Grass Species Adaptability in the Southern High Plains—a 36-Year Assessment

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Abstract

A 36-yr old species adaptation test was evaluated and the relative quality of some persisting native and introduced grass species was determined. The site was Conlen loam on the Rita Blanca National Grassland in Dallam County, Texas. Of the 25 species planted, only yellow bluestem *(Bothriochloa ischaemum),*[1] Caucasian bluestem *(Bothriochloa caucasica),* and galleta *(Hilaria jamesii)* tended to dominate the plots on which they were originally planted. Yellow and Caucasian bluestem had spread into plots planted to other grasses but galleta had spread very little. Yellow bluestem was as high or higher in protein, mineral content, and digestibility (IVDMD) than the other grasses analyzed [Caucasian bluestem, galleta, sideoats grama *(Bouteloua curtipendula),* blue grama *(Bouteloua gracilis),* and western wheatgrass *(Agropyron smithii)*]. The contents of Caucasian bluestem and galleta were not significantly different from those of yellow bluestem, except that galleta was lower in IVDMD, especially when mature. These 3 grasses merit consideration in range seeding programs on Conlen and similar soils in the Southern High Plains.

For many years, there has been a continuing search for grasses that will increase the productivity of rangelands. Both introduced species and improved selections of native species have been investigated. On the Southern High Plains, there have been some successes with introduced species but when prolonged droughts occur, the introduced species are often replaced by annual weeds, native grasses, or persistant introduced grasses from adjacent or nearby plots. Sites of adaptation studies are often destroyed after the selections are rated and little attention is given to plants that may have invaded the test species. Although comparatively short-term adaptation studies are valuable for cursory evaluation of species, they do not evaluate long-term persistance, indicate aggressiveness of species in invading other species, nor indicate species which may become prevalent where a test species has failed.

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The purpose of this study was to evaluate the standing crop and species composition on a 36-yr old adaptation test site and to determine the relative seasonal quality of some native and introduced species that persisted on the site.

History

In 1942, the Nursery Division of the Soil Conservation Service was involved in revegetation studies in areas of the Texas Panhandle that had been cropped and abandoned during the "Dust Bowl" era. They conducted a grass adaptability study on Conlen loam (fine, loamy, carbonatic, mesic Calciorthidic Paleustoll) approximately 37 km north and 13.5 km west of Dalhart, Dallam County, Texas. The Sunray-Conlen soil association makes up about 25% of Dallam County. The soils are used for crops and range. The natural vegetation type in the area is shortgrass prairie. Most common species on undisturbed Conlen loam soils are sideats grama *(Bouteloua curtipendula)* and blue grama *(Bouteloua gracilis).* Elevation at the site is approximately 1260 m above sea level. Annual precipitation at Dalhart averages 43 cm. Departures from that average for 1942 through 1979 are shown in Figure 1. Approximately 85% of the precipitation falls during the warm season,

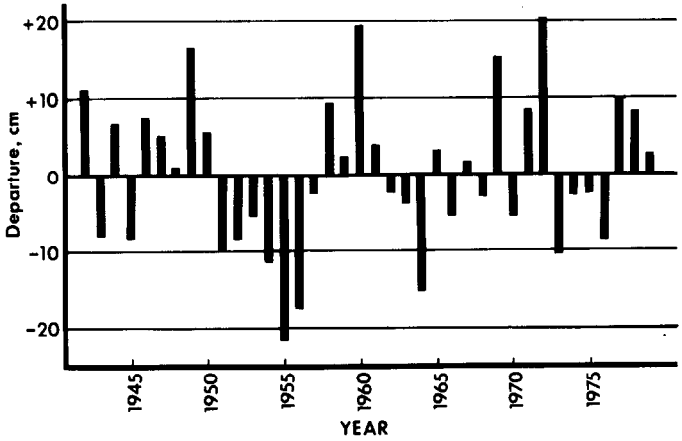

Fig. 1. *Departure from average annual precipitation (43 cm) at Dalhart, Texas. 1942-1979.*

April through October. The average frost-free period is 178 days with the average last occurrence of 0° C or below in the spring and the first occurrence in the fall being 23 April and 18 October, respectively, (Ford and Fox 1975).

The grasses were planted in sudangrass *(Sorghum vulgare)* stubble on 3 May 1942. Twenty-nine plots (approximately 4.3 × 61 m) were planted to 25 species of grasses. There were duplicate plots of little bluestem *(Schizachyrium scoparium)*, sideoats grama, blue grama, and switchgrass *(Panicum virgatum)* and single plots of 21 other species. Where 2 plots of the same species were planted, different selections of the species were used. Species planted and identification numbers of seed sources are given in Tables 1, 2, and 3. The "Kg" numbers were those of the Kansas SCS Plant Materials Center. The Kansas numbering system is still in use. The system used in Texas has been changed and we have been unable to locate a key to the CT numbers.

