Timing of Grazing Termination in Dual-Purpose Winter Wheat Enterprises: Two-Year Summary

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Story In Brief

Timing of grazing termination is a key management variable in maximizing income from dual-purpose winter wheat enterprises. The objective of this research was to determine the effect of grazing winter wheat pasture past first hollow stem (FHS) on steer BW gain and subsequent grain yield; and to develop production functions relative to time of grazing termination. Grazing trials were initiated at the emergence of FHS on March 13 and 5, of 2003 and 2005, respectively. Angus steers grazed four clean-tilled, dryland winter wheat pastures in 2003 (n = 52) and a single pasture in 2005 (n = 34). Forage mass averaged 2116 lb DM/ac during 2003 and 810 lb DM/ac during 2005. Beginning in early February, grazing exclosures were set at approximately weekly intervals. Body weight of growing steers increased linearly ($P<.01$; $Y = 864.7 + 3.49x$) following FHS at the rate of 3.49 lb/d. Grain yield responded quadratically ($P<.01$; $Y = 30.4 – .12x – .008x^2$) relative to days grazing past FHS. Grain yield decreased 10% by grazing 2 wk past FHS, and an additional 10% for each of the next 2 wk. While the steers used in this study were heavy, their BW gain was excellent during the post-FHS grazing period. The response of grain yield to grazing past FHS was less dramatic than previously reported and indicates a "safety zone" around FHS allowing producers time to remove cattle from wheat without substantial harm to grain yield.

Key Words: Winter Wheat Pasture, Grazing Termination, ADG, Grain Yield

Introduction

Dual-purpose winter wheat enterprises require a high level of management in order to maximize total income. This is especially challenging because maximizing steer gains and grain yields are often antagonistic (Dunphy et al., 1982; Redmon et al., 1996). Because both components of dual-purpose wheat enterprises are of such importance, it is critical to find the optimal balance between the two dichotomies. Redmon et al. (1996) reported that grain yield was reduced 1.24 bu/ac for each day grazed past first hollow stem (FHS). The objective of this research was to quantify the effect of grazing past FHS on steer BW gain and subsequent grain yield; and to develop production functions that could be used to develop an economic model relative to time of grazing termination in dual-purpose winter wheat enterprises.

Materials and Methods

A two year study was conducted during the 2002-2003 and 2004-2005 winter wheat pasture years at the Wheat Pasture Research Unit at Stillwater, OK. One clean-tilled, dryland pasture (90 ac) was planted to hard red winter wheat on Sept. 4, 2002 (variety 2174) and Sept. 7, 2004 (variety Ok 102). Seeding rate was 120 lb/ac and 87 lb N/ac was applied as anhydrous ammonia immediately prior to planting each year. The 90 ac pasture was subdivided into 4 equal paddocks in 2002, and 2 equal paddocks in 2004 (only one of which was used for grazing past FHS in 2004). First hollow stem is defined as the growth stage when hollow stem can first be identified above the root system and below the developing head (Krenzer and Horn, 1997). It is recommended that grazing be terminated when FHS reaches 1.5 cm above the crown to minimize reductions in grain yield (Krenzer and Horn, 1997). Length of FHS was monitored in plants from nongrazed plots each year beginning in early February as recommended by Redmon et al. (1996). Duration of grazing past FHS was 35 d (March 13 to April 17, 2003) and 52 d (March 5 to April 26, 2005). Weighted average stocking density for 2003 was 1.11 steers/ac (1054 lb BW/ac), and was adjusted during the post FHS grazing period based on available forage. Stocking density was .71 steers/ac (612 lb BW/ac) in 2005 and was held constant throughout the post FHS grazing period.

Different grazing termination dates were simulated within pastures by use of 16 ft long wire panels to exclude cattle from 256 ft^2 areas each time an exclosure was established. The first grazing exclosures were set in early February and additional exclosures were added at approximately weekly intervals through late April of each year. Calendar dates on which exclosures were established and the corresponding days from FHS are shown in Table 1. Forage mass was determined at random locations within close proximity (approximately 100 ft) to the exclosures by clipping wheat forage to ground level inside 2 ft^2 quadrants. Forage mass was determined on March 13, April 1, and April 17, 2003, and on dates corresponding to erection of exclosures beginning on March 7, 2005.

