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A Comparison of Native Grass and Triticale Pastures during Late Winter for Growing Cattle in Semiarid, Subtropical Regions

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Abstract: Forage-based beef production is one of the most productive agricultural systems, especially in semiarid, subtropical environments, yet it is temporally variable due to climatic factors. Dormant native perennial warm-season grasses are available for grazing from autumn through spring; however, their protein concentration is inadequate to support growing cattle. Winter cereal forages, such as triticale [×*Triticosecale* Wittm. ex A. Camus (*Secale* × *Triticum*)], can fill fall through spring forage gaps with sufficient protein concentration. Triticale productivity was evaluated, and beef stocker performance on triticale was compared with supplemented native grassland for late winter pasture in each of three years at New Mexico State University's Rex E. Kirksey Agricultural Science Center in Tucumcari, NM USA. Study results indicated that triticale pasture forage mass varied over the three years due to precipitation and different triticale planting dates each year, influencing the length of grazing period. Triticale provided late winter average daily gain approximately twice that of cattle grazing dormant native grass with protein supplementation (0.70 vs. 0.36 kg hd^{-1} d^{-1}, $p < 0.0001$). Therefore, triticale can be utilized to provide adequate growth of young calves without the added costs of supplementation.

Keywords: animal performance; climatic factors; forage nutritive value; forage yield; beef cattle; native grass; pastures; small grains; stockers; triticale

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1. Introduction

Beef demand is increasing globally due to population increases [1]; however, ongoing challenges to agriculture are now also being influenced by societal and ecological concerns about the sustainability of humanity and the environment [2]. Greater integration of crop–livestock systems may have a role in the solution [2]. Forage-based beef production is one of the most productive agricultural systems, yet it is temporally variable due to climatic factors [1]. The Southern High Plains (SHP) of the USA are subhumid and subtropical, with a continental precipitation pattern characterized by hot, moist summers and cool, dry winters with generally limited and erratic precipitation and temperatures [3].

The goal of grazing programs is to provide high quality standing forage year-round to reduce the costs of feeding hay and supplements [4]. Options for grazing in semiarid, subtropical environments include native grasses (predominantly actively growing or dormant perennial warm-season grasses, PWSG), winter cereals and other annual or perennial cool- or warm-season domesticated pastures, crop residues, and grain crops [1,5]. During their period of active growth from spring through summer, native PWSG can provide adequate nutrition for growing cattle [6]. Native PWSG also are available for grazing after they become dormant in autumn; however, plant maturity and weathering reduce their nutritive value, making them nutritionally inadequate to support most classes of livestock, especially in regard to crude protein (CP) [6,7]. Protein supplementation is often required with dormant PWSG, but their use is considered economically viable due to their potentially high forage accumulation [6,8]. In the SHP, winter cereal forages are used extensively for grazing [9], especially by stocker (growing) cattle from November into May [1,4]. Spring-born calves are usually weaned in autumn when weaned cattle prices are generally low, compared to spring prices [8]. At weaning, beef calves generally weigh 204–317 kg at 6–10 months of age, are grazed as stockers until 12–16 months old, and then are taken to the feedlot for 4–6 months for finishing [1]. Therefore, grazing winter cereals can be an opportunity for cow-calf producers to retain ownership of spring-born calves in the autumn after weaning [8].

Winter wheat (*Triticum aestivum*) has been the principal winter pasture for stocker cattle in the SHP, and fits well with the spring through autumn growing period and autumn through spring dormant period of PWSG [4]. Other winter cereals that are well-adapted to the SHP include cereal rye (*Secale cereale*) and triticale [×*Triticosecale* Wittm. ex A. Camus (*Secale* × *Triticum*)], a hybrid of wheat and rye. These cereals have forage production similar to that of wheat in the SHP [9], although rye and triticale tend to have greater sustained winter growth than wheat. This being stated, cereal rye is very early maturing [10], leading to a shorter grazing season than either wheat or triticale [11]. Triticale is generally limited to forage production due to low grain yields and poor grain milling properties [9]. Myer et al. [11], in the humid subtropical USA, reported that stockers grazing triticale had greater average daily gains (ADG) and more uniform distribution of yield when compared to cereal rye. Otherwise, little information is available about performance under stocker grazing [11,12], especially in semiarid, subtropical environments.

