Winter-annual pasture as a supplement for beef cows

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ABSTRACT: In each of two experiments, 120 pregnant beef cows were stratified by body condition score, BW, breed, and age, randomly divided into six groups of 20, and assigned to one of six 5.1-ha bermudagrass (Cynodon dactylon [L.] Pers.) pastures (two replicates/treatment) in early January to evaluate the use of winter-annual pasture as a supplement. All cows in Exp. 1 and 2 had ad libitum access to bermudagrass/dallisgrass (Paspalum dilatatum Poir.) hay plus three treatments: 1) a concentrate-based supplement fed 3 d/wk, 2) limit grazing on winter-annual pasture 2 d/wk (7 hr/d; 0.04 ha/cow grazing d−1), or 3) limit grazing on winter-annual pasture 3 d/wk (7 hr/d; 0.04 ha · cow−1 · grazing d−1) sod-seeded into a portion of the pasture until mid-May. The seeded portion of pastures in Exp. 1 was planted with a mixture of wheat (Triticum aestivum L.) and rye (Secale cereale L.), but annual ryegrass (Lolium multiflorum Lam.) was added to the seed mixture in Exp. 2. In mid-May, cows were blocked by treatment and the previous sorting factors, randomly assigned to six new groups of 20, and placed on the six perennial pastures until calves were weaned. Groups of cows were exposed to a bull for 60 d beginning in mid-May. In Exp. 1 and 2, limit-grazing winter-annual pasture compared to the concentrate-based supplement or limit grazing 2 vs 3 d/wk did not affect (P > 0.15) cow BW. In Exp. 1, cows limit grazed on winter-annual pasture had a lower (P = 0.05) body condition score than cows fed the concentrate-based supplement in the early spring. However, in Exp. 2, cows limit grazed on winter-annual pasture had higher (P ≤ 0.07) body condition score than cows fed the concentrate-based supplement. The conception rate of cows in Exp. 1 and 2 did not differ (P > 0.22) between cows fed concentrate-based supplements and cows limit grazed on winter-annual pasture. In Exp. 2, cows limit grazed 2 d/wk tended to have a greater (P = 0.10) conception rate than cows limit grazed 3 d/wk. In Exp. 1 and 2, birth weight, total gain, BW, and ADG of calves were not affected (P > 0.15) by treatment. We conclude that wheat and rye pasture is a marginal supplement for lactating beef cows. However, cows limit grazed 2 d/wk on winter-annual pasture of wheat, rye, and annual ryegrass as a supplement maintained BW and body condition score as well as cows fed the concentrate-based supplement. But, grazing pasture 3 vs 2 d/wk did not seem to affect performance of cows.

Key Words: Feed Supplements, Fodder Crops, Grasses, Grazing Systems, Supplemental Feeding Programs

Introduction

Decreasing stored feed requirements of beef cows is a topic that has received considerable attention in recent years (White et al., 1989). However, beef cattle produc-
lum incarnatum L.) and arrowleaf (Trifolium vesico-
sum Savi) clover as a supplement to Argentine bahiagrass (Paspalum notatum Flugge) hay (DeRouen et al., 1991) demonstrated that winter-annual pasture grazing could decrease winter hay DMI by as much as 30% compared to bahiagrass hay plus a concentrate-based protein supplement.

In light of these facts, we designed a limit-grazing system that was intended to supplement gestating and lactating beef cows and decrease hay requirements. The following two studies evaluated the limit grazing of sod-seeded winter-annual pasture for 2 or 3 d/wk compared to traditional concentrate-based supplements.

Materials and Methods

All animal procedures in Exp. 1 and 2 were conducted in accordance with the recommendations of Consortium (1988) and were approved by the University of Arkansas Institutional Animal Care and Use Committee.

Experiment 1. On 6 January 1997, at the Southwest Research and Extension Center (33° 42′ N, 93° 31′ W), 120 pregnant cross-bred beef cows (average BW = 501 ± 10 kg) of mostly English (Angus and Hereford) and Continental (Simmental) breeding were weighed, body condition score (Wagner et al., 1988) was recorded, and a seven-way clostridial antigen (Vision 7; Bayer Corp., Shawnee Mission, KS) was administered to increase clostridial antibodies at calving (Clarkson et al., 1985). Cows were sorted into six groups of 20 stratified by body condition score, BW, breed, and age, and assigned to six 5.1-ha dormant common bermudagrass pastures until 14 May (two groups/treatment). Groups of cows remained in their assigned pasture all winter and had ad libitum access to hay plus one of the following three supplements beginning on 6 January: 1) fed a concentrate-based supplement (corn gluten feed; 21% CP, 75% TDN on a DM basis) 3 d/wk (Monday, Wednesday, and Friday; average, 0.56 kg of DM/cow daily), which was TDN on a DM basis) 3 d/wk (Monday, Wednesday, and Friday; average, 0.56 kg of DM/cow daily), which was estimated daily hay DMI/cow, quantities of hay offered in each pasture were corrected for wastage based on feeder type and the data of Buskirk et al. (2000) and then divided by the number of cows in each pasture. Chemical composition of the hay and supplement was determined at a commercial laboratory (Dairy One, Ithaca, NY); DM and CP were determined as described by AOAC (1990) and TDN was determined as described by Weiss et al. (1992).

