INFLUENCE OF SUPPLEMENTAL SILAGE ON FORAGE INTAKE AND UTILIZATION OF STOCKER CATTLE GRAZING WHEAT PASTURE

G.J. Vogel[1], G.W. Horn[2], W.A. Phillips[3], J.W. Oltjen[4] and M.A. Worthington[5]

Story in Brief

Twenty-four fall weaned steers were used in each of three trials on wheat pasture to determine effects of increasing amounts of supplemental silage on forage intake and rate of passage. Steers grazed a common wheat pasture and were fed either 0, .35, .70, or 1.05 lbs silage dry matter/100 lbs body weight. In addition, eight ruminally cannulated Hereford steers were allotted to one of two treatments, 0 or .55 lb silage dry matter/100 lb body weight, to determine effects of supplemental silage on extent and rate of in situ ruminal digestion of wheat forage. Wheat forage intake decreased linearly with increasing amounts of supplemental silage indicating steers were substituting silage for wheat forage. Fill, flow and fecal output increased linearly with increasing levels of silage. The potentially digestible fractions of dry matter and neutral detergent fiber of wheat forage were not influenced by supplemental silage. The extent of ruminal digestion of wheat forage was greater where silage was fed due in part to an increased rate of dry matter and neutral detergent fiber digestion indicating that supplemental silage had a positive associative effect on wheat forage utilization. These results may partially explain the mechanism by which relatively small amounts of supplemental silage allowed stocking densities to be doubled without decreasing weight gains of stocker cattle on wheat pasture.

(Key Words: Wheat Pasture, Stocker Cattle, Supplementation, Silage)

Introduction

Daily gain of stocker cattle is a key figure that affects profitability of stocker cattle enterprises. Because wheat forage is a high quality forage, gains of stocker cattle grazing wheat pasture are potentially good. However, gains of stocker cattle grazing wheat pasture are frequently depressed because of inadequate amounts of available forage during the fall and winter and because of snow and(or) ice cover of wheat forage. Identification of sound supplementation programs may improve gains by adding stability to the existing forage supply. Results of stocker cattle performance trials (Ford et al., 1983; Phillips et al., 1984; and Vogel et al., 1985) have shown that silage supplementation of stocker cattle grazing wheat pasture allowed stocking densities to be doubled without decreasing stocker cattle performance. Results of trials that were conducted concurrently to investigate the effects of increasing amounts of supplemental silage on flow through the gastrointestinal tract, and ruminal digestion of wheat are reported here.

[1]Graduate Assistant, [2]Professor, [3]Research Scientist, USDA/ARS, [4]Assistant Professor, [5]Herdsman Supervisor

Materials and Methods

Four trials were conducted from 1982 to 1985. In each of the first 3 trials (1982-1984) 24 fall weaned steers (average BW of 570 lb) grazing a common pasture (5.6 acres) were allotted to one of four treatments in a completely randomized design. Treatment 1 steers received no supplemental silage, while steers of treatments 2,3, and 4 were supplemented with .35, .70, and 1.05 lb silage dry matter (DM)/100 lb body weight (BW), respectively. In trial 4 (1985) eight ruminally cannulated Hereford steers (average BW of 704 lb) were allotted to one of two treatments. Steers of treatment 1 received no supplemental silage while steers of treatment 2 received .55 lb silage DM/100 lbs body weight. Wheat silage was used in trial 1 (1982), whereas sorghum silage was used in trials 2,3, and 4 (1983-1985). Each trial consisted of a 12-day adaptation period and a 4 day experimental period. During the adaptation period, steers were removed from pasture at sunset, immediately placed in individual stalls and fed silage, and placed on pasture the following morning. Daily intakes of silage were recorded. On day 1 of the experimental period, steers were fed 200 grams of ytterbium (Yb)-labelled wheat forage DM in addition to their normal allottment of silage. Fecal grab samples were subsequently taken over a 4-day period. In trial 4 steers were also fed a pulse dosage of 200 grams of dysprosium (Dy)-labelled sorghum silage DM in addition to the Yb-labelled wheat forage. Fecal Yb and Dy concentrations were fit to the one compartment model of Ellis et al. (1979):

$$Y = K_0 * T * e^{-K_1 T}$$

where Y= fecal marker concentration

K_0= initial concentration in the compartment, g/kg

K_1= the time dependant rate constant, 1/h

T= time post dosage minus time delay, h

From these parameters the following were calculated:

Fecal Output (FO), kg/day = (Marker dose,g/K_0)*24

Wheat Forage FO (WFO), kg/day= FO-(Silage DM Intake * Silage Indigestibility)

Flow, %/h = .59636 * K_1

Turnover, h = 1/Flow

Fill, kg = Marker dose, g/(K_0 * K_1 * .59635)

In trial 4 duplicate nylon bags containing 3 grams of wheat forage or 4 grams of sorghum silage were placed in the rumen of each steer for 4, 8, 12, 19, 24, 36, 48, and 60 hours. Dry matter (DM) and NDF disappearance estimates (% of initial amount remaining) for each incubation time were iteratively fit to a nonlinear equation to estimate potential degradability (p)

$$p = a + b(1-e^{-ct})$$

where a= the highly soluble rapidly disappearing fraction

b= that fraction other than "a" that disappears at a constant fractional rate of time

c= digestion rate constant

t= time

Using the fitted constants (i.e. a, b, and c) the effective ruminal degradability (RD) was estimated from the equation of Orskov and McDonald (1979) where:

$$RD = a + bc/(c+k)$$

The rate constant k represents the passage rate constant obtained from the forage intake and passage rate data. When the nonlinear equation

Table 1. Silage and forage composition during forage intake trials on wheat pasture.

Feedstuff	Forage Availability	CP*	IVDMD*	DM,%*	n
	lb DM/acre	-- % of DM --			
Trial 1:					
Wheat silage		9.44	50.73	36.68	8
Wheat forage	484	27.25	74.90	25.80	5
Trial 2:					
Sorghum silage		8.64	56.38	27.92	8
Wheat forage	2076	30.19	77.80	16.13	7
Trial 3:					
Sorghum silage		9.74	50.00	25.44	8
Wheat forage	1613	24.33	75.22	29.70	4
Trial 4:					
Sorghum silage		8.35	56.65	20.14	12
Wheat forage	746	30.25	80.50	17.26	6
SEM	163	.187	2.308	.917	

*CP = crude protein; IVDMD = in vitro dry matter digestibility; DM = dry matter

estimated fraction a to be less than 0, lag time (T) was estimated as $T = -\log((a/b)+1)/c$. Consequently, where fraction a was less than 0, RD was calculated as:

$$RD = (a+b)(c/c+k)e^{-kT}.$$

During each trial silage and wheat forage samples were collected daily, composited across days, and analyzed for dry matter (DM), crude protein (CP), and in vitro dry matter digestibility (IVDMD). In addition, forage availability was estimated by hand clipping 3 one-half square meter plots. The results of these analyses are presented in Table 1.

Results and Discussion

Forage intake and passage rate data from trials 1, 2, and 3 are presented in Figures 1 and 2, respectively. Actual silage consumption for steers of treatments 1 to 4 was 0, .32, .60, and .78 lb DM/100 lb BW. As silage DM consumption increased, WF consumption decreased linearly ($p<.10$) from 2.67 lb DM/100 lb BW for steers of treatment 1 to 2.20 lb DM/100 lb body weight for steers of treatment 4 suggesting that steers were substituting silage for WF. Yet, this was not a direct substitution on a lb for lb basis since total feed (forage + silage) intake increased as the amount of supplemental silage increased. These same trends for forage intake were also observed in trial 4 (Table 2). Wheat forage consumption of steers fed silage decreased by .6 lb DM/100 lb body weight when compared to steers consuming WF alone although total forage intake was similar for steers of both treatments ($p>.05$).