The surrounding area was planted to a mixture of blue grama, sideoats grama, little bluestem, and sand lovegrass *(Eragrostis trichodes)*. The blue grama seed contained some sand dropseed *(Sporobolus cryptandrus)* the sideoats grama seed contained some blue grama, hairy grama *(Bouteloua hirsuta)*, and sand dropseed.

The soil was very dry at seeding time. The first effective rains after seeding occurred in early July. A rather uniform thin stand was observed on all plots on 29 July 1942. A heavy growth of sudangrass was also present at that time. Further information on stand establishment is sketchy; however, an undated memo indicated that Russian wildrye *(Elymus junceus)*, plains bristlegrass *(Setaria macrostachya)*, and blue panicum *(Panicum antidotale)* did not become established.

In 1954, the plot area was cross-fenced to exclude grazing on one-half of each plot. Otherwise, after establishment and until this study was initiated, the plots and the surrounding area were grazed for about 6 months annually, beginning in May or June.

Methods and Materials

In 1978 and 1979, grazing was excluded on the entire area until after major growth had occurred and forage inventories were made (8 August and 6 August, respectively). After the forage inventories, cattle were allowed on the grazed area. Forage inventories, as described by Shoop and McIlvain (1963), were made on plots that had been seeded to yellow bluestem *(Bothriochloa ischaemum)*, Caucasian bluestem, western wheatgrass *(Agropyron smithii)*, two sideoats grama selections, and galleta *(Hilaria jamesii)*.

Step-point analyses for species composition were made on all of the plots on 28 June 1978. This procedure follows closely that described by Brown (1954). Each of 4 individuals identified the species nearest to the boot tip at 25 points along 4 transects through each plot. These 100 points were used to determine the relative plant species composition in each of the 29 plots for both the ungrazed and grazed areas.

Yellow bluestem, Caucasian bluestem *(Bothriochloa caucasica)*, western wheatgrass, sideoats grama, blue grama, and galleta were sampled periodically and analyzed for crude protein (CP), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and in vitro dry matter disappearance (IVDMD). Samples were taken at 18 dates between May 1978 and March 1980. Corresponding sampling dates in the successive growing and dormant seasons for each year were usually within 12 days of each other, thus years were used as replicates in statistical analyses. Dates in Figure 2 are "average" sampling dates, and values plotted are averages for the two sampling years. Plants were collected from the grazed area except at a few sampling dates during the dormant season when it was necessary to collect plants from the ungrazed area. This was done because sufficient material was not present on the grazed area. Forage samples were collected to simulate grazing. Plant parts sampled were those that were being removed by livestock. Phenological stage at the time of collection was recorded for each species.

Chemical analyses for N, P, and K were by the methods of Thomas et al. (1967). Calcium and Mg were determined by atomic absorption[1] on the wet digest obtained in the above method. In vitro dry matter disappearance was determined by the method of Tilley and Terry (1963) as modified by Barnes et al. (1971).

Statistical analysis of chemical data was by analysis of variance. When significant "F" values were obtained, Duncan's multiple range test (Duncan 1955) was used to separate means.

[1]Revision of analytical methods for atomic absorption spectrophotometry. 1968. Perkin-Elmer, Norwalk, CT 06852.

Table 1. Average percent species composition on plots seeded to warm-season taller grasses in 1942 and either grazed (G) or ungrazed (U) since that time as measured by 100 step points per plot on 28 June 1978.

	Planted Grasses (I.D. No.[1])															
	Bothriochloa ischaemum (Kg 495)		*Bothriochloa caucasica* (Kg 40)		*Schizachyrium scoparium* (CT 1580)		*Schizachyrium scoparium* (CT 1844)		*Andropogon hallii* (CT 1806)		*Sorghastrum nutans* (Kg 494)		*Panicum virgatum* (CT 1810)		*Panicum virgatum* (CT 208)	
Species encountered[2]	U	G	U	G	U	G	U	G	U	G	U	G	U	G	U	G
Bothriochloa caucasica	2	—	80	72	90	61	74	36	52	12	12	—	15	2	7	6
Andropogon hallii							5	—	19	2						
Agropyron smithii							—	1	2	—						
Bouteloua curtipendula	—	1	—	2	1	1	2	5	10	11	60	52	58	15	58	56
Bouteloua gracilis	—	18	1	5	9	18	16	23	14	27	6	31	4	30	5	15
Bothriochloa ischaemum	94	72	19	18			1	24	1	32	—	4	2	50	1	20
Hilaria jamesii											2	—				
Sporobolus cryptandrus							—	1	5	5	1	—	2	—	2	—
Aristida purpurescens									—	4	—	7				
Aristida longiseta											5	—				
Aristida purpurea											6	—				
Buchloe dactyloides																
Sorghastrum nutans													14	—	20	—
Panicum virgatum													1	—		
Salsola kali	—	6														
Other plants	4	3	—	3			2	1	2	2	3	5	4	3	6	3