Winter-annual paddocks were sod-seeded into a portion of 5.1-ha common bermudagrass pastures (1.7 ha in pastures limit grazed 2 d/wk and 2.6 ha in pastures limit grazed 3 d/wk) during the first week of October 1996. The seeding rate was 134 kg/ha of a 1:1 mixture (wt:wt) of ‘Elbon’ rye and ‘Hickory’ wheat (soft red) and was no-till drilled in the sod with a Tye Pasture Pleaser (Tye Company; Lockney, TX). Drilled portions of the pastures were fertilized with P and K 2 wk after planting based on soil test recommendations (Chapman, 1998) plus 55 kg of N/ha. Before planting, standing herbage mass was removed from the area by continuously stocking with cattle until the standing herbage mass was visually estimated to be < 5 cm to ensure that winter-annual grasses had minimal competition. In late-January and mid-March sod-seeded portions of pastures were fertilized with an additional 55 kg of N/ha using ammonium nitrate. The entire pastures were fertilized with 55 kg of N/ha using ammonium nitrate in late May, late June, and early August.

On 14 May, the cows were resorted into six new groups stratified by the preceding four sorting factors plus the winter supplementation treatments. The six new groups of cows were allowed to graze six 5.1-ha tall fescue (Festuca arundinacea Schreb.) pastures until 19 June, when they were returned to the previous bermudagrass pastures until 30 September. From 14 May until 14 July (60 d), six Angus bulls that had passed a breeding soundness examination remained with the cows, one bull per group. The grazing management used when the cows grazed tall fescue and bermudagrass pastures in the summer was continuous stocking because previous research at the Southwestern Research & Extension Center showed no benefits to lactating cows or nursing calves when rotationally grazing bermudagrass pasture compared to continuous-stocking bermudagrass pasture (Brown et al., 1997). Cows always had ad libitum access to a self-fed commercial mineral mixture (Vigortone 32S; PM Ag Products, Inc., Cedar Rapid, IA; Ca, 13.5%; P, 7.0%; salt, 21.8%; Co, 18 ppm;
Winter-annual pasture for beef cows

Cubs, 1,250 ppm; I, 70 ppm; Mn, 1,198 ppm; Se, 26 ppm; Zn, 2,996 ppm; Vitamin A, 662,000 IU/kg; Vitamin D₃, 66,000 IU/kg; and Vitamin E, 221 IU/kg (as-fed).

Cows and calves were weighed and body condition scores of the cows were recorded on 1 April, 14 May, 19 June, 30 July, and 30 September. The morning after calving, calves were weighed, tattooed in both ears with an individual number, and male calves were surgically castrated. On 14 May, cows were treated for internal and external parasites (Ivomec; Merck & Co., Inc., Whitehouse Station, NJ), vaccinated with a seven-way clostridial antigen (Vision 7), and vaccinated for infectious bovine rhinotracheitis, bovine viral diarrhea, parainfluenza-3, bovine respiratory syncytial virus plus five strains of leptospirosis (Bovishield 4 + VL5; SmithKline Beecham Animal Health, Exton, PA). Cows were checked for pregnancy by rectal palpation on 30 September. Postpartum interval was calculated by subtracting 283 d from the calving date of the following year to estimate conception date.

The experiment was analyzed using PROC GLM (SAS Inst. Inc., Cary, NC) as a completely randomized design with the effect of treatment and the covariates of cow age and calving date in the model for data collected during the winter grazing period (Lentner and Bishop, 1986). In the ANOVA for data collected during the spring and summer after cows had been sorted into new groups, the effect of summer pasture was added to the model as a block (Lentner and Bishop, 1986). Because each pasture of cows during the winter grazing period was considered an experimental unit, treatment effects were tested using pasture within treatment as the error term. One cow and two calves died during the study. The cow and calf were immediately replaced with a new group with the same number, and male calves were surgically castrated. The postpartum interval was calculated as described in Exp. 1.

Experiment 2. On 6 January 1998 (yr 1) and 12 January 1999 (yr 2), 120 pregnant cross-bred beef cows (average BW = 544 ± 13 and 565 ± 13 kg in yr 1 and 2, respectively) were weighed, body condition score was recorded (Wagner et al., 1988), and a seven-way clostridial antigen (Vision 7 in Yr 1; Vision 7 Somnus, in Yr 2; Bayer Corp.) was administered (Clarkson et al., 1985) as described in Exp. 1. Cows were sorted into six groups stratified by body condition score, BW, breed, and age. The six groups were kept separate all winter (two groups/treatment) in 5.1-ha dormant common bermudagrass pastures. Hay feeding and treatments began on the day of sorting and were the same as described in Exp. 1, except that the concentrate-based supplement was 33% corn and 67% corn gluten feed (17% CP; 80% TDN) and cows were fed 1.2 kg/animal daily. The bermudagrass/dallisgrass hay contained 9% CP and 56% TDN in yr 1, and 10% CP and 54% TDN in yr 2. Winter-annual paddocks were sod-seeded into a portion of 5.1-ha common bermudagrass pastures during the first week of October in both years as described in Exp. 1. However, seeding rates were 134 kg/ha of an 1:1 mixture (wt:wt) of ‘Koolgrazer’ rye and wheat (‘Hickory’ in yr 1; variety not specified in yr 2) no-till drilled in the sod, and 22 kg of ‘Marshall’ annual ryegrass/ha no-till drilled perpendicular to the cereal grain rows. Pastures were prepared for planting, fertilizer was applied, hay was fed, supplement and hay was analyzed, daily hay DMI was estimated, and self-fed minerals mixes were provided as described in Exp. 1.

On 23 April (yr 1) and 28 April (yr 2), the cows were sorted again before breeding and placed in six different new groups stratified by the preceding sorting factors plus the winter supplementation treatments. Each new group was allowed to graze an entire 5.1-ha common bermudagrass pasture until 11 September (yr 1) and 5 October (yr 2) using continuous stocking (Brown et al., 1997). In yr 1/2 May until 2 July and yr 2 (3 May until 3 July), six Angus bulls that had passed a breeding soundness examination were placed with the cows, one bull per group.

Cows and calves were weighed and body condition score of the cows was recorded on 1 April, 23 April, 2 June, 23 July, and 11 September in yr 1 and on 30 March, 28 April, 25 May, 29 June, 3 August, and 5 October in yr 2. At calving in both years, calves were weighed, tattooed in both ears with an individual number, and male calves were surgically castrated. On 14 May (yr 1) and 25 May (yr 2), cows were processed including treatment for internal and external parasites (Ivomec in yr 1; Cydectin; Fort Dodge Animal Health; Overland Park, KS in yr 2), and vaccination with a seven-way clostridial antigen (Vision 7 Somnus) and infectious bovine rhinotracheitis, bovine viral diarrhea, parainfluenza-3, bovine respiratory syncytial virus plus five strains of leptospirosis (Bovishield 4 + VL5; SmithKline Beecham Animal Health, in yr 1; Triangle 4 + PH-K and TriVib L5; Fort Dodge Animal Health in yr 2). Cows were checked for pregnancy by rectal palpation on 11 September (yr 1) and 5 October (yr 2). Postpartum interval was calculated as described in Exp. 1.

Body weight of cows and calves and cow body condition score data were analyzed by year because sampling dates were different between years. These data were analyzed using PROC GLM (SAS Inst. Inc.) as a completely randomized design with the effect of treatment and the covariates, cow age and calving date, in the model for data collected during the winter grazing period (Lentner and Bishop, 1986). For data collected during the spring and summer grazing period, the effect of pasture was added to the model as a block (Lentner and Bishop, 1986). Groups of cows during the winter grazing period were the experimental units, so the treatment effects were tested with pasture within treatment as the error term. Cow body condition score at
Table 1. Body weight, body condition score (BCS), BCS at calving, conception rate, postpartum interval, and hay DMI of mature beef cows fed bermudagrass/dallisgrass hay supplemented by limit grazing on wheat and rye pasture 2 or 3 d/wk or by feeding a concentrate-based supplement (Exp. 1)

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatmenta</th>
<th>P-valueb</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SUPP 2DW 3DW</td>
<td>S vs. G 2 vs 3</td>
</tr>
<tr>
<td>Cow BW, kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>January 6</td>
<td>509 494 505</td>
<td>10.0 0.48 0.52</td>
</tr>
<tr>
<td>April 1</td>
<td>468 462 470</td>
<td>9.3 0.83 0.55</td>
</tr>
<tr>
<td>May 14</td>
<td>498 467 488</td>
<td>9.5 0.16 0.21</td>
</tr>
<tr>
<td>June 19</td>
<td>468 454 474</td>
<td>9.0 0.71 0.22</td>
</tr>
<tr>
<td>July 30</td>
<td>562 486 502</td>
<td>10.7 0.56 0.38</td>
</tr>
<tr>
<td>September 30</td>
<td>507 494 504</td>
<td>9.6 0.56 0.53</td>
</tr>
<tr>
<td>Cow BCSc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>January 6</td>
<td>5.3 5.2 5.3</td>
<td>0.11 0.58 0.46</td>
</tr>
<tr>
<td>April 1</td>
<td>4.6 4.6 4.5</td>
<td>0.04 0.41 0.17</td>
</tr>
<tr>
<td>May 14</td>
<td>4.6 4.1 4.3</td>
<td>0.11 0.04 0.41</td>
</tr>
<tr>
<td>June 19</td>
<td>4.5 4.7 5.0</td>
<td>0.08 0.05 0.11</td>
</tr>
<tr>
<td>July 30</td>
<td>5.0 4.9 5.0</td>
<td>0.07 0.78 0.37</td>
</tr>
<tr>
<td>September 30</td>
<td>5.9 5.9 5.8</td>
<td>0.07 0.54 0.24</td>
</tr>
<tr>
<td>BCS at calving</td>
<td>4.7 4.7 4.7</td>
<td>0.11 0.86 0.99</td>
</tr>
<tr>
<td>Conception rate, %</td>
<td>91 81 78</td>
<td>6.9 0.23 0.74</td>
</tr>
<tr>
<td>Postpartum interval, d</td>
<td>92 90 88</td>
<td>3.01 0.49 0.67</td>
</tr>
<tr>
<td>Hay DMI, kg/d</td>
<td>11.7 10.2 10.3</td>
<td>0.37 0.05 0.89</td>
</tr>
</tbody>
</table>

aSUPP = supplemented with corn gluten feed fed 3 d/wk; 2DW = limit grazed sod-seeded winter-annual pasture 2 d/wk, 3DW = limit grazed sod-seeded winter-annual pasture 3 d/wk from January until May.