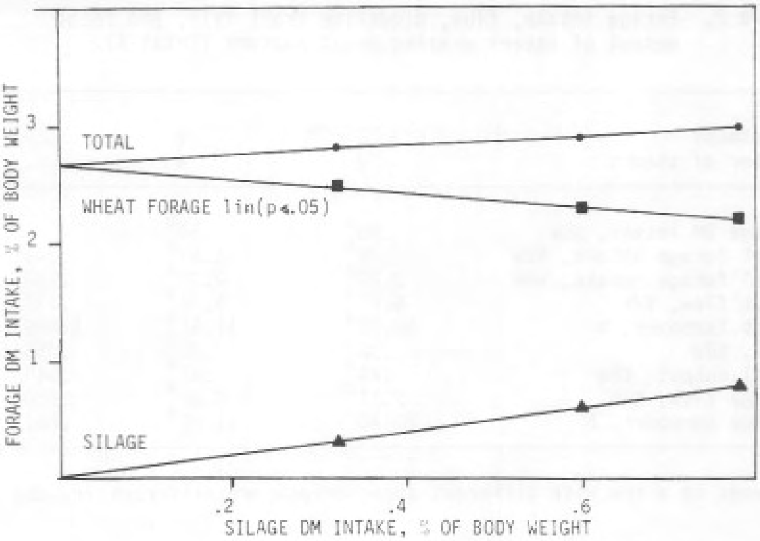

Figure 1. Forage DM intakes of steers grazing wheat pasture (Trials 1, 2, and 3)

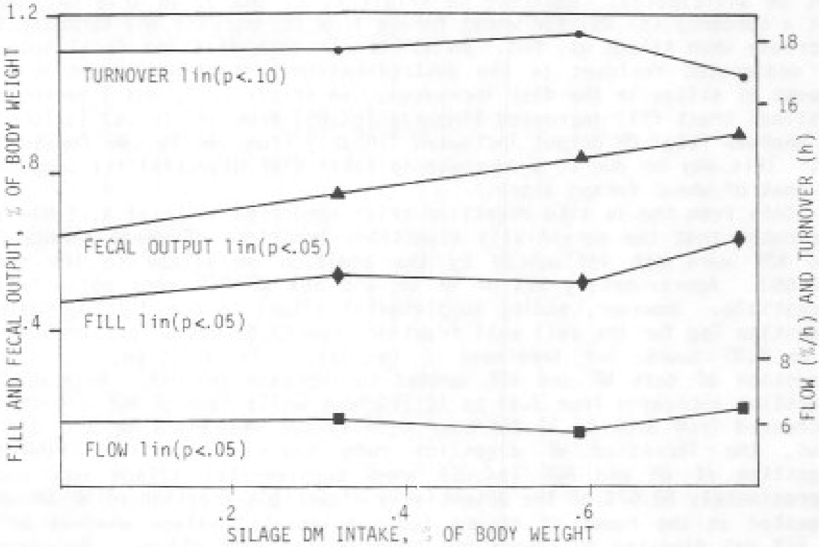

Figure 2. Fill and fecal output of the gastrointestinal tract and flow and turnover of wheat forage (Trials 1, 2, and 3)

Table 2. Forage intake, flow, digestive tract fill, and fecal output of steers grazing wheat pasture (Trial 4).

Treatment Number of steers	1 4	2 4	SEM
Silage DM intake, %BW	.00[a]	.55[b]	
Wheat forage intake, %BW	2.27[a]	1.67[a]	.241
Total forage intake, %BW	2.27[a]	2.22[a]	.233
Wheat flow, %/h	6.57[a]	5.78[a]	.732
Wheat turnover, h	16.24[a]	17.51[a]	1.849
Fill, %BW	.30[a]	.42[a]	.056
Fecal output, %BW	.44[a]	.57[a]	.044
Silage flow, %/h	5.17[a]	4.86[a]	.600
Silage turnover, h	20.46[a]	21.01[a]	.861

[ab]Means in a row with different superscripts are different ($p<.05$)

Passage rate data from trials 1, 2, and 3 indicated that turnover decreased ($p<.10$) and flow of wheat forage increased ($p<.05$) linearly with increasing amounts of supplemental silage. Yet, differences among treatments were small and differences in wheat forage utilization would not be anticipated. Contrary to trials 1, 2, and 3, in trial 4 there was a tendency ($p>.05$) for wheat forage flow to decrease and turnover to decrease when silage was fed. In all trials both fill and fecal output of undigested residues in the gastrointestinal tract increased as the amount of silage in the diet increased. In trials 1, 2, and 3 gastrointestinal tract fill increased linearly ($p<.05$) from .47 to .63 lb/100 lb BW whereas fecal DM output increased linearly from .64 to .90 lb/100 lb BW. This may be due to a decrease in total diet digestibility compared to that of wheat forage alone.

