Effect of Atrazine, Fertilizer, and 2,4-D on Winter Grazing Preferences of Beef Cows on Northcentral Oklahoma Tallgrass Prairie

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Abstract

A good condition, tallgrass prairie experimental area was treated with selected combinations of atrazine, 2,4-D, and NPK fertilizer in spring 1975 and 1976. Crude protein contents in November herbage ranged from 3.4% to 6.3% in treated samples. Untreated herbage contained 5.0% crude protein. Nonlactating beef cows were allowed to graze freely on the area during December, 1976. Utilization of herbage ranged from 43% to 87%. Utilization was greatest on NPK areas (82%), 3.4 kg atrazine + NP areas (85%), and 3.4 kg atrazine + NPK areas (87%). Decreaser species comprised a larger percentage of the total production on atrazine + NP, atrazine + NPK, and 2,4-D + NPK areas than on fertilizer-only areas. Tallgrass prairie treated with atrazine and fertilizer or 2,4-D and fertilizer was preferred by beef cows as winter forage over untreated herbage. There was a 15% increase in herbage utilization for every 1% increase in crude protein in the herbage in December.

Herbicides and fertilizers are effective forage improvement tools when combined with a sound management plan. However, ranchers are often forced to supply a supplemental protein source to maintain animals and effectively use available forage when grazing an area in winter (Shepherd and Hughes 1970).

The ideal winter forage should supply proper protein and energy needs. Various combinations of fertilizers and herbicides increase forage quality and production during the growing season (Duncan and Hylton 1970, Kay and Torell 1970, Houston and van der Sluijs 1975). However, after plant maturity, crude protein content is at or below animal maintenance levels (Baker et al. 1980).

Little quantitative data has been published relating animal preference for fertilized and herbicide-treated areas, but these chemicals can influence livestock preference (Green et al. 1958, Smith and Lang 1958, Shaw and Dodd 1979). Plant hormone metabolism is influenced by triazine herbicides, and growth stimulations affect the entire morphological structure of the plant (Ebert 1976). These effects on plant morphology and physiology plus other environmental influences (Laycock and Price 1970) may influence animal preference for forages during the winter.

The objective of this study was to determine differences in cattle utilization of mature tallgrass prairie and relate utilization to differences in crude protein and herbage production created by previous herbicide and fertilizer treatments.

Study Area

The study area was 2.25 ha of loamy upland rangeland, 11 km

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north of Stillwater, Okla. Elevation is about 280 m. Stillwater has a continental climate with average absolute monthly maximum temperatures exceeding 40°C from June through September, and average absolute monthly minimum temperatures below -20°C from December through March. Annual precipitation averages 820 ± 250 mm and its distribution during the 210-day growing season is 21% (April-May), 28% (June-August), and 17% (September-October). The land slope is 2 to 6% and soils are predominately fine-loamy, mixed, thermic, Udic Argiustolls (Gray and Galloway 1959). The range site is good condition loamy prairie previously used as a native hay meadow or moderately grazed by cows and calves. The major plants in the study area included *Schizachyrium scoparium*, *Sorghastrum nutans*, *Panicum virgatum*, *Andropogon gerardi*, *Panicum scribnerianum*, *Ambrosia psilostachya*, and *Carex* spp.

Methods

This experiment was part of a larger study designed to measure forage quality and production changes after application of atrazine, 2,4-D, and N(33-0-0), P(0-45-0) and K(0-0-60) fertilizers. In 1975 a randomized block experimental design with three replications of 15 treatments was used (Table 1). All standing vegetation was mowed to a 10-cm stubble height in March, 1976, and left on the plot as ground litter. A split-plot design was superimposed on the randomized block design in 1976. One-half of each 12 × 15 m plot received the same treatment as in 1975 (retreated areas), while the other half remained untreated to measure residual effects (residual areas).

Fertilizer (N, P, K) was broadcast May 10 at the rate of 67-45-45 kg/ha respectively. Foliar sprays of 1.1 and 3.4 kg a.i./ha atrazine

Table 1. Treatment codes, treatments, and month of application for the 15 treatments.

Treatment code	Treatment and month of application
U	Untreated or control.
N	67-0-0 ¹
NP	67-45-0, June.
NPK	67-45-45, June.
DNPK	0.8 kg 2,4-D/ha plus 67-45-45, June.
A61	1.1 kg atrazine/ha, June.
A71	1.1 kg atrazine/ha, July.
A63	3.4 kg atrazine/ha, June.
A73	3.4 kg atrazine/ha, July.
AN	3.4 kg atrazine/ha plus 67-0-0, June
ANP	3.4 kg atrazine/ha plus 67-45-0, June.
ANPK	3.4 kg atrazine/ha plus 67-45-45, June.
ADNPK	3.4 kg atrazine/ha, 0.8 kg 2,4-D/ha plus 67-45-45, June
D6	0.8 kg 2,4-D/ha, June.
D7	0.8 kg 2,4-D/ha, July.

¹67 kg N/ha - 0 kg P₂O₅/ha - 0 kg K₂O/ha.

Fig. 1. Winter grazing of experimental area by nonlactating beef cows.

(2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine) and 0.8 kg a.i./ha 2,4-D, ((2,4-dichlorophenoxy) acetic acid) were applied on June 4 or July 8.

Standing herbage biomass was estimated for each species in early November, 1976, using the modified weight-estimate (Pechanec and Pickford 1937) and double sampling methods (Wilm et al. 1944). Clipped samples were analyzed for nitrogen by the macro-Kjeldahl procedure (AOAC 1970). The area was ungrazed between March, 1975, and December, 1976.