[1]Numbers are those given in combined third and fourth annual technical reports of SCS Nursery Observational Studies, Western Gulf Region, 1 Jan. 1942 to 1 Jan. 1944.
[2]Source: National List of Scientific Plant Names (USDA-SCS, 1971). *Bothriochloa* sp. and *Schizachyrium* sp. are listed as *Andropogon* spp. in the source reference.

Table 2. Average percent species composition on plots seeded to warm-season short and mid-grasses in 1942 and grazed (G) or ungrazed (U) since that time as measured by 100 step points per plot on 28 June 1978.

Species encountered[2]	Planted grasses (I.D. No.[1])																			
	Buchloe dactyloides (CT 1815)		*Bouteloua curtipendula* (CT 482)		*Bouteloua curtipendula* (CT 1794)		*Bouteloua gracilis* (CT 1246)		*Bouteloua gracilis* (CT 408)		*Hilaria jamesii* (CT 1790)		*Setaria macrostachya* (CT 1258)		*Eragrostis curvula* (CT 1796)		*Eragrostis trichodes* ——		*Panicum antidotale* (CT 1843)	
	U	G	U	G	U	G	U	G	U	G	U	G	U	G	U	G	U	G	U	G
Bothriochloa caucasica	—	1	3	5	3	2	7	3	1	2	24	1	4	—	25	3	26	4	16	6
Agropyron smithii	1	—					3	—	10	2	—	1								
Bouteloua curtipendula	10	5	43	20	57	58	47	57	9	40	23	16	67	62	52	22	28	12	23	18
Bouteloua gracilis	3	15	7	17	17	24	15	14	5	14	1	2	6	20	1	18	13	8	10	7
Bothriochloa ischaemum	—	9	—	7	2	—	—	1	—	2	—	3	—	3	1	34	—	57	—	62
Hilaria jamesii											50	75	3	1						
Sporobolus cryptandrus	6	1	—	2	1	1	5	1	3	6	1	—	1	—	—	2	—	1	—	1
Aristida purpurescens	31	15	7	15	—	9	4	16	7	24			3	5	—	13	—	10		
Aristida longiseta	—	10	5	—			5		4				3	—				1		
Aristida purpurea	—	10	5	7			8	—	5	3			5	4						
Buchloe dactyloides	—	16																		
Sorghastrum nutans															6	—	20	—	34	—
Andropogon saccharoides															6	—			7	—
Salsola kali	42	15	28	15	14	6	13	—	50	4			—	1						
Other Plants	7	3	4	5	6	—	3	8	4	3	1	2	8	4	9	8	12	7	10	6

[1]Numbers are those given in combined third and fourth annual technical reports of SCS Nursery Observational Studies, Western Gulf Region, 1 Jan. 1942 to 1 Jan. 1944.
[2]Source: National List of Scientific Plant Names (USDA-SCS, 1971). *Bothriochloa* sp. and *Schizachyrium* sp. are listed as *Andropogon* spp. in the source reference.

Results and Discussion

Precipitation at Coldwater, Texas, about 11 km northeast of the study, totaled 28 cm (15 cm below average) in 1978 and 46 cm (3 cm above average) in 1979. Warm-season precipitation (April through October) totaled 20 cm in 1978 and 38 cm in 1979. In 1978, 71% of the warm-season precipitation occurred in April through June. July through October precipitation totaled only 6 cm, thus the vegetation was dormant or near dormant for much of that period. Note that precipitation at Dalhart was considerably higher than at Coldwater in 1978 (Fig. 1). In 1979, precipitation was more plentiful and more evenly distributed and growth continued through late summer.

Species Composition

Yellow and Caucasian bluestem dominated the plots on both the ungrazed and grazed areas (Table 1). Yellow bluestem had a species composition of 94 and 72% while Caucasian bluestem had 80 and 72% composition in their respective ungrazed and grazed plots. Sand bluestem *(Andropogon hallii)* comprised 19 and 2% of the species in its ungrazed and grazed plots, respectively. Little bluestem, Indiangrass *(Sorghastrum nutans),* and switchgrass were rarely found. Sideoats grama and galleta sustained reasonably good stands 36 years after planting (Table 2). Generally, these 2 species comprised more than 50% of the vegetation composition. Blue grama, a principal native to the area, made up only 5 to 15% of the vegetation. Buffalograss *(Buchloe dactyloides)* comprised 16% of the vegetation on the grazed area of the plot while it did not occur on the ungrazed area. Plains bristlegrass, weeping lovegrass *(Eragrostis curvula),* sand lovegrass, and blue panicum either were not present or were minor components of the vegetation.

Western wheatgrass made up 25 and 1% of the vegetation on the ungrazed and grazed areas, respectively (Table 3). None of the other cool-season grasses [Crested wheatgrass *(Agropyron cristatum),* Canada wildrye *(Elymus canadensis),* Russian wildrye, green needlegrass *(Stipa viridula),* Indian ricegrass *(Oryzopsis hymenoides),* and needleandthread *(Stipa comata)*] persisted. Prairie dropseed *(Sporobolus asper),* alkali sacaton *(Sporobolus airoides),* giant sandreed *(Calamovilfa gigantea),* and sand dropseed did not maintain consequential stands.

The ability of plants to spread or invade other sites is an indication of their adaptability. Some species were as abundant on adjacent plots as they were on plots where they were planted. Caucasian bluestem was quite prevalent in the neighboring plots. For example, it made up 82 and 52% of the species composition on the ungrazed portions of the little bluestem and sand bluestem plots, respectively. Although Caucasian bluestem was found in almost every plot, it was more abundant in the ungrazed than the grazed areas. In contrast, yellow bluestem had a higher percent species composition in the grazed compared to the ungrazed plots. Sims and Dewald (1982) reported that these Old World bluestems react ecologically as secondary successional species and increase under grazing and disturbances in their natural habitat (Harlan et al. 1958).

Sideoats grama was a significant invader in some plots. The percent species composition across all plots was higher for sideoats grama than any other species. Average species composition of sideoats grama in the ungrazed plots was 34% compared to 26% in the grazed plots. Composition of blue grama across all ungrazed plots was 9% compared to about 20% in the grazed plots. It occurred in almost every plot.

Sideoats grama was found on 27 ungrazed and 29 grazed plots while Caucasian bluestem was found on 27 ungrazed and 25 grazed plots. Yellow bluestem, on the other hand, occurred in only 12 ungrazed plots and 27 grazed plots. Although sand dropseed was relatively widespread and occurred on 19 ungrazed and 17 grazed plots, species composition was only 3 and 2%, respectively. Russian thistle *(Salsola kali),* a transient species, occurred on about one-third of the ungrazed plots and one-fourth of the grazed plots. Scattered silver bluestem *(Andropogon saccharoides)* plants were present on 5 plots on which planted grasses were not found.

A review of the grass species adaptabilty trials on similar sites in the Southern Plains shows results similar to those obtained in our study. McGinnies et al. (1983) concluded from studies in southeast Colorado that blue grama, sideoats grama, and yellow bluestem were among the most persistent warm-season grasses planted. Vallentine (1971) summarized recommendations for adaptable species for planting in the Southern Plains and listed many of the plants that were evaluated in the Dalhart plantings. Although many grass species have been shown to be persistent and useful in the Southern Plains, planting success is still marginal for some of the species (Great Plains Council 1966, Merkel and Herbel 1973).

Table 3. Average percent species composition on plots seeded to cool-season and other grasses in 1942 and either grazed (G) or ungrazed (U) since that time as measured by 100 step points per plot on 28 June 1978.

Species encountered[2]	Planted grasses (I.E. No.[1])																					
	Agropyron cristatum (CT 1799)		*Agropyron smithii* (CT 1816)		*Elymus canadensis* (CT 1802)		*Elymus junceus* (CT 1813)		*Calamovilfa gigantea*		*Oryzopsis hymenoides* (CT 1819)		*Stipa viridula* (CT 1766)		*Stipa comata* (CT 1523)		*Sporobolus asper* (Kg 1695)		*Sporobolus airoides* (CT 1820)		*Sporobolus cryptandrus* (CT 1804)	
	U	G	U	G	U	G	U	G	U	G	U	G	U	G	U	G	U	G	U	G	U	G
Bothriochloa caucasica	41	17	8	10	14	4	—	1	26	2	19	1	3	14	25	13	6	1	3	—	2	3
Andropogon hallii																	2	—	4	—	14	—
Agropyron smithii	29	—	25	1	22	9	9	17													—	1
Bouteloua curtipendula	8	9	14	3	23	7	27	26	22	52	51	33	61	50	53	5	37	21	36	56	48	36
Bouteloua gracilis	10	25	2	18	5	42	7	23	14	12	8	20	13	17	5	48	13	20	20	26	15	26
Bothriochloa ischaemum	1	28	—	18	—	8	—	4	1	8	1	4	—	1	—	1	4	23	—	2	—	1
Hilaria jamesii					1	—			14	6	9	36					—	1	2	12	1	2
Sporobolus cryptandrus	2	1	4	3	2	2	7	1	2	4			2	—			2	4	5	—	1	3
Aristida purpurescens	—	13	22	11	23	8	15	7	2	5			2	11	—	7	—	6			1	7
Aristida longiseta			—	8			—	9	3	1	—	4	4	—							4	2
Aristida purpurea			—	11	—	9	6	4	6	7	2	—	11	3	1	—						
Sorghastrum nutans																	6	9	17	—		
Andropogon saccharoides															5	—	7	8	—	6		
Panicum virgatum																	14	—				
Salsola kali	4	—	22	15	7	5	25	3	2	—	—	2	1	—					5	—	1	7
Other plants	5	7	3	2	3	6	4	4	8	4			3	4	11	4	9	7	8	4	13	12