The objectives of this study were: (1) to compare the performance of stocker cattle grazing dormant native PWSG with protein supplementation, or triticale, and (2) to evaluate to productivity of actively growing triticale during that late winter grazing period.

2. Materials and Methods

2.1. Test Description, Management, and Data Collection

Triticale was compared to supplemented native PWSG for winter pasture in studies conducted over three winters in the semiarid, subtropical SHP of the USA at the New Mexico State University Rex E. Kirksey Agricultural Science Center in Tucumcari, NM, USA (35.20° N, 103.69° W; elev. 1247 masl). Completely randomized designs with two replicates were used in each of the late winter to early spring grazing periods of 2012–13, 2013–14, and 2015–16. Native PWSG pastures used each year had not been grazed for several years due to prolonged drought and to allow for recovery. No grazing took place in the late winter of 2014–15 due to insufficient growth the previous summers to accumulate forage mass for grazing. Weather data were collected from a station located within 1.8 km of each pasture. The dominant PWSG species in the native short (<25 cm height)- to mixed short- and tallgrass prairie at the site included blue grama *(Bouteloua gracilis)*, sideoats grama (*Bouteloua curtpeudula*), and sand dropseed (*Sporobous cryptandrus*). Sub-dominant grasses were yellow bluestem (*Bothrichloa ischaemum*), threeawns (*Aristida* spp.), lovegrass (*Eragrostis* spp.), vine mesquite (*Panicum obtusum*), and silver bluestem (*Bothriochloa saccharoides*) [5].

The triticale pastures (2.43 ha) were planted (112 kg seed ha^{-1}) into conventionally tilled seedbeds on 9 November 2012, 1 October 2013, and 27 August 2015. Irrigations with treated municipal wastewater (Class 1B, which is a suitable level of treatment for application to animal feed and fiber crops, [13]) totaled 175, 386, and 276 mm throughout the pre-grazing and grazing periods of 2012–13, 2013–14, and 2015–16, respectively. Nitrogen was applied to the triticale pastures approximately one month after planting each year (52, 58, and 74 kg N ha^{-1} in 2012, 2013, and 2015, respectively). No pesticides were applied to any pasture.

Recently weaned British × Continental crossbred beef heifers from the NMSU Corona Range and Livestock Research Center (2013 and 2014) or steers from a regional sale barn (2016) were assigned to each pasture replicate each year by initial body weight [219 ± 23 kg in 2013 (53 hd), 223 ± 17 kg in 2014 (28 hd), and 190 ± 1 kg in 2016 (23 hd)]. Differences between 2013, 2014, and 2016 in initial body weights are likely due to a consistent single source with a limited spring calving period in the first two years, compared to sale barn cattle from multiple unknown origins in the third year. Range pastures were unequally sized, ranging from 5 to 16 ha across years; consequently, various numbers of animals were assigned to those pastures to provide for up to 50% utilization, as a moderate grazing intensity [14,15], during the anticipated grazing season to end in mid-March (30 d in 2013, 84 d in 2014, and 53 d in 2016). The initial stocking rates for range pastures averaged 0.56, 0.57, and 0.24 animal units (AU = 454.5 kg) ha^{-1} in 2013, 2014, and 2016, respectively. A total of six animals were allocated to triticale pastures based on body weight to have the same initial stocking rate in those pastures within the year (1.19, 1.21. and 2.03 AU ha^{-1}, for 2013, 2014, and 2016, respectively). Grazing took place from 13 February to 20 March 2013, 20 December 2013 to 14 March 2014, and 21 January to 14 March 2016 using continuous stocking. Every year, immediately prior to grazing, a sample was hand-clipped to ground level from a 0.5 m^2 area in each of three visibly representative areas in each pasture [5], and dried in a forced-air oven at 60 °C for 48 h [5]. These samples were submitted for estimation of CP and fiber-based components by near-infrared spectroscopy (NIRS) at Ward Laboratory (Kearney, NE, USA) using a calibration developed for grass hay by the NIRS Consortium (https://www.nirsconsortium.org/; accessed on 11 June 2021). Results of that analysis are presented in Table 1. Since CP concentrations were <80 g kg^{-1} [7], dormant native grass CP supplementation levels were determined based on these values and cattle body weights to sustain average daily gains of 0.5 kg hd^{-1} d^{-1} [16]. Producers Pride 24% (240 g kg^{-1}) Protein Tub (Tractor Supply Co., Brentwood, TN, USA) was used in 2013 and fed ad libitum, and Hi-Pro 20% (200 g kg^{-1}) Southwest Breeder cubes (Hi-Pro Feeds, LLC, Friona, TX, USA) was used in 2014 and 2016. Cubes were fed in troughs in 2014 and 2016, and adjusted monthly based on weight gain. Actual protein supplement consumption for the grazing periods was 0.17 kg hd^{-1} d^{-1} in 2013 and 1.18 kg hd^{-1} d^{-1} in 2014 and 2016. Mineral [Hi-Pro Beef Range Mineral (Hi-Pro Feeds, LLC, Friona, TX, USA)] was supplied ad libitum in all pastures each year.