Table 1. Grazing termination dates for 2003 and 2005 and corresponding days before (-) or after (+) first hollow stem (Days ± FHS).

2003[a]			2005[a]	
Date	Days ± FHS		Date	Days ± FHS
Feb. 12	-29		Feb. 3	-30
Feb. 18	-23		Feb. 21	-12
Mar. 4	-9		Feb. 28	-5
Mar. 11	-2		Mar. 7	2
Mar. 13	0		Mar. 11	6
Mar. 17	4		Mar. 18	13
Mar. 21	8		Mar. 25	20
Mar. 26	13		Apr. 1	27

Apr. 1	19		Apr. 8	34
Apr. 8	26		Apr. 15	41
Apr. 15	33		Apr. 22	48
[a]First hollow stem occurred on March 13, 2003 and March 5, 2005.				

Predominantly Angus steers (greater than 7/8 Angus) were used in both years of this study. Fifty-two steers were used during 2003 (1.11 steers/ac), while 34 steers were used during 2005 (.71 steers/ac). During both years, steers were gathered at 0800 and weighed following a 6-h period in which feed and water were withheld. Steers were weighed on March 13 and 21, and April 1 and 17 in 2003, and March 7 and 18, and April 4, 18, and 26 in 2005.

Wheat grain was harvested on June 19, 2003 using a Gleaner Model A combine (AGCO Corp., Duluth, GA) with an 8-ft header. In 2005, grain was harvested on June 22 with a Hege 185 combine (Wintersteiger Ag., Niederlassung, Germany) with a 5-ft header. Grain yields were calculated as the total weight (lb) of wheat grain harvested per unit of area (ac) and did not reflect differences in test weights per bushel.

Statistical Analyses. The MIXED procedure of SAS was used to determine the best fit regression equations. Independent variables included in the model were days from FHS, as well as the squared and cubed forms of this variable. A hierarchical model was evaluated to test the linear, quadratic, and cubic effects of days from FHS on the response variables. The interaction between year and plot was considered a random effect. Higher order terms were removed until significant effects were detected ($P \leq .05$). Author judgment was used to determine the model with the most parsimonious fit (i.e. the simplest model was used as long as model predictive power was not sacrificed). R-square values reflect the variation of the response that FHS explained, adjusted for the random effects of plot and year combinations.

Results and Discussion

First hollow stem stage of development was reached on March 13, 2003, and March 5, 2005. The closeness in calendar date of FHS emergence is somewhat surprising considering the difference in cultivars and growing conditions between the 2 yr, and should not be indicative of calendar date being an acceptable criterion for grazing termination. It is recommended that FHS be monitored in a nongrazed plot of the pasture being grazed, rather than using an arbitrary calendar date for making decisions on when to terminate grazing (Redmon et al., 1996).

Forage Allowance. Forage mass is shown in Figure 1. Average forage mass was 2116 and 810 lb DM/ac for 2003 and 2005, respectively. With reduced forage mass in 2005, a lighter stocking density was used and held constant at .71 steers/ac, compared with an average stocking density of 1.11 steers/ac in 2003. It is common practice for producers to increase stocking density when grazing past FHS (as compared with the stocking density used for winter grazing) to counter the rapid spring growth of wheat after FHS.

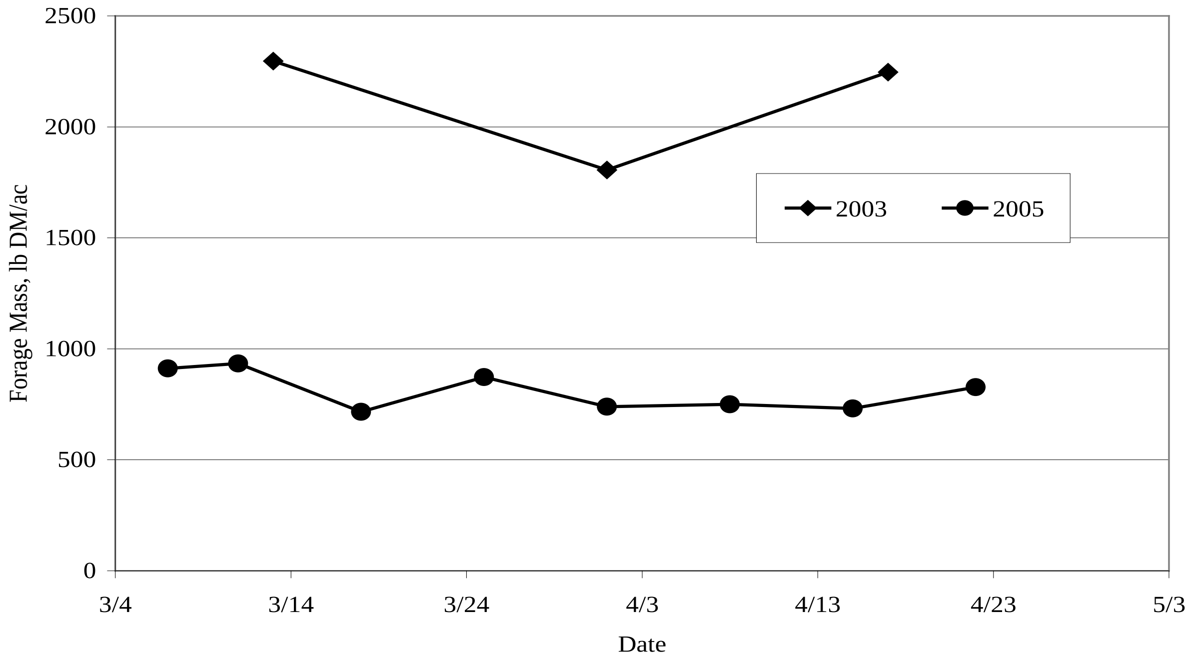

Figure 1. Forage mass after first hollow stem (FHS).

Steer Performance. Growth performance of steers is shown in Table 2. Steers were heavy at FHS and averaged 892 ± 66 and 787 ± 93 lb for 2003 and 2005, respectively. Nevertheless, ADG by steers after FHS was 3.53 lb in 2003 and 3.48 lb in 2005. Due to 17 additional grazing days, total steer gain during grazing past FHS was greater in 2005. Steer BW are shown graphically in Figure 2. The important aspect of this figure is the consistency of the slope parameter (ADG) across years. Despite relative differences in BW, steer BW increased linearly (P<.01) at the rate of 3.49 lb/d during the period of grazing past FHS. Total steer gain/ac after FHS was 132 and 128 lb BW/ac for 2003 and 2005, respectively.

Table 2. Growth performance of steers after first hollow stem (FHS).

Observations[a]	Initial Wt., lb	Final Wt., lb	ADG, lb	Total Gain, lb/steer	Gain per Acre, lb
2003					
Past. 1	874	999	3.65	125	138
Past. 2	902	1007	3.24	105	117
Past. 3	883	1002	3.51	119	132

Past. 4	908	1034	3.68	125	139
2003 Averages	892	1010	3.53	119	132
2005					
Avg.	787	968	3.8	181	128
[a]n=13 steers/pasture (2003) and 34 steers/pasture (2005).					