[1]Numbers are those given in combined third and fourth annual technial reports of SCS Nursery Observational Studies, Western Gulf Region, 1 Jan. 1 1942 to 1 Jan. 1944.
[2]Source: National List of Scientific Plant Names (USDA-SCS, 1971). *Bothriochloa* sp. and *Schizachyrium* sp. are listed as *Andropogon* spp. in the source reference.

Standing Crop of Established Grasses

Yellow bluestem, Caucasian bluestem, western wheatgrass, sideoats grama, and galleta had sufficient cover of the planted species to be recognized as established stands. Yellow and Caucasian bluestems had the greatest standing crop in the ungrazed plots and galleta had the greatest standing crop in the grazed area. Yellow bluestem had 2,037 kg/ha compared to 1,845 kg/ha for Caucasian bluestem and 324, 662, and 802 kg/ha for western wheatgrass, sideoats grama, and galleta plots, respectively (Table 4).

The ungrazed yellow and Caucasian bluestem plots were nearly closed communities. After almost 40 years since planting, Caucasian bluestem was the second most dominant species in the yellow bluestem plot and yellow bluestem was the second most dominant species that had become established in the ungrazed Caucasian bluestem plot. While the Old World bluestems were not particularly abundant in the western wheatgrass and sideoats grama plots in the ungrazed condition, they did represent a considerable portion of the standing crop in the ungrazed galleta plot (Table 4). In the ungrazed western wheatgrass, sideoats grama, and galleta plots, the standing crop of other grasses was relatively high, particularly buffalograss and threeawns (*Aristida* sp.). Blue grama did not invade the ungrazed yellow and Caucasian bluestem plots, but was found in the ungrazed western wheatgrass, sideoats grama, and galleta plots.

The average production of the established species on the ungrazed area was 1,055 kg/ha compared to 437 kg/ha on the grazed area. Galleta was the only planted species of the 5 established stands that produced more in the grazed (1,135 kg/ha) than the ungrazed (802 kg/ha) plot. Production of blue grama across all plots was 18 kg/ha for the ungrazed plots compared to 72 kg/ha for the grazed plots.

The average production of grasses in the ungrazed area was 1,415 kg/ha compared to 840 kg/ha in the grazed plots. The differences between the grazed and ungrazed plots in standing crops of sand dropseed, the 2 Old World bluestems, and "other plants" were not great enough to show a distinct grazing response.

Chemical Composition of Forage, and Digestibility

Percentages of CP, P, K, Ca, and Mg and IVDMD of simulated forage samples of the 5 "established" grasses and blue grama 9 sampling dates between May and March are shown in Figure 2.

Crude Protein

Crude protein levels in the grasses at the different sampling dates are shown in Figure 2A. Western wheatgrass was as high or higher in CP than the other grasses at all sampling dates. Yellow bluestem, although ranked fifth at the first sampling, compared favorably with western wheatgrass at the other dates and ranked second over the nine sampling dates. Blue grama averaged lower, but not significantly lower, than western wheatgrass and yellow bluestem. The other 3 grasses averaged significantly lower than western wheatgrass but not significantly different from yellow bluestem. If only the frost-free season is considered (20 May - 24 Oct) the ranking of the grasses is not changed.

Phosphorus

In May, sideoats grama and western wheatgrass were highest, blue grama and galleta were intermediate, and the 2 bluestems were lowest in P (Fig. 2B). In June, yellow bluestem was highest, Caucasian bluestem was lowest, and the other 4 grasses were intermediate and similar in P levels. At later dates during the growing season, Caucasian bluestem was consistently as low or lower in P than the other grasses. Although P levels in all grasses decreased as the season progressed, those in yellow bluestem and galleta did not diminish as early as those in the other grasses. After frost, all grasses were low in P concentration. Galleta averaged highest in P (0.17%) and Caucasian bluestem averaged lowest (0.12%). The other 4 grasses were intermediate and not significantly different from galleta or Caucasian bluestem.