Table 1. Initial nutritive value (g kg^{-1} of dry matter) of native grass and triticale pastures grazed at Tucumcari, NM, USA. Values are the mean ± standard deviation for each year.

	Native Grass			Triticale		
Year	**2013 (*n* = 2)**	**2014 (*n* = 6)**	**2016 (*n* = 6)**	**2013 (*n* = 2)**	**2014 (*n* = 6)**	**2016 (*n* = 6)**
CP [1]	60.5 ± 19.1	77.0 ± 14.1	51.7 ± 17.1	222.0 ± 11.3	168.6 ± 19.4	148.2 ± 22.4
NDF	694 ± 6.4	685 ± 34.7	817 ± 36.8	465 ± 18.6	513 ± 47.5	396 ± 18.4
ADF	516 ± 4.9	456 ± 14.3	522 ± 27.2	206 ± 6.4	290 ± 12.4	192 ± 14.9
TDN	437 ± 6.4	489 ± 0.7	429 ± 31.0	791 ± 7.1	708 ± 21.8	807 ± 16.9

[1] CP, NDF, ADF, and TDN signify crude protein, neutral detergent fiber, acid detergent fiber, and total digestible nutrients, respectively, all estimated by near infrared spectroscopy.

Every 28 days after the initiation of grazing, animals were weighed following a 16-h fast with water. On those days, standing forage within 0.5 m^2 was also hand-clipped to ground level near the same three uniformly distributed locations in each pasture each year [5]. Sampling locations were selected to represent the forage mass in that area. Hand-clipped samples were dried in a forced-air oven at 60°C for 48 h to determine the forage dry matter (DM) mass at the beginning of each month of grazing and when grazing was ceased. Monthly individual animal average daily gains (ADG) were calculated using the 28-day body weights and the number of days between weigh days. The grazing period average daily gains and total gain animal^{-1} were calculated for each pasture replicate each year using initial and final body weights and the total number of days on pasture.

2.2. Statistical Analysis

Due to differences in the lengths of grazing seasons each year, monthly measurements were analyzed by year using the mixed procedure of SAS (SAS Inst., Inc., Cary, NC, USA) to compare pasture type (triticale or CP-supplemented native grass), month (measurement period as split plot repeated measures over time), and their interaction. Monthly forage and cattle data were averaged by pasture; consequently, each year was a completely randomized design with two replications in which the pasture within a year was the experimental unit. Pasture type and measurement period (month) were considered fixed effects, and replicate within pasture type was considered random. The grazing period total gain animal^{-1} and season mean ADG were analyzed across years using the mixed procedure of SAS to compare pasture type and year (2013, 2014, and 2016), and their interaction. Year (for grazing period gain and season mean ADG), replicate within year, and residual mean squares were considered as random and used as denominators for tests of significance. All differences reported were significant at $p < 0.05$. When the month (first analysis described above) or year (second analysis described) × forage interaction was significant, the least significant differences were used to determine where differences occurred among treatment least squares means using the PDMIX800 SAS macro (SAS Inst., Inc., Cary, NC, USA) [17].

3. Results and Discussion

3.1. Weather

Table 2 shows weather data for each 12 month period during the study and the long-term averages, as well as the non-study year (2014–15). Persistent drought continued into late summer 2013, limiting native grass productivity in the first two study years. Temperatures were also slightly to well-above average for most months during the native grass growing season (about March through October at this location).

Table 2. Monthly mean air temperatures and total precipitation at Tucumcari, NM, USA, during the study and intervening periods and the long-term means or totals (1905–2016).

Temperature, °C													
Study Period	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**Annual Mean**
2012–2013	28.3	27.2	22.2	15.0	11.7	6.1	3.3	6.1	6.7	12.2	18.9	26.7	15.4
2013–2014	26.7	26.7	22.8	14.4	8.3	3.3	3.9	5.6	9.4	14.4	18.9	24.4	14.9
2014–2015	26.1	26.1	21.1	17.2	7.2	4.4	2.2	5.6	10.0	14.4	16.7	24.4	14.6
2015–2016	26.7	25.6	24.4	16.1	8.9	9.4	3.3	8.3	11.7	13.9	18.9	25.6	16.1
Long-term	26.1	25.0	21.7	15.6	8.3	3.9	3.3	5.6	9.4	14.4	18.9	24.4	14.7
Precipitation, mm													
Study Period	**July**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**Annual Total**
2012–2013	8	25	36	10	0	13	10	22	0	0	21	29	174
2013–2014	31	23	109	7	11	3	0	1	6	5	61	102	359
2014–2015	65	21	69	5	9	10	37	23	10	49	102	53	451
2015–2016	192	52	33	21	31	72	0	24	2	17	33	83	561
Long-term	71	72	42	34	17	16	10	13	20	30	51	51	426

Tilhou et al. [6] reported that native tall prairie PWSG (e.g., *Panicum virgatum*, *Andropogon gerardii*, *Sorghastrum nutans*) were fully dormant in the upper humid, subtropical USA by late September. Temperatures after triticale planting each year (Table 2) were sufficiently warm to promote germination and growth of winter cereal forages [18], and irrigation was applied as needed throughout the winter cereal growing season to further promote growth [19].

3.2. Monthly Forage Mass

Data and results of statistical analyses for monthly forage mass are presented in Table 3. These data were statistically analyzed by year due to the difference in the number of months grazed. In 2013, grazing was delayed until February to allow for greater accumulation of triticale due to the late planting that year [11,20–22]. Additionally, long-term drought persisted throughout 2012 (Table 2), minimizing the accumulation of native grass during its mid-spring through summer growing season [6,14]. Even with the delayed grazing, low initial forage mass in 2013 limited grazing to a single month and, as expected, a difference was observed between the months due to removal by the animals (Table 3).

Table 3. Monthly forage dry matter (DM) mass of native grass or triticale pastures grazed by growing beef cattle and average daily gain during the late winters of 2013, 2014, and 2016 [1] at Tucumcari, NM, USA. Values are the means of two pasture replicates within each year.

Month [2]	Forage Mass, kg DM ha^{-1}					Individual Animal Average Daily Gain, kg hd^{-1} d^{-1}				
	2013		2014		2016	2013	2014		2016	
Dec	-		1143	a [3]	-	-	-		-	
Jan	-		901	ab	2419	-	0.32	b	-	
Feb	1066	a	463	c	2412	-	0.74	a	0.13	b
Mar	407	b	568	bc	2203	0.62	0.59	a	1.15	a
SED [4]	221		168		496	0.11	0.09		0.10	
Pasture										
Native grass	740		435	b	1944	0.55	0.39	b	0.29	b
Triticale	732		1103	a	2745	0.68	0.71	a	0.99	a
SED	221		119		405	0.11	0.07		0.10	
					p-values					
Pasture	0.9737		0.0005		0.1513	0.3508	0.0050		0.0024	
Month	0.0408		0.0131		0.9197	-	0.0096		0.0006	
Pasture × Month	0.8645		0.6985		0.6294	-	0.0110		0.5457	