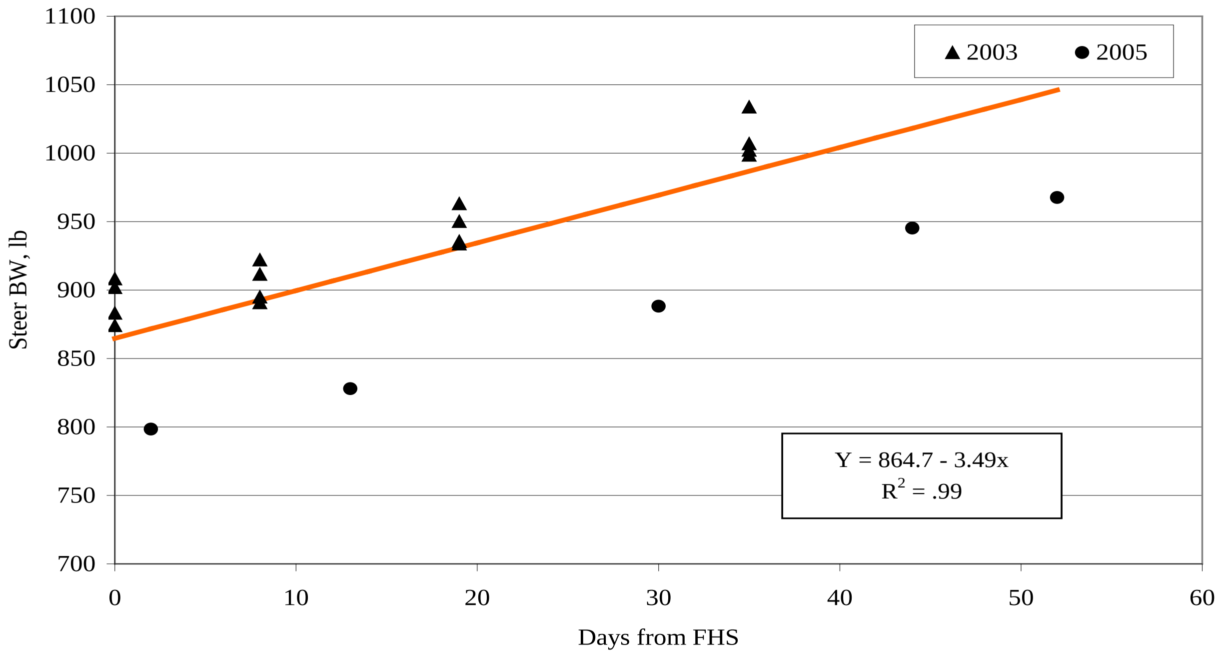

Figure 2. Regression of steer BW on days grazed past first hollow stem (FHS).

Grain Yield. Grain yield response to grazing termination is shown in Figure 3. Overall, grain yields in 2005 were less than those observed in 2003. Wheat grain yield exhibited a quadratic ($P<.01$) response to grazing termination dates before and after FHS ($Y = 30.4 - .12x - .008x^2$). Based on our regression equation, peak grain yield occurred 8 d prior to FHS, and was 30.9 bu/ac. The reason for numerically reduced grain yields at grazing termination dates in advance of FHS is not apparent and may be related to insect damage, weed infestation, or abiotic factors that would inhibit recovery from grazing, such as water deficit or temperature stress. With grazing termination observations up to 56 d prior to FHS, Redmon et al. (1996) reported the slope of grain yield decline prior to FHS was not different from zero. Our response function, in conjunction with that of Redmon et al. (1996), indicates that grain yield is not significantly affected by terminating grazing prior to the emergence of FHS.