bContrasts: S vs G = SUPP vs 2DW and 3DW; 2 vs 3 = 2DW vs 3DW.

cBody condition score range, 1 to 9; 1 = emaciated, 9 = obese (Wagner et al., 1988).

calving, conception rate, postpartum interval, hay DMI, calf birth weight, calf total gain, and 205-adjusted BW data were analyzed using PROC GLM (SAS Inst. Inc.) as a completely randomized design with the effect of treatment, year, and treatment × year and the covariates, cow age and calving date, in the model (Lentner and Bishop, 1986), and the treatment effects were tested with pasture within treatment × year as the error term. Birth date (Julian date) was analyzed similarly to the preceding model except calving date was not used as a covariate, after analysis dates were converted to the Gregorian date for presentation in the text. One cow and three calves died in yr 1, and two cows and one calf died in yr 2 during the studies. The affected cows and calves were immediately replaced with a spare cow-calf pair to equalize stocking rate; however, the data from spares were not used in the statistical analysis. Least-square means were separated using the following contrasts: 1) concentrate-based supplement vs limit grazed and 2) limit grazed 2 vs 3 d/wk (Steel and Torrie, 1980).

Results and Discussion

Cow performance. In Exp. 1, BW did not differ between cows supplemented with corn gluten feed and cows limit grazed on winter-annual pasture on any date (Table 1). Also, BW did not differ between cows limit grazed on winter-annuals pasture 2 or 3 d/wk on any date. In Exp. 2, during both years, BW did not differ between cows supplemented with a concentrate-based supplement and cows limit grazed on winter-annual pasture or between cows grazed on winter-annuals pasture 2 or 3 d/wk (Table 2). Other research has reported that cows fed warm-season hay and continuously stocked on sod-seeded winter-annual pasture maintained a heavier BW than cows fed a protein supplement (Hill et al., 1985; DeRouen et al., 1991). In contrast, Utley and McCormick (1978) and Bagley et al. (1987) reported that BW did not differ (P > 0.05) between cows fed supplemented hay and cows with limited access to winter-annual pasture. Researchers examining the use of high-quality hay (15% CP; 61% TDN) as a supplement for beef cows grazing western Nebraska rangeland reported that these forages were as effective as concentrate-based supplements in maintaining cow BW (Villalobos et al., 1997). Because no differences in BW existed between cows on the 2 d/wk and 3 d/wk grazing of winter-annual pasture in both experiments, 2 d/wk seems adequate to supplement mature beef cows during gestation and lactation.

In Exp. 1, body condition score on 6 January, 1 April, 30 July, and 30 September did not differ between cows supplemented with corn gluten feed and cows limit grazed on winter-annual pasture (Table 1). On 14 May at the beginning of the breeding season, cows limit grazed on wheat and rye pasture had a lower (P = 0.04) body condition score than cows supplemented with corn gluten feed. We also noted that winter-annual pasture comprised of wheat and rye matured early in the grazing season (early April; personal observation), and there did not seem to be sufficient grass for grazing at
Table 2. Body weight, body condition score (BCS), BCS at calving, conception rate, postpartum interval, and hay DMI of beef cows fed bermudagrass hay supplemented by limit grazing on winter-annual pasture 2 or 3 d/wk or by feeding a concentrate-based supplement (Exp. 2)