[1] Due to differences in the number of months grazed each year, data were analyzed by year. [2] Grazing took place from 13 February to 20 March 2013, 20 December 2013 to 14 March 2014, and 21 January to 14 March 2016. Forage mass and animal weights were measured every 28 d beginning with the onset of grazing each year. Forage mass reflects standing forage at the beginning of the monthly period, or the end of grazing in March, and average daily gain reflects that calculated for the previous month. [3] Means within a column followed by similar lower-case letters are not significantly different at $p = 0.05$. [4] SED signifies standard error of the difference between means.

Differences between pastures existed for forage mass, with triticale having over twice the forage mass compared to native grass in 2014 (Table 3). Although native grass pastures were used that had an additional year to accumulate forage mass, similar to 2012–2013 (Table 2), precipitation during the April through October native grass growing season in 2014 had not been conducive for growth, or came too late to promote significant native grass growth [6]. Otherwise, pre-planting precipitation in September 2013 and the earlier planting of triticale led to greater forage mass of triticale in 2014 (Table 3) [22]. All pastures contained the minimum amount of forage mass to not limit DM intake by cattle [7,11]. It should be noted that forage mass reported for March represents the amount of forage mass after grazing was ceased, which actually represents the residual forage mass.

There was no difference between pastures in forage mass again in 2016 (Table 3). Weather data for 2014–15 are included in Table 2 to show at least a temporary alleviation of the drought in 2015 to promote native grass growth for grazing in late winter 2015–2016 (Table 3) [14,15,23]. Much earlier planting of triticale, coupled with greater precipitation (Table 2), led to greater forage mass in those pastures as well. Despite greater forage mass for both pasture types, grazing was delayed until January 2016 (Table 3) due to limited availability of a uniform group of yearling cattle at the sale barn. With the increase in native grass growth due to greater precipitation (Table 2), regional cattle growers retained ownership of heifers to restock their ranches. This also led to the considerably lesser initial stocking rate in 2016 compared to previous years, which would have reduced forage intake throughout the 2-month grazing period.

The production of native grass and winter annual cereal forages is uncertain across years due to variable precipitation (Tables 1 and 2) [14,15,21,23,24]. Initial forage masses of the native grasses in the present study were 1050, 747, and 2386 kg DM ha^{-1} for 2013, 2014, and 2016, respectively. Forage mass of native grass pastures when grazing was concluded was 431, 269, and 2122 kg DM ha^{-1} for 2013, 2014, and 2016, respectively, in the present study. Nonetheless, these values compare well with those measured previously at the study site prior to the drought [5], as well as elsewhere for mixed shortgrass prairie in various latitudes in semiarid western North America [14,15,23,25]. Previously at the study site, native grasses had initial forage masses of 1323 and 1565 kg DM ha^{-1} in December of years 1 and 2, respectively, with forage mass of 683 and 1513 kg DM ha^{-1} at the conclusion of grazing in spring of years 1 and 2, respectively [5]. Native grasses in the nearby Oklahoma Panhandle yield approximately 1700 to 3400 kg DM ha^{-1}, with tallgrasses being at the upper end of the range and shortgrasses, similar to those at the present study site, being at the lower end [1]. Tilhou et al. [6] reported that a late summer through autumn drought reduced stockpiled native tallgrass forage mass by 50%, compared to typical precipitation in the humid, upper subtropical USA. Previously at the study site, winter wheat had initial forage masses of 917 and 756 kg DM ha^{-1} in December of years 1 and 2, respectively [5]. Coleman et al. [26], in the upper Southern Great Plains, reported that autumn winter wheat forage yield was 497 kg DM ha^{-1}. Differences between this and other studies in forage production, especially of the native mixed PWSG prairie, is likely due to the proportion of component species, climatic factors, and grazing history [25]. The native grass pastures in the present study had not been grazed for several years due to drought. Holechek et al. [15] reported that light to moderate grazing (<40% utilization) during the winter period promoted drought recovery of shortgrasses, and Eneboe et al. [14] found that moderate utilization (40–50%), even during the growing season, did not influence shortgrass prairie sustainability. The target in the present study of 50% utilization of native grasses was exceeded in 2013 and 2014, as indicated by the difference between the first and last month forage masses previously shown. However, greater summer growth by the native grasses in 2015 and delayed grazing in 2016 prevented that level of utilization in 2016, even to a level categorized as light grazing [14,15]. This also was partially due to not finding a large enough group of uniform cattle of similar weights to the first two years at the sale barn to stock native grass pastures that year and to maintain at least six animals in every pasture.

3.3. Monthly Animal Average Daily Gains

Data and results of statistical analysis for monthly individual animal ADG are presented in Table 3. As with the monthly forage mass data, ADG data were statistically analyzed by year due to the difference in the number of months grazed. There was no difference between pastures for ADG in 2013. Differences among months were observed in both 2014 and 2016 since ADG was less in the first month than in later months (Table 3). This reduced performance in the first month may be due to acclimation effects of transporting cattle to a new environment (climate/elevation/pasture species composition), and may be associated with the lack of difference between pastures in 2013 when grazing took place for only one month. Reduced performance in the first month after changing environments has been observed in other studies at this location, especially when moving cattle to a pasture of greater nutritive value than they previously grazed (L. Lauriault, unpublished data).

Despite the low initial ADG, differences existed between pasture types in 2014 and 2016, with the triticale pastures providing greater ADG in both years than native grass pastures (Table 3). In the analysis by year for 2014 for monthly ADG, the pasture × month interaction also was significant since, while triticale provided greater ADG than native grass in the first two months, there was no difference in the third month (Figure 1).

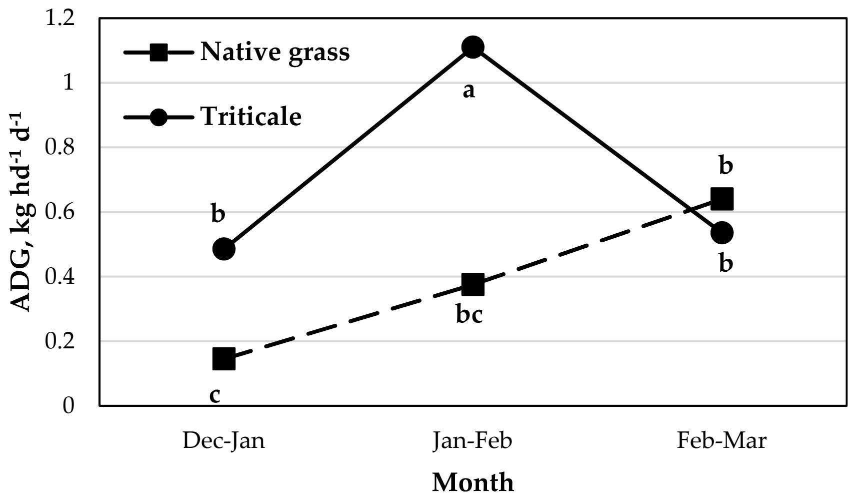

Figure 1. The pasture × month interaction for average daily gain (ADG) of stocker cattle grazing supplemented dormant native grass or triticale in 2014 at Tucumcari, NM, USA. For months on the x-axis, Dec-Jan, Jan-Feb, and Feb-Mar represent 20 December 2013 to 15 January 2014; 15 January to 12 February 2014; and 12 February to 14 March 2014, respectively. Values are the means of two pasture replicates. Letters indicate significant differences among all means in the interaction at $p = 0.05$ (standard error of the difference between means in the interaction = 0.13).