Potassium

The grasses were variable in K concentration (Fig. 2C). In May, levels varied from 1.0 (blue grama) to 2.1% (western wheatgrass). Potassium concentration in the other 4 grasses ranged between 1.0 and 1.5%. In May, June, and July, yellow bluestem and western wheatgrass maintained K levels near 1.5% or higher while concentrations in the other grasses ranged from about 0.7 to 1.3%.

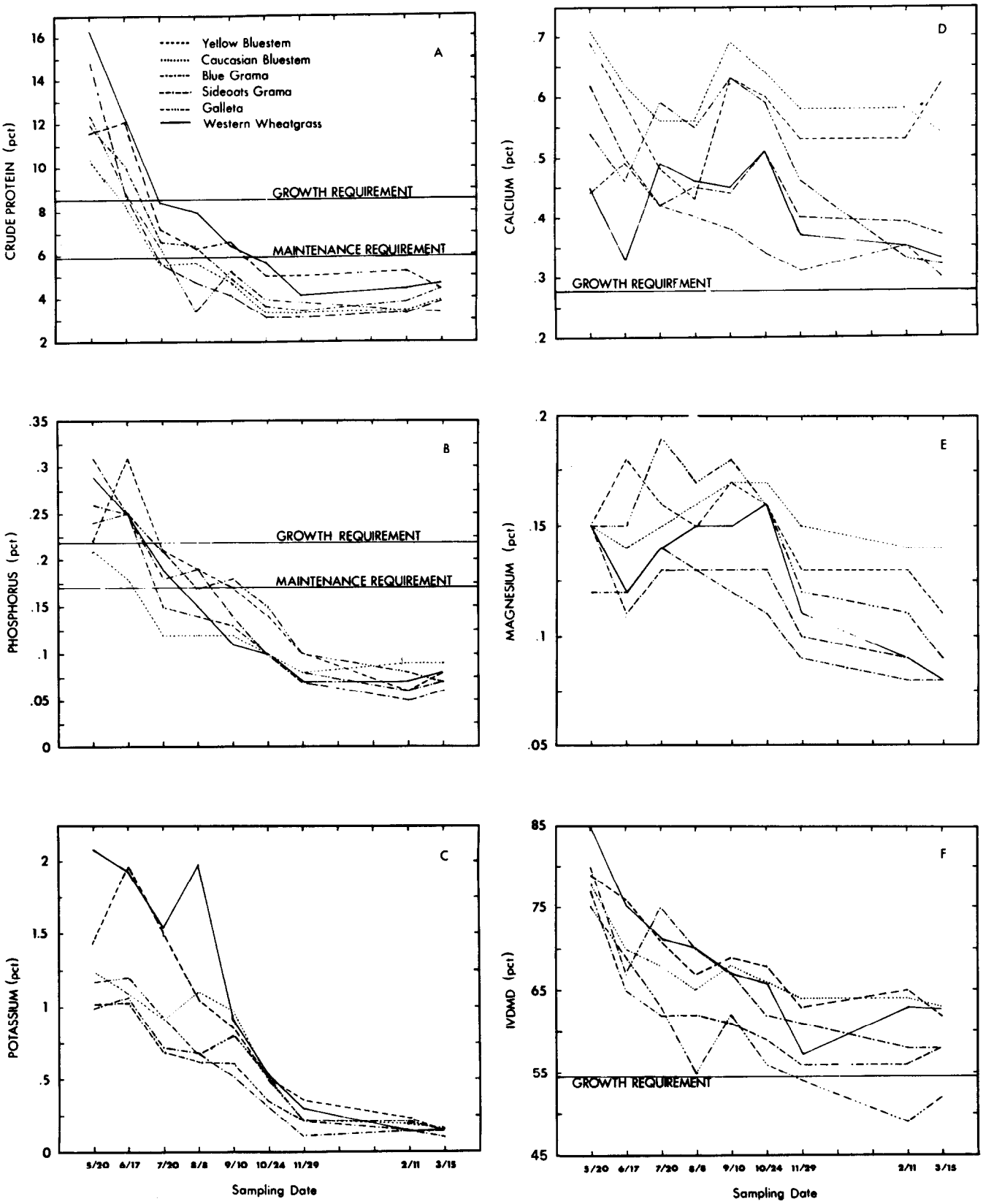

Fig. 2. Average percent composition of crude protein (A), phosphorus (B), potassium (C), calcium (D), magnesium (E), and in vitro dry matter digestibility (F) for six grasses collected on 9 dates in each of 1978 and 1979 from plantings near Dalhart, Texas.