<table>
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<tr>
<th>Item</th>
<th>Treatmenta</th>
<th>P-valueb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td>SUPP 2DW 3DW SE</td>
<td>S vs G 2 vs 3</td>
</tr>
<tr>
<td>Cow BW in yr 1, kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>January 6</td>
<td>541 545 546 13.6</td>
<td>0.81 0.93</td>
</tr>
<tr>
<td>April 1</td>
<td>518 522 526 12.2</td>
<td>0.74 0.85</td>
</tr>
<tr>
<td>April 23</td>
<td>507 515 530 16.1</td>
<td>0.49 0.55</td>
</tr>
<tr>
<td>June 2</td>
<td>505 514 521 8.5</td>
<td>0.29 0.63</td>
</tr>
<tr>
<td>July 23</td>
<td>510 513 510 12.9</td>
<td>0.94 0.86</td>
</tr>
<tr>
<td>September 11</td>
<td>523 528 529 13.7</td>
<td>0.73 0.95</td>
</tr>
<tr>
<td>Cow BW in Yr 2, kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>January 12</td>
<td>568 562 564 13.3</td>
<td>0.79 0.93</td>
</tr>
<tr>
<td>March 30</td>
<td>555 549 521 13.6</td>
<td>0.60 0.73</td>
</tr>
<tr>
<td>April 28</td>
<td>548 542 549 13.4</td>
<td>0.88 0.72</td>
</tr>
<tr>
<td>May 25</td>
<td>543 533 541 13.2</td>
<td>0.74 0.71</td>
</tr>
<tr>
<td>June 29</td>
<td>541 529 538 14.6</td>
<td>0.67 0.70</td>
</tr>
<tr>
<td>August 3</td>
<td>544 536 540 11.8</td>
<td>0.69 0.83</td>
</tr>
<tr>
<td>October 5</td>
<td>541 534 536 12.8</td>
<td>0.73 0.94</td>
</tr>
<tr>
<td>BCS in yr 1c</td>
<td></td>
<td></td>
</tr>
<tr>
<td>January 6</td>
<td>6.2 6.2 6.2 0.11</td>
<td>0.70 0.98</td>
</tr>
<tr>
<td>April 1</td>
<td>6.7 6.6 6.7 0.09</td>
<td>0.41 0.17</td>
</tr>
<tr>
<td>April 23</td>
<td>6.1 6.7 6.7 0.11</td>
<td>0.02 0.69</td>
</tr>
<tr>
<td>June 2</td>
<td>5.9 6.2 6.3 0.07</td>
<td>0.05 0.25</td>
</tr>
<tr>
<td>July 23</td>
<td>6.3 6.5 6.3 0.02</td>
<td>0.02 0.02</td>
</tr>
<tr>
<td>September 11</td>
<td>5.9 6.0 6.1 0.05</td>
<td>0.12 0.09</td>
</tr>
<tr>
<td>BCS in yr 2</td>
<td></td>
<td></td>
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<tr>
<td>January 12</td>
<td>6.2 6.3 6.4 0.06</td>
<td>0.21 0.15</td>
</tr>
<tr>
<td>March 30</td>
<td>6.6 7.0 7.0 0.13</td>
<td>0.07 0.96</td>
</tr>
<tr>
<td>April 28</td>
<td>6.2 6.3 6.4 0.09</td>
<td>0.44 0.28</td>
</tr>
<tr>
<td>May 25</td>
<td>6.5 6.5 6.7 0.08</td>
<td>0.51 0.12</td>
</tr>
<tr>
<td>June 29</td>
<td>6.7 6.6 6.6 0.04</td>
<td>0.22 0.29</td>
</tr>
<tr>
<td>August 3</td>
<td>6.4 6.4 6.6 0.03</td>
<td>0.05 0.03</td>
</tr>
<tr>
<td>October 5</td>
<td>6.2 6.1 6.2 0.12</td>
<td>0.67 0.54</td>
</tr>
<tr>
<td>BCS at calving, %</td>
<td>92 93 85 3.0</td>
<td>0.36 0.10</td>
</tr>
<tr>
<td>Conception rate, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postpartum interval, d</td>
<td>72 72 71 1.6</td>
<td>0.51 0.97</td>
</tr>
<tr>
<td>Hay DMI, kg/d</td>
<td>11.5 9.9 9.9 0.24</td>
<td>0.02 0.25</td>
</tr>
</tbody>
</table>

aSUPP = supplemented with a mixture of corn (33%) and corn gluten feed (67%) fed 3 d/wk; 2DW = limit grazing sod-seeded winter-annual pasture (wheat, rye, and annual ryegrass) 2 d/wk, 3DW = limit grazing sod-seeded winter-annual pasture 3 d/wk from January until May. 

bContrasts: S vs G = SUPP vs 2DW and 3DW; 2 vs 3 = 2DW vs 3DW.

cBody condition score, range 1 to 9; 1 = emaciated, 9 = obese (Wagner et al., 1988).

A time when nutrient requirements would be highest (peak lactation; NRC, 1996). We hypothesized that if annual ryegrass was added to the winter-annual pasture to extend the grazing season until bermudagrass pasture was available, cow body condition score might be maintained (Utley et al., 1976; Hoveland et al., 1978). On 19 June after cows had grazed tall fescue for 36 d, the body condition score of cows that had been limit grazed on winter-annual pasture was higher ($P = 0.05$) than cows that had been supplemented with corn gluten feed. The body condition score of cows limit grazed on winter-annual pasture 2 or 3 d/wk did not differ on all dates.

In yr 1 of Exp. 2, body condition score did not differ between cows supplemented with a concentrate and cows limit grazed on winter-annual pasture on 6 January and 1 April (Table 2). But on 23 April, 3 June, and 23 July, cows limit grazed on winter-annual pasture had a greater ($P \leq 0.05$) body condition score than cows supplemented with concentrate. However, on 11 September, body condition score did not differ between cows limit grazed on winter-annual pasture compared to cows supplemented with concentrate. The body condition score of cows limit grazed on winter-annual pasture 2 or 3 d/wk did not differ on and between 6 January and 2 June. However, on 23 July, the body condition score of cows that had been limit grazed 3 d/wk was lower ($P = 0.02$) than cows limit grazed 2 d/wk. On 11 September, the body condition score of cows that had been limit grazed 3 d/wk tended to be greater ($P = 0.09$) than cows limit grazed 2 d/wk. In yr 2 of Exp. 2, body condition score on 12 January, 28 April, and 29 June did not differ between cows supplemented with concentrate and cows limit grazed on winter-annual pasture (Table 2).
2). On 30 March and 3 August, cows limit grazed on winter-annual pasture tended to have a greater \( (P \leq 0.07) \) body condition score than cows supplemented with concentrate. Similarly, Villalobos et al. (1997) reported that in cows grazing dormant Nebraska Sandhills rangeland, supplementing with high-quality hay improved body condition score of lactating cows compared to providing concentrate-based supplements. The body condition score of cows limit grazed on winter-annual pasture 2 or 3 d/wk did not differ on and between 12 January and 29 June. On 3 August, the body condition score of cows that had been limit grazed 3 d/wk was greater \( (P = 0.03) \) than cows limit grazed 2 d/wk. But, on 5 October the body condition score of cows that had been limit grazed 3 d/wk did not differ from cows limit grazed 2 d/wk.