The steady increase in ADG for native grass across all months and for triticale in the first two months may be due to acclimation to the new environment. For 2013 and 2014 of the present study, cattle were moved from dormant native grass to the study site, which indicates little diet change for those grazing native grass, but a dramatic diet change for those moving onto triticale, which may partially explain the difference observed for the first two months of 2014 (Figure 1). The decline for triticale in the third month may be due to the limited forage mass of that forage, although the pasture × month interaction was not significant for forage mass that year (Table 3). While high-quality forage increases ADG across a wide range of quantities, animal growth declines when forage mass of cool-season annual forages drops below about 1100 kg DM ha^{-1} [7,12]. This does not particularly pertain to tufted native shortgrasses in semiarid regions, such as those grazed in the present study, as cattle grazing those species adapt to much lower levels of forage mass [7,14] poised on tussocks, as that improves accessibility by providing dense feeding stations isolated by surrounding open areas. The lack of any interaction for 2013 and 2016 is likely due to limited initial forage mass for both pasture types in 2013, and somewhat unlimited forage mass for both pasture types throughout the grazing season in 2016 (Table 3).

Differences are common among studies and years in animal grazing days and ADG due to forage mass and precipitation [24,27] (or irrigation), as well as foraging species, fertility, and other management factors [25]. Myer et al. [11] reported greater ADG by cattle grazing triticale than when grazing cereal rye, while Mullenix et al. [12] found that triticale had lower ADG than wheat or annual ryegrass (*Lolium multiflorum* Lam.). Using put-and-take management controlled by available forage mass under continuous stocking, Dubeux et al. [24] reported total seasonal animal production was similar among annual ryegrass mixtures with oat (*Avena sativa*), cereal rye, and triticale, despite different seasonal growth patterns. Myer et al. [11] also reported no difference between triticale and cereal rye in growing cattle carrying capacity.

3.4. Grazing period Total Animal Gain andAverage Daily Gains

Grazing period individual animal gain and ADG data statistically analyzed across years are presented in Table 4.

Table 4. Grazing period total and season mean average daily gain (ADG) of growing beef cattle grazing native grass or triticale pastures grazed during the late winters of 2013, 2014, and 2016 [1] at Tucumcari, NM USA. Values are the means of two pasture replicates within each year.

	Year				Pasture			*p*-Values		
Variable	**2013**	**2014**	**2016**	**SED** [2]	**Native Grass**	**Triticale**	**SED**	**Year**	**Pasture**	**Year × Pasture**
Grazing days	30	84	59							
Total gain, kg animal^{-1}	22c [3]	50a	36b	3	24	48	2	0.0001	<0.0001	0.0013
ADG, kg d^{-1}	0.62a	0.34b	0.64a	0.05	0.36	0.70	0.04	0.0016	0.0001	0.0021

[1] Grazing took place from 13 February to 20 March 2013, 20 December 2013 to 14 March 2014, and 21 January to 14 March 2016. [2] SED signifies standard error of the difference between means for the treatment effect. [3] Year means within a row followed by similar letters are not significantly different at $p = 0.05$.

For both variables, the year, pasture, and year × pasture effects were significant (Table 4), and the interactions are shown in Table 5.

Table 5. The year × pasture interaction for grazing period [1] total gain and average daily gain of growing beef stockers grazing supplemented dormant native grass, or triticale in three late-winter periods at Tucumcari, NM, USA. Values are the means of two pasture replicates.

Pasture	**2013**		**2014**		**2016**	
Grazing Days	**30**		**84**		**59**	
Grazing period gain, kg animal^{-1}, SED [2] = 4						
Native grass	20	d [3]	35	c	16	d
Triticale	24	d	65	a	56	b
Season mean average daily gain, kg hd^{-1} d^{-1}, SED = 0.04						
Native grass	0.55	bc	0.24	e	0.29	de
Triticale	0.68	b	0.45	cd	0.99	a

[1] Grazing took place from 13 February to 20 March 2013, 20 December 2013 to 14 March 2014, and 21 January to 14 March 2016. [2] SED signifies standard error of the difference between means. [3] Letters indicate significant differences among means within an interaction at $p = 0.05$.

