. J. Anim. Sci. 83:1726–1731.

Ghanbari-Bonjar, A., and H.C. Lee. 2003. Intercropped wheat (*Triticum aestivum* L.) and bean (*Vicia faba* L.) as a whole-crop forage: Effect of harvest time on forage yield and quality. Grass Forage Sci.58:28–36.

González-V., E.A., and C.W. Hanselka. 2002. Ecología y manejo de matorrales. Caso provincia biótica tamaulipeca. INIFAP-Texas A&M University. Social and Comercial Press. Cd. Victoria, Tamps, Mexico.

Hossain, I., F.M. Epplin, G.W. Horn, and E.G. Krenzer, Jr. 2004. Wheat production practices used by Oklahoma grain and livestock producers. Available at http://osuextra.okstate.edu/pdfs/B-818.pdf (verified 3 Dec 2007). Oklahoma Agric. Exp. Stn. B-818. Oklahoma State University, Stillwater.

Rodney W. Hintz' and Kenneth A. Albrecht. 1994. Dry Matter Partitioning and Forage Nutritive Value of Soybean Plant Components. Agron J. 86:59-62.