In Exp. 1, conception rates and postpartum intervals did not differ among cows supplemented with corn gluten feed and cows limit grazed on winter-annual pasture, but the conception rates of cows limit grazed on winter-annual pasture were numerically less (Table 1). The cows limit grazed on winter-annual pasture had lower \( (P = 0.04) \) body condition score at the beginning of the breeding season on 14 May compared to cows supplemented with corn gluten feed. Research into the effects of body condition score on conception rates during a controlled breeding season has shown that decreasing body condition score before the breeding season has a negative affect on conception rates (Selk et al., 1988; DeRouen et al., 1994). In Exp. 1, the conception rates and postpartum intervals did not differ between cows limit grazed on winter-annual pasture 2 or 3 d/wk.

In Exp. 2, the effect of treatment on body condition score at calving, conception rate, and postpartum interval did not interact \( (P > 0.22) \) with year; therefore, data are presented by treatment means across years (Table 2). Body condition scores at calving did not differ between cows supplemented with concentrate and cows limit grazed on winter-annual pasture. However, the body condition score of cows limit grazed on winter-annual pasture 2 d/wk tended to be greater \( (P = 0.10) \) than with cows limit grazed 3 d/wk. Conception rates did not differ between cows supplemented with concentrate and cows limit grazed on winter-annual pasture. Other researchers also reported that conception rate did not differ \( (P > 0.05) \) between cows fed bermudagrass hay and cows fed bermudagrass hay with access to winter-annual pasture (Utley and McCormick, 1978; Hill et al., 1985; Bagley et al., 1987). Supporting these results, DeRouen et al. (1991) reported that cows fed bahiagrass hay and continuously stocked on sod-seeded winter-annual pasture did not differ \( (P > 0.05) \) in conception rate from cows maintained on bahiagrass hay plus a protein supplement. Conception rates for cows limit grazed on winter-annual pasture 3 d/wk tended \( (P = 0.10) \) to be lower than for cows limit grazed 2 d/wk. Research has demonstrated that high plasma urea nitrogen concentrations \( (> 16.5 \text{ mg/100 mL}; \text{Kaim et al., 1983; Elrod and Butler, 1993}) \) resulting from high dietary CP concentrations inhibit fertility in Holstein heifers regardless of ruminal degradable protein concentration in the diet (Elrod et al., 1993). We did not estimate total CP concentration in diets consumed by cows in our study; however, cows limit grazing on winter-annual pasture 3 d/wk should have consumed a diet high in CP concentration considering that winter-annual grasses often exceed 16% CP on a DM basis (West et al., 1988). The postpartum interval did not differ between cows supplemented with concentrate and those limit grazed on winter-annual pasture, or between cows limit grazed on winter-annual pasture 2 or 3 d/wk.

In Exp. 1, hay DMI by cows (Table 1) was decreased \( (P = 0.05) \) 12.4% by limit grazing on winter-annual pasture compared to supplementing with corn gluten feed. However, hay DMI was not affected by limit grazing on winter-annual pasture 3 vs 2 d/wk. In Exp. 2 (Table 2), hay DMI was 13.9% lower \( (P = 0.02) \) in cows limit-grazing winter-annual pasture than in cows supplemented with concentrate, but DMI was not affected \( (P = 0.25) \) by limit-grazing winter-annual pasture 3 compared to 2 d/wk. Based on the chemical composition and daily hay DMI for cows fed concentrate-based supplements, this forage supplied 6.6 kg of TDN and 1.3 kg of CP per cow daily in Exp. 1. In Exp. 2, the hay DMI of concentrate-based supplemented cows supplied 6.3 kg of TDN and 1.1 kg of CP daily. The NRC (1996) requirements indicate that, during the first 3 mo of lactation, the cows in Exp. 1 required 0.9 kg of supplemental TDN and 0.2 kg of supplemental CP (the concentrate-based supplement supplied 0.5 kg of TDN and 0.1 kg of CP daily); however, in Exp. 2 the supplemental requirement for TDN was 1.7 kg and for CP was 0.3 kg (the concentrate-based supplement supplied 1.0 kg of TDN and 0.2 kg of CP daily). Hay DMI was decreased by limit-grazing winter-annual pasture in Exp. 1 and 2. In Exp. 1, the body condition score of cows was lower \( (P < 0.05) \) during lactation compared to the concentrate-based supplement, suggesting that the winter-annual pasture was supplying less supplemental TDN and CP than the cows required. To the contrary, in Exp. 2 the body condition score of cows grazing the annual forage were higher \( (P < 0.05) \) during lactation than cows fed the concentrate-based supplement (Table 2), suggesting that the winter-annual pasture was supplying more supplemental TDN and CP than the cows required. Other research reported that hay DMI was an average of 21.8% greater in cows fed warm-season grass hay alone than in cows fed warm-season grass hay with limited access to winter-annual pasture (Bagley et al., 1987; DeRouen et al., 1991). When high-quality grass hay was fed as a supplement for beef cows grazing dormant rangeland, range forage intake was 12.9% lower \( (P < 0.05) \) than when cows were supplemented with a 36.0% CP grain-based supplement (Villalobos et al., 1997). No differences were recorded in hay DMI of cows grazing winter-annual forage 2 vs 3 d/wk.
Table 3. Birth weight, body weight, total BW gain, and ADG of calves nursing mature beef cows fed bermudagrass/dallisgrass hay supplemented by limit grazing on wheat and rye pasture 2 or 3 d/wk or by feeding a concentrate-based supplement (Exp. 1)

<table>
<thead>
<tr>
<th>Item</th>
<th>SUPP</th>
<th>2DW</th>
<th>3DW</th>
<th>SE</th>
<th>P-value&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight, kg</td>
<td>34</td>
<td>36</td>
<td>37</td>
<td>0.9</td>
<td>0.12</td>
</tr>
<tr>
<td>Calf BW, kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.49</td>
</tr>
<tr>
<td>April 1</td>
<td>61</td>
<td>61</td>
<td>64</td>
<td>1.0</td>
<td>0.15</td>
</tr>
<tr>
<td>May 14</td>
<td>96</td>
<td>95</td>
<td>101</td>
<td>1.3</td>
<td>0.36</td>
</tr>
<tr>
<td>June 19</td>
<td>125</td>
<td>121</td>
<td>129</td>
<td>2.7</td>
<td>0.96</td>
</tr>
<tr>
<td>July 30</td>
<td>167</td>
<td>164</td>
<td>168</td>
<td>3.2</td>
<td>0.76</td>
</tr>
<tr>
<td>September 30</td>
<td>211</td>
<td>206</td>
<td>210</td>
<td>4.5</td>
<td>0.63</td>
</tr>
<tr>
<td>Total gain, kg</td>
<td>176</td>
<td>169</td>
<td>173</td>
<td>4.2</td>
<td>0.39</td>
</tr>
<tr>
<td>ADG, kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.59</td>
</tr>
<tr>
<td>Birth to May 14 (75 d)</td>
<td>0.81</td>
<td>0.77</td>
<td>0.84</td>
<td>0.03</td>
<td>0.87</td>
</tr>
<tr>
<td>May 14 to September 30 (139 d)</td>
<td>0.82</td>
<td>0.80</td>
<td>0.78</td>
<td>0.03</td>
<td>0.33</td>
</tr>
<tr>
<td>Birth to September 30 (214 d)</td>
<td>0.82</td>
<td>0.79</td>
<td>0.81</td>
<td>0.02</td>
<td>0.39</td>
</tr>
</tbody>
</table>

<sup>a</sup>SUPP = supplemented with corn gluten feed fed 3 d/wk; 2DW = limit grazed sod-seeded winter-annual pasture 2 d/wk; 3DW = limit grazed sod-seeded winter-annual pasture 3 d/wk from January until May.

<sup>b</sup>Contrasts: S vs G = SUPP vs 2DW and 3DW; 2 vs 3 = 2DW vs 3DW.

Calf performance. In Exp. 1, birth date of calves did not differ (<i>P = 0.31</i>) between cows supplemented with corn gluten feed and cows limit grazed on winter-annual pasture, or cows limit grazed 2 or 3 d/wk (<i>P = 0.46</i>; average birth date 28 February ± 2.3 d). Birth weight and BW of calves (Table 3) born to cows limit grazed on winter-annual pasture and cows supplemented with corn gluten feed did not differ and calf birth weight did not differ between cows limit grazed either 2 or 3 d/wk. On 1 April, BW of calves from cows limit grazed 2 or 3 d/wk did not differ, but on 14 May the BW of calves from cows limit grazed 3 d/wk was greater (<i>P = 0.04</i>) than for calves from cows limit grazed 2 d/wk. On and between 19 June and 30 September, the BW of calves from cows limit grazed 3 vs 2 d/wk did not differ. Total gain and ADG from birth until weaning did not differ for calves from cows supplemented with corn gluten feed and calves from cows limit grazed on winter-annual pasture and did not differ between calves from cows limit grazed on winter-annual pasture 2 or 3 d/wk. In Exp. 2, the effect of treatment on calf birth date, birth weight, total gain, and adjusted 205-d BW did not interact (<i>P > 0.52</i>) with year; therefore, data are presented by treatment across years (Table 4). The average birth date of calves from cows supplemented with concentrate-based supplement (5 March) and cows limit grazed on winter-annual pasture did not differ (<i>P = 0.63</i>). However, birth date of calves from cows limit grazed 2 d/wk (3 March) was 5 d earlier (<i>P = 0.03</i>) than for calves from cows limit grazed 3 d/wk (8 March; SE = 1.3). Birth weight, total gain, and adjusted 205-d BW of calves (Table 4) were not affected by treatment. Calf ADG and BW on or between April and weaning were not different for the three dietary treatments.