Table 4. Standing crop of herbage (kg/ha) by species and species group in 1978 and 1979 on plots planted to five species on the Rita Blanca National Grasslands in 1942 and either grazed or ungrazed since that time (see text). Grazed areas were ungrazed during sampling years.

	Species Planted											
	Bothriochloa ischaemum		*Bothriochloa caucasica*		*Agropyron smithii*		*Bouteloua curtipendula*		*Bouteloua curtipendula*		*Hilaria jamesii*	
	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979
						Ungrazed						
Bothriochloa ischaemum	988	3087	253	17	8	18	4	—	6	6	212	748
Bothriochloa caucasica	258	—	1119	2565	25	1	52	150	2	12	25	28
Agropyron smithii	—	—	—	2	187	460	—	—	—	13	—	—
Bouteloua curtipendula	1	10	4	—	152	54	480	752	710	704	34	55
Hilaria jamesii	—	3	—	—	—	—	—	—	—	—	1099	504
Bouteloua gracilis	—	—	1	—	48	52	10	11	57	12	19	4
Andropogon hallii	—	—	—	—	—	—	—	—	—	—	—	—
Sporobolus cryptandrus	31	17	8	—	52	99	18	22	16	—	13	2
Other grasses	4	—	1	—	349	145	238	399	8	254	4	260
Total grasses	1282	3117	1386	2584	821	840	802	1334	799	1001	1406	1601
Other plants	26	64	—	10	445	298	406	274	198	370	4	18
Total standing crop	1308	3181	1387	2594	1266	1138	1208	1608	997	1371	1410	1620
						Grazed						
Bothriochloa ischaemum	211	604	66	3	66	333	47	384	1	74	55	155
Bothriochloa caucasica	—	—	302	798	22	22	38	309	10	47	27	133
Agropyron smithii	—	—	—	—	12	49	—	—	—	—	—	2
Bouteloua curtipendula	18	48	24	63	65	45	159	179	368	287	36	84
Hilaria jamesii	—	—	—	1	—	—	—	—	—	7	1365	905
Bouteloua gracilis	106	201	11	7	123	149	31	26	112	86	18	—
Andropogon hallii	—	—	—	—	92	—	—	1	—	1	—	—
Sporobolus cryptandrus	37	87	2	3	27	113	47	81	6	6	2	—
Other grasses	2	31	7	—	161	119	258	257	50	263	6	131
Total grasses	374	971	412	875	568	830	580	1237	547	770	1509	1410
Other plants	76	322	12	167	102	154	137	166	170	166	16	58
Total standing crop	450	1304	424	1042	670	984	717	1403	717	936	1525	1468

Between 20 July and 8 August, K levels in yellow bluestem and western wheatgrass decreased about one-third while decreases in the other grasses were less. By frost, all 6 grasses were low in K, and concentrations continued to decrease as weathering continued after frost. Western wheatgrass and yellow bluestem averaged 1.0 and 0.9%, respectively, while blue grama and sideoats grama both averaged 0.5%. Caucasian bluestem and galleta were intermediate with 0.7 and 0.6% K, respectively.

Calcium

Calcium concentrations of grasses did not decline as much as CP, P, and K concentrations declined as the plants matured (Fig. 2D). The 2 bluestems were highest in Ca at the beginning of the season and remained high during all sampling dates. Blue grama and western wheatgrass were lowest in Ca. Galleta and sideoats grama were intermediate in Ca concentration. Calcium concentrations decreased after frost.

Magnesium

Magnesium concentrations, like Ca did not decline significantly during the growing season (Fig. 2E). The 2 grama grasses were as low or lower in Mg than the other grasses at most dates and averaged lowest. The 2 bluestems and galleta were highest and western wheatgrass was intermediate in Mg concentration. Magnesium concentrations did not decrease significantly after frost.

IVDMD

In May, IVDMD of the grasses ranged from 75 (galleta) to 85% (western wheatgrass) and averaged 79% (Fig. 2F). Digestibility decreased as the season progressed. The average decreased to 63% prior to frost and decreased to 59% at the first sampling after frost. Western wheatgrass and the 2 Old World bluestems were highest, the 2 grama grasses were intermediate, and galleta was lowest in IVDMD.

Nutritional Value

Recommended nutrient requirements for range animals for gestation and maintenance and for lactation and growth have been suggested by Cook and Harris (1968) and Church (1972). These requirements are lower than feedlot standards (NRC 1976) but represent required levels for range animals assuming that the daily dry matter intake requirements are being met. These are shown in Figure 3 for CP and P. Church (1972) gives 0.16% as the maintenance requirement and 0.28% as the growth requirement of Ca. Crude protein, P, and Ca are the nutrients most likely to be limiting in rangeland production systems (Church 1972).

Cook and Harris (1968) indicate that the metabolizable energy (ME) requirement for gestation and maintenance is about 1.46 kcal/g and for lactation and growth reaches 1.98 kcal/g of forage. Minson (1979) summarized several papers that relate nutrient components in forages to their ME levels. The relationship $y = 0.20 + 0.33$ IVDMD is an estimate of the metabolizable energy of grass hays. This relationship was used to determine the level of IVDMD required to meet the energy requirements as shown in Figure 2F. An IVDMD of 38% will meet the ME requirement for gestation or maintenance. An IVDMD of 54% would supply about 1.98 kcal of ME/g of forage as required for lactation and growth.

The CP level required by dry pregnant cows is 5.9% and that required for maintenance of 200 kg steers or heifer calves is 8.5%. Thus, calves grazing these grasses would require some protein supplement by mid- or late July in order to continue weight gains. Dry pregnant cows grazing Caucasian bluestem, sideoats grama, or galleta would require protein supplement by early to mid-August for maintenance needs. By late October, CP concentration in all grasses had dropped to levels at which supplementation would be required for all classes of beef cattle.

The P level required by dry pregnant cows and maintenance of 200 kg steers or heifer calves is about 0.17%. Dietary P levels must be 0.22% or greater for 200 kg steers or heifer calves to gain 0.5 kg/day. All grasses contained sufficient P to meet these standards in mid-June, but by mid-July cattle grazing pure stands of Caucasian bluestem or sideoats grama would require supplemental P. By early August, all grasses except yellow bluestem and blue grama

would require supplementation, and by mid-September non of the grasses contained sufficient P to meet the above-stated requirements.

The minimum K requirement for growing finishing steers and pregnant cows is 0.6 to 0.8% (NRC 1976). The grasses maintained sufficient K until September, but after that, supplement would be required for all large cattle.

The minimum Ca requirement for dry pregnant cows and that required for maintenance of 200 kg steers and heifer cows ranges from 0.16 to 0.18% (Church 1972, NRC 1976). Church (1972) recommends 0.27 to 0.29% Ca for lactating cows. Calcium levels in these grases are adequate for beef cattle throughout the year.

The minimum Mg requirement for beef cattle is given as 0.04 to 0.10% (NRC 1976). The grasses in this study had Mg concentrations above the minimum requirement for cattle.

Most of the grasses have sufficient energy to meet the requirement for growth and lactation of range cattle. During winter some additional energy would be required for maximum growth and milk production. Generally, range cows are not expected to produce at these high levels when the range vegetation is dormant.

In New Mexico, Pieper et al. (1978) found the average CP of whole "intact plants" of grazed blue grama, sideoats grama, and galleta to be 6.2%. This compares with 6.3% in the present study. Savage and Heller (1947) reported similar results. Average protein content of perennial grasses in their study (species included those in the present study) was about 18% in April, 12% in May and declined to 6% or less for the late summer and winter.

The seasonal patterns of P, K, and Mg reported by Pieper et al. (1978) and Savage and Heller (1947) were similar to those in this study. Peak levels of these constituents tended to occur a little earlier at this site than at the higher altitude site in New Mexico. However, the average contents were somewhat higher in samples collected at this site where they were collected to simulate grazed forage. The average Ca content for the grasses was 0.36% for the New Mexico study compared to 0.48% for grasses collected from the Texas High Plains.

The IVDMD of the grasses collected in the present study was somewhat higher than that of those collected in New Mexico. Pieper et al. (1978) reported 49% for blue grama, galleta, and sideoats grama compared to 62% in the present study. Highest IVDMD in the New Mexico study occurred in July (56%) and lowest during midwinter (40%). This compares to a high of 78% and a low of 56% from July to midwinter in the Texas High Plains.

Summary and Conclusions

After 36 years, yellow and Caucasian bluestem dominated both ungrazed and grazed areas of plots on which they were planted and had spread into plots planted to other grasses. Only sideoats grama, a native of the area, was found on as many plots as was Caucasian bluestem. Galleta dominated the plot on which it was planted but had spread very little. Except for galleta on the grazed area, the 2 Old World bluestems had highest forage yields of the established grasses under both ungrazed and grazed conditions. Yellow bluestem was as high or higher in CP, mineral content, and IVDMD than the other grasses analyzed. The contents of Caucasian bluestem and galleta were not significantly different from those of yellow bluestem, except that galleta was lower in IVDMD, especially when it was mature. These three grasses merit consideration in range seeding programs on Conlen and similar soils in the Southern High Plains.

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