Data from the in situ digestion trial conducted in trial 4 (Table 3) indicated that the potentially digestible fractions of wheat forage DM and NDF were not influenced by the addition of silage to the diet ($p>.05$). Approximately 95% of WF DM and 66% WF NDF were potentially digestible. However, adding supplemental silage to the diet decreased digestion lag for the cell wall fraction from 12.63 hours for treatment 1 to 9.07 hours for treatment 2 ($p<.05$). In addition, rates of digestion of both WF and NDF tended to increase ($p>.05$). Rate of DM digestion increased from 8.49 to 12.34%/hour while rate of NDF digestion increased from 8.04 to 11.26%/hour when silage was added to the diet. Thus, the increased WF digestion rate caused increased ruminal digestion of DM and NDF ($p<.05$) when supplemental silage was fed. Approximately 63.07% of the potentially digestible fraction of WF DM was digested in the rumen of steers fed supplemental silage whereas only 52.52% was digested in steers not supplemented with silage. Moreover, there was a 49% increase in digestion of the NDF fraction of wheat forage for steers fed silage. Similar to the wheat forage, the potentially digestible fractions of silage DM and NDF were greater for steers were fed silage ($p<.05$). Yet, the rates of DM and NDF of silage digestion tended to be higher for steers of treatment 1. Consequently,

Table 3. Ruminal digestion of wheat forage and silage of steers on wheat pasture (Trial 4).

Treatment Silage DM intake, %BW	1 0	2 .55	SEM
Wheat Forage			
DM			
Potentially digestible, %	95.24[a]	95.38[a]	4.22
Digestion rate, %/h	8.49[a]	12.34[a]	1.63
Digestion lag, h	.769[a]	.519[a]	.82
Ruminal degradability,%	52.52[a]	63.07[b]	2.11
NDF			
Potentially digestible, %	66.06[a]	66.04[a]	4.22
Digestion rate, %/h	8.04[a]	11.26[a]	1.59
Digestion lag, h	12.63[a]	9.07[b]	.95
Ruminal degradability, %	16.71[a]	24.87[b]	2.20
Sorghum Silage			
DM			
Potentially digestible, %	46.07[a]	69.53[b]	.42
Digestion rate, %/h	6.53[a]	4.00[a]	1.63
Ruminal degradability, %	29.93[a]	33.22[a]	2.11
NDF			
Potentially digestible, %	23.53[a]	51.07[b]	4.99
Digestion rate, %/h	7.08[a]	4.08[a]	1.58
Digestion lag, h	11.00[a]	10.77[a]	.95
Ruminal degradability, %	7.78[a]	11.92[a]	2.20

[ab]Means in a row with different superscripts are different ($p<.05$)

extent of ruminal digestion of silage DM and NDF was similar for both treatments.

In conclusion, use of supplemental silage decreased WF intake although total forage intake remained fairly constant. However, the decrease in WF intake appeared to be offset by an increase in WF utilization. These results may partially explain the mechanism by which relatively small amounts of supplemental silage allowed stocking densities to be doubled without decreasing weight gains of stocker cattle on wheat pasture.

Literature Cited

Ellis, W.C. et al. 1979. Quantitating ruminal turnover. Fed. Proc. 38:2702.

Ford, M.J. et al. 1983. Supplementation of wheat pasture and bermudagrass stocker cattle with silage. Anim. Sci. Res. Rep. MP-114:226.

Orskov, E.R. and I. McDonald. 1979. The estimation of protein degradability in the rumen from incubation measurements weighted according to rate of passage. J. Agric. Sci. 92:499.

Phillips, W.A. et al. 1984. Use of silage in wheat pasture and bermudagrass stocker programs. Anim. Sci. Res. Rep. MP-116:168.

Vogel, G.J. et al. 1985. Use of silage in wheat pasture and bermudagrass stocker programs. Anim. Sci. Res. Rep. MP-117:238.