The lack of a treatment effect on calf BW noted in Exp. 1 and 2 is contrary to other research reporting a 7% or more greater weaning weight of calves nursing cows fed warm-season grass hay and continuously stocked on sod-seeded winter-annual pasture compared to calves nursing cows stocked on dormant pasture and fed warm-season grass hay plus a protein supplement (Utley and McCormick, 1978; Hill et al., 1985; DeRouen et al., 1991). There are two factors that may help explain differences among the foregoing studies and ours. First, the calves in our study had access to winter-annual pasture only when cows were allowed to graze (14 or 21 total h/wk), which would decrease forage allowance and may decrease forage intake by the calves (Redmond et al., 1995). The calves in the other studies had continual access to winter-annual pasture (Utley and McCormick, 1978; Hill et al., 1985; DeRouen et al., 1991). For example, Bagley et al. (1987) reported that calves nursing cows continuously stocked on winter-annual pasture had 11.7% greater (<i>P > 0.01</i>) adjusted 205-d BW than calves from cows not allowed access to winter-annual pasture. Second, calves in the study of DeRouen et al. (1991) that had an increase in growth as a result of grazing winter-annual pasture tended to be older (December through April calving dates) than the calves in our study (February through April calving dates), at the time when winter-annual pasture was most productive and at its highest quality. Nursing calves that had been artificially reared did not utilize large amounts of forage DM in their diet (<i>&lt; 1.8% of BW</i>) until they were 87 to 108 d of age (<i>&gt; 2.3% of BW</i> after 108 d; Broesder et al., 1990). Similarly, Anсотегу et al. (1991) reported that the largest increase (62 to 67%) in forage OM intake occurred between 70 and 100 d of age, after which only small increases (as a percentage of BW) were observed. These researchers suggested that calves older than 70 to 100 d would be self-sufficient for nutrient harvesting when adequate forage (quality and quantity) is available (Broesder et al., 1990; Anсотегу et al., 1991). In contrast, research with fall-calving cow herds (Apple et al., 1991, 1993) noted a greater response in calf growth compared to our cow herd. This
Table 4. Birth weight, BW, ADG, total gain, and adjusted 205-d BW of calves nursing beef cows fed bermudagrass hay supplemented by limit grazing on winter-annual pasture 2 or 3 d/wk or by feeding a concentrate-based supplement (Exp. 2)

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatmenta</th>
<th>P-valueb</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SUPP 2DW</td>
<td>3DW SE</td>
</tr>
<tr>
<td>Birth weight, kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>April 23</td>
<td>78</td>
<td>78</td>
</tr>
<tr>
<td>June 2</td>
<td>111</td>
<td>108</td>
</tr>
<tr>
<td>July 23</td>
<td>158</td>
<td>152</td>
</tr>
<tr>
<td>September 11</td>
<td>204</td>
<td>216</td>
</tr>
<tr>
<td>Calf BW in yr 1, kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>March 30</td>
<td>68</td>
<td>70</td>
</tr>
<tr>
<td>April 23</td>
<td>92</td>
<td>92</td>
</tr>
<tr>
<td>May 25</td>
<td>121</td>
<td>119</td>
</tr>
<tr>
<td>June 29</td>
<td>152</td>
<td>147</td>
</tr>
<tr>
<td>October 5</td>
<td>218</td>
<td>211</td>
</tr>
<tr>
<td>ADG in yr 1, kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birth to April 23 (43 d)</td>
<td>0.98</td>
<td>0.96</td>
</tr>
<tr>
<td>April 23 to September 11 (141 d)</td>
<td>0.90</td>
<td>0.99</td>
</tr>
<tr>
<td>ADG in yr 2, kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birth to April 28 (60 d)</td>
<td>1.02</td>
<td>0.91</td>
</tr>
<tr>
<td>April 28 to October 5 (160 d)</td>
<td>0.79</td>
<td>0.74</td>
</tr>
<tr>
<td>Total gain, kg</td>
<td>174</td>
<td>165</td>
</tr>
<tr>
<td>Adjusted 205-d BW, kg</td>
<td>212</td>
<td>203</td>
</tr>
</tbody>
</table>

aSUPP = supplemented with a mixture of corn (33%) and corn gluten feed (67%) fed 3 d/wk; 2DW = limit grazing sod-seeded winter-annual pasture (wheat, rye, and annual ryegrass) 2 d/wk, 3DW = limit grazing sod-seeded winter-annual pasture 3 d/wk from January until May.
bContrasts: S vs G = SUPP vs 2DW and 3DW; 2 vs 3 = 2DW vs 3DW.

difference in calf BW may have resulted from the fact that, in previous trials, calves were older and able to utilize greater quantities of forage and they had greater forage allowances because they were either continuously stocked or creep grazed on the winter-annual pasture.

Implications

Cows limit grazed on wheat-rye pasture 2 d/wk seemed to maintain body weight as well as did cows supplemented with concentrate-based supplement. However, we noted that limit-grazed cows failed to maintain body condition score in the middle of the breeding season, which may negatively impact rebreeding efficiency. We conclude that wheat and rye pasture mixtures are a marginal supplement for lactating beef cows in southwest Arkansas because of the early-maturing characteristics of the grasses. Cows limit grazed on wheat, rye, and annual ryegrass pasture 2 d/wk maintained body weight and body condition score as well as cows supplemented with a concentrate-based supplement. Grazing pasture 3 vs 2 days/week did not seem to improve the performance of cows or calves, and this increase in grazing may be deleterious to conception rates.

Literature Cited