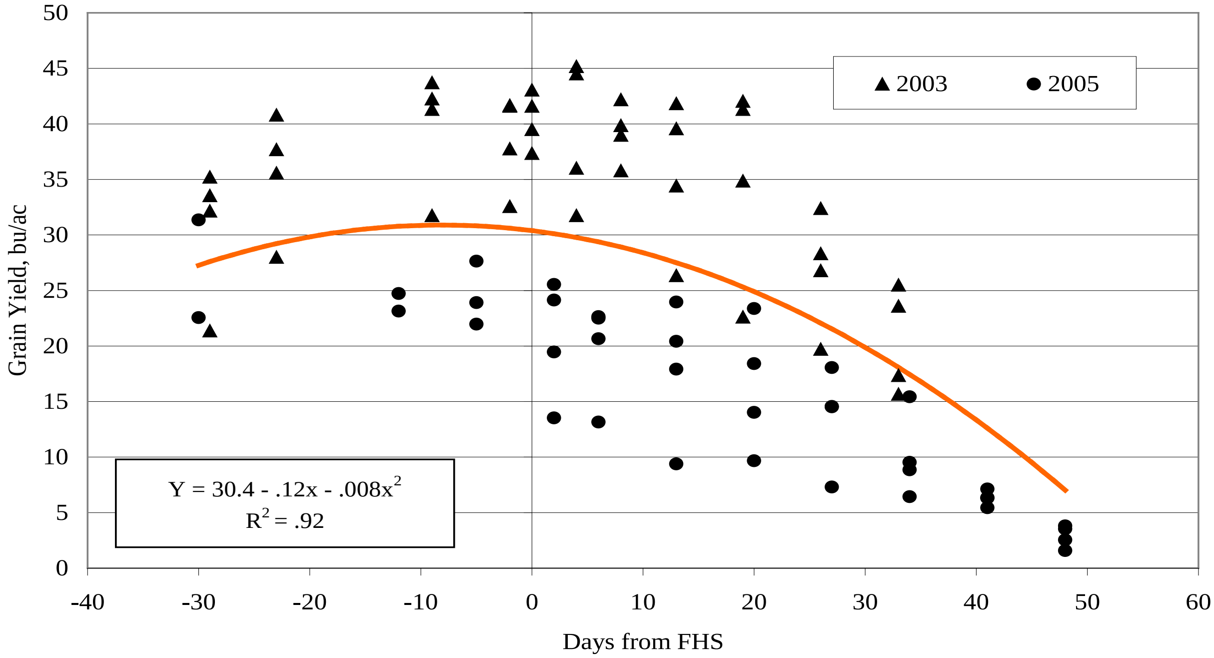

Figure 3. Wheat grain yield response to different grazing termination dates expressed as days before (-) or after (+) first hollow stem (FHS).

A comparison of the effects of grazing past FHS on steer gain and grain yield is shown in Table 3. Estimated steer BW, steer gain per acre, and grain yield were determined based on prediction equations from this data set. Grazing 1 wk past FHS resulted in an additional 18.9 lb/ac of steer BW, while maintaining 96% of the grain yield available at FHS. Based on our prediction equation for the effect of grazing past FHS on grain yield, grain yield was decreased about 10% by grazing 2 wk past FHS, with another 10% reduction for each of the third and fourth weeks grazed past FHS. Despite the antagonistic effects of steer gain and grain yield, our data implies that grazing 4 wk past FHS added 87 lb of BW gain/ac, while still providing 70% of the grain yield potential under dual-purpose management. These estimates must be used with caution, as any outcome is partly dependent on environmental effects and growing conditions.

Table 3. Comparison of steer growth performance and grain yield relative to days grazed past first hollow stem (FHS).

Days past FHS	Predicted Effect on Steer BW, lb[a]	Additional Steer Gain per Acre, lb[b]	Predicted Effect on Grain Yield, bu/ac[c]	Predicted Grain Yield, % of est. at FHS
0	865		30.4	
3	+ 10.5	+ 5.9	- .4	98.6
7	+ 24.4	+ 18.9	- 1.2	95.9
10	+ 34.9	+ 28.7	- 2.0	93.5

14	+ 48.8	+ 41.7	- 3.2	89.4
21	+ 73.2	+ 64.4	- 5.9	80.5
28	+ 97.7	+ 87.1	- 9.4	69.1
35	+ 122.1	+ 109.8	- 13.6	55.3
42	+ 146.5	+ 132.5	- 18.5	39.0

[a]Effect on steer BW calculated from regression equation shown in Figure 1 (Y = 864.7 + 3.49x)

[b]Additional steer gain per acre calculated from regression equation (P<.01; Y = -3.80 + 3.25x)

[c]Effect on grain yield calculated from regression equation shown in Figure 2 ($Y = 30.4 – .12x – .008x^2$)

Implications

The economic optimum grazing termination date depends on the value of the additional cattle BW gain and grain markets. While the steers used in this study were heavy at FHS (i.e., 787 and 892 lb), BW increased linearly at the rate of 3.49 lb/d. Grain yield did not decrease linearly with days grazed past FHS, indicating that a “safety zone” exists for removal of grazing cattle without a drastic reduction in grain yield. While numerous external factors will influence these relationships, the production functions reported herein should aid decision making relative to grazing termination date in dual-purpose winter wheat enterprises.

Literature Cited

Dunphy, D.J. et al.1982. Crop Sci. 22:106.

Krenzer, E.G., Jr., and G.W. Horn. 1997. Oklahoma Agric. Exp. Sta. PT 97-5.

Redmon, L.A. et al. 1996. Agron. J. 88:94.

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