For grazing period gain, there was no difference in 2013, while triticale provided greater gains than supplemented native grass in 2014 and 2016. The difference in gain for native grass in 2013 and 2014 and triticale in all three years is likely due to the number of months grazed each year (1, 4, and 2 months for 2013, 2014, and 2016, respectively). Capitan et al. [5], from research conducted previously at the same location as the present study, reported a year × forage interaction for grazing period ADG (0.15 versus 0.04 kg hd^{-1} d^{-1} in year 1 and 0.16 versus 1.11 kg hd^{-1} d^{-1} in year 2 for stocker cattle grazing native grass and winter wheat each year, respectively). The differences in ADG in that study were due to greater wheat available forage mass in late winter and spring of year 2 driven by winter precipitation [5]. The fact that the gains in this study by animals grazing native grass in 2016 were not greater than when they grazed native grasses for half the amount of time in 2013 is not well understood, but it could be due to the protein supplement used in 2013 vs. 2014 and 2016 and their influence on ADG (Table 5). A 240 g kg^{-1} protein molasses tub was available for ad libitum feeding in 2013, while a 200 g kg^{-1} cube was fed three times per week in 2014 and 2016, based on the stockers' body weight and requirement for growth. At any rate, only in 2013 was the target ADG of 0.5 kg hd^{-1} d^{-1} [16] attained by stockers grazing native grass, despite a much lesser rate of CP supplement consumption, while 0.5 kg hd^{-1} d^{-1} gains were made, or nearly so by those grazing triticale in all years (Table 5) without supplementation.

The ADG in the present study is less than that measured by others [5,28] for stockers grazing winter wheat with unlimited forage mass, but greater than that measured by those authors for animals grazing either dormant native warm-season grasses with a protein supplement or winter wheat with limited forage mass. Both of those studies [5,28] found that low ADG when weanling growth was restricted in the winter grazing period led to greater feed efficiency in the next feeding period (summer grazing or finishing), compared to animals fed for unrestricted growth during winter.

Tilhou et al. [6] stated that even low rates of voluntary intake by livestock grazing dormant PWSG could offset the cost of more expensive feed sources, resulting in economic returns. In this region, the inputs, planting, and irrigating costs for winter cereals is approximately 586 USD ha^{-1}, while protein supplement is 19.17 USD hd^{-1} yr^{-1} for yearling cattle [29]. Autumn and winter growth of winter cereals is usually less than spring growth, leading to reduced stocking rates until late winter [8]. Therefore, the opportunity to purchase stocker calves in autumn is often limited by insufficient growth of winter cereals [21]. Nevertheless, winter cereals can still provide valuable forage from Dec–Feb to fill the gap between autumn and spring [26]. Lauriault et al. [30] suggested that using warm-season annual grass forages, such as pearl millet (*Pennisetum glaucum* (L.) R. Br.), could provide adequate nutrition for growing cattle during the frost-prone autumn, allowing winter cereals to accumulate greater biomass for winter pasture. Alternatively, when dormant native grass is available in autumn, perhaps cattle growers could use that first and provide required supplementation, but at a lesser rate per animal due their lesser body weights, thereby saving on supplementation cost. Delaying grazing of winter cereal forages until the dormant grass is utilized to a specified level also would allow the cereals to increase initial forage mass, at which time the supplementation could end due to the greater nutritive value of the actively growing winter cereals, which also would promote compensatory gain [5,28].

In summary, forage mass of triticale and native grasses for grazing during the late winter period were largely influenced by summer through spring and spring through autumn precipitation, respectively. Otherwise, late winter ADG by stockers grazing triticale was approximately twice that of similar cattle grazing dormant native grass with protein supplementation. To save on supplementation costs, stocker operators could have cattle utilize dormant native grass in autumn and early winter providing supplementation, based on the cattle's lesser body weights. This also would allow deferred grazing of winter cereals to increase initial forage mass and avoid supplementation when body weights are greater and achieve compensatory gain for spring sales when yearling cattle prices are greater [8]. Finally, based on consistently lesser ADG in the first month of grazing each year compared to subsequent months, acclimation to a new environment and pasture type by grazing cattle may take up to a month. This acclimation period should be a consideration for grazing research, but stocker operators also should understand the likelihood of initial reduced animal performance.

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