Fifteen nonlactating beef cows freely grazed the experimental area for 18 days in December (Fig. 1). Cows were fed 0.9 kg/head/day of 41% protein range cubes in unused areas of the enclosure. After the cows were removed, the residual herbage was determined. The difference in standing herbage before and after grazing was considered to be utilization (National Academy of Sciences 1962).

Statistically significant differences among treatments for production, grazing residue, crude protein content and utilization were tested using analysis of variance and least significant differences (Steel and Torrie 1980). The results are shown in the figure captions.

Fig. 2. Herbage production, grazing residue and crude protein content of herbage on residual areas, December, 1976. Herbage production (kg DM/ha) $P < .01$, $LSD_{.05} = 800$; residue (kg DM/ha) $P < .20$; crude protein (%) $P < .28$; utilization (kg DM/ha) $P < .02$, $LSD_{.05} = 1100$; utilization (%) $P < .22$.

Results and Discussion

Rainfall from May through October, 1976, was 47% of the average with no month receiving above average rainfall amounts. The previous summer (1975) was also dry and no recharge of subsoil water occurred during the 1975-76 winter. Herbage was under water stress for much of the 1976 growing season.

Herbage production on residual areas (treated 1975, untreated 1976) in November varied from 2600 to 4300 kg/ha (Fig. 2). Untreated areas produced 2600 kg/ha while the average for treated areas was 3350 kg/ha. Herbage production on residual areas was influenced by 1975 treatments, either directly or from changes in species present (Baker et al. 1980).

Standing litter remaining after grazing on residual areas varied from 1000 to 2200 kg/ha with an average of 1500 kg/ha (Fig. 2). The four areas with the most herbage before grazing were NPK, N, ANPK, ANP, and all of these areas had less than average residue remaining after grazing. On these four areas tallgrass (*Andropogon gerardi*, *Panicum virgatum*, *Sorghastrum nutans*) plus *Schizachyrium scoparium* production was 63% (N), 71% (NPK), and 72% (ANP, ANPK) of total herbage production. The amount of residue remaining after grazing varied less among areas than did total herbage present before grazing. Utilization ranged from 38% to 72% and averaged 54% for all 15 treatments. No areas were grazed excessively. The area receiving the greatest degree of utilization (72%) had a grazing residue of 1200 kg/ha.

The crude protein content of herbage on residual areas ranged from 3.3% to 4.9% with an average of 4.1% (Fig. 2). Crude protein content of untreated herbage was 4.4%. All crude protein values were well below the protein level needed for maintenance of a mature beef cow.

Areas retreated in 1976 produced 2600 to 5200 kg/ha herbage (Fig. 3). Untreated areas produced only 2600 kg/ha, while the treated areas averaged 3750 kg/ha. All areas, except N-only, with above average production had received a combination of fertilizers or fertilizer and herbicide. Tallgrass plus *Schizachyrium scoparium* production on the four treatments producing the most herbage was 62% (ANP), 70% (NPK), 77% (ANPK), and 81% (DNPK) of total herbage production.

The average grazing residue on retreated areas was 1200 kg/ha. Most treated areas with above average herbage production also had below average grazing residue. Utilization ranged from 43% to

Fig. 3. Herbage production, grazing residue and crude protein content of herbage on retreated areas, December, 1976. Herbage production (kg DM/ha) $P < .02$, $LSD_{.05} = 1450$; residue (kg DM/ha) $P < .19$; crude protein (%) $P < .01$, $LSD_{.05} = 1.5$; utilization (kg DM/ha) $P < .01$, $LSD_{.05} = 1300$; utilization (%) $P < .01$, $LSD_{.05} = 24$.

Fig. 4. Crude protein (%) and herbage utilization (%) relationships for 1975 treated (residual) herbage and 1976 retreated herbage.

87% and averaged 66% on treated areas and 55% on untreated areas. Utilization on retreated areas averaged much greater than on residual areas.

The average crude protein content of herbage on all areas retreated in 1976 was 4.7% (Fig. 3), only slightly higher than on residual areas. All areas with above average herbage production also had herbage with above average protein content. All treatments with herbicide plus fertilizer, except AN, produced herbage with higher protein content than the average, while herbage on areas treated with only herbicide had below-average protein content.

Utilization increased as the protein content of the dormant herbage increased. For each 1% increase in crude protein content in the herbage there was a corresponding 15% increase in herbage utilization (Fig. 4). The simple linear correlation coefficient between crude protein content and utilization was 0.79 ($P < .01$) using all 30 plots. There was no significant differences in regression equations for crude protein content and utilization on retreated and residual areas.

There was a 1200 kg/ha range between the smallest and largest residue figures for both retreated and residual herbage. A comparison of herbage utilization with crude protein and herbage production shows that cows removed nearly three times as much herbage from ANP areas as from untreated areas. Increasing herbage production did not decrease the crude protein content or utilization of cured herbage as has often been found with 2,4-D and fertilizer studies (Black and Wight 1979).

Conclusions

The addition of atrazine or 2,4-D with NP or NPK fertilizer in the spring provided a higher protein winter forage. Beef cows

preferred the mature, tallgrass herbage with higher protein contents even though protein differences were small. These results are also evident in herbage treated only during the previous year.

Further study is necessary to determine longterm effects of repeated treatments of atrazine on tallgrass species' growth and quality, how treated herbage is affected by weather conditions, and the influence on preference by grazing animals. Our results indicate the proper application of atrazine and fertilizer may be used to influence grazing distribution when lightly grazed areas are fertilized for winter grazing.

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