Phenology and Forage Production of Cool Season Grasses in the Southern Plains

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Highlight: *Thirteen varieties of cool season grasses were tested under dryland and irrigated conditions in the Southern High Plains. All introduced varieties out-produced the two native species. Peak percent of forage protein content corresponded with peak growth periods. Sandia orchardgrass and NM-384 tall fescue were the most productive varieties under irrigation but did not survive limited irrigation. Luna pubescent wheatgrass and largo tall wheatgrass were the most resistant to limited moisture conditions and are recommended for irrigated, cool season forage planting.*

The prolonged dry winters and the summer pattern of precipitation of the Southern Plains favor warm-season over cool-season plant growth. Only one perennial cool-season grass, western wheatgrass (*Agropyron smithii*), is persistent on the Southern Plains. Its production, however, is limited to swales and other low places that receive runoff water. Winter wheat (*Triticum* spp.) also provides some grazing during the winter, but ranchers have to move the cattle off early in the year, usually about the middle of March, to allow grain production. Removal of stock from the winter pastures comes when most of the warm-season grasses are not yet ready for grazing. Availability of green forage during April, May, and June would greatly improve profits from livestock grazing in the Southern Plains. Increased stocker operations in this region make year-round green forage even more desirable.

Because of the need for extension of the green forage period, a study was established in 1966 to determine the adaptability and productivity of cool-season grasses. The objective was to determine phenological development and seasonal forage yields of 13 cool-season grasses under irrigated and dryland conditions.

Methods

The study was conducted on the Texas Tech University Research Center, 12 miles northeast of Amarillo, Texas. The continental climate and topography of the Research Center are typical of the Southern Great Plains. The soil on the study area is a Pullman silty clay loam, which is found extensively throughout the Amarillo area. Precipitation averages 20 inches per year, coming mostly as spring and summer rain showers (Fig. 1). The average maximum temperature of 93°F occurs in July while the average minimum of 25°F occurs in January.

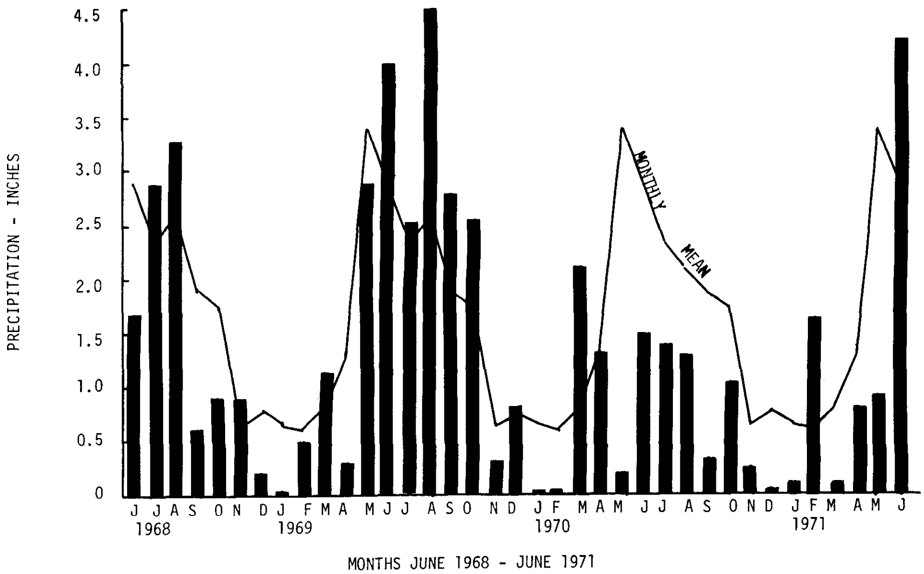

Fig. 1. *Mean monthly precipitation and the amounts recorded during the period of the study at Amarillo, Texas, 11 miles west of the study area (from U.S. Weather Bureau records).*

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Table 1. Species and strains of cool season grasses tested, and the height (inches) of monthly clipping used.

Common name	Scientific name	Strain	Clipping height Proper	Heavy[1]
Intermediate wheatgrass	*Agropyron intermedium*	A-12496	6	3
Tall wheatgrass	*Agropyron elongatum*	Largo	7	4
Orchardgrass	*Dactylis glomerata*	Sandia	5	–
Pubescent wheatgrass	*Agropyron trichophorum*	A-11701	5	–
Intermediate wheatgrass	*Agropyron intermedium*	Amur	6	–
Tall wheatgrass	*Agropyron elongatum*	Alkar	7	4
Tall wheatgrass	*Agropyron elongatum*	Jose	7	4
Pubescent wheatgrass	*Agropyron trichophorum*	Luna	5	3
Pubescent wheatgrass	*Agropyron trichophorum*	A-1488-MC	5	–
Tall fescue	*Festuca arundinacea*	NM-384	5	–
Western wheatgrass	*Agropyron smithii*	Common	4	2
Orchardgrass	*Dactylis glomerata*	Common	5	–
Canada wildrye	*Elymus canadensis*	Common	5	–

[1] The heavy clipping height was used only on 6 species.

Extremes of 109°F and minus 10°F have been recorded at Amarillo. The growing season is approximately 191 days. The elevation of the study area is approximately 3440 ft. Yearly soil temperatures measured at the U. S. Department of Agriculture's Southwest Great Plains Experiment Station, 20 miles west, average 50.4°F and 51.8°F at a depth of 2 to 6 inches, respectively.

During the winter of 1966-67, 14 varieties (Table 1) of cool-season grasses were seeded in 40 inch rows with eight replications of 4 rows 30 ft long. First and second year stands were good to excellent except for McGregor hardingrass (*Phalaris tuberosa*). It did not survive the first winter season, so was deleted from the study.

All replications were irrigated to enhance establishment and growth through the 1967 growing season. Irrigation was continued as needed for optimum growth after 1967 on four replications while three replications received no more additional water. Two applications of 60 lb of nitrogen in the form of ammonium sulfate were applied as top dressing to all plots in August and again in March each year, providing 120 lb nitrogen/acre/year during both seasons of the study.

One part of the study dealt with the forage yield of plants as affected by monthly and annual clipping under irrigation and dryland conditions; the second with phenology and general observations of each species. Forage production was determined under both dryland and irrigated conditions for all 13 varieties. Six of the irrigated varieties were clipped at two heights to simulate proper and heavy use at monthly intervals throughout the season (Table 1). Three 2.9 row-ft samples per species in the four replications under irrigation were clipped at monthly intervals from August, 1968, to July, 1970. After oven-dry weights were obtained, small portions of each grass sample were taken for each clipping level to make a composite sample for protein analyses using the Kjeldahl method.

Additionally, all 13 species were compared under dryland and irrigated conditions. For this trial three replications were clipped at the proper level and irrigated as soil moisture indicated. Three replications were clipped at the proper level but not irrigated except by rainfall. Three 2.9 row-ft samples were collected from each replication for each species (Fig. 2).

During the 1968-69 season, monthly measurements of plant height, leaf length, leaf width, and number of leaves per shoot were made. Flowering period, general growth, characteristics, and tenderness of foliage were observed throughout the study. Plant height was measured from the crown to the base of the spike, or tip of the growing point when the spike was absent. Leaf length was measured on the second leaf from the top. Leaf width was measured on the same leaf, using the mid portion of the blade. Two sets of such observations were made per species per replication.

Fig. 2. *Ricardo de Leon compares proper clipping height of Jose tall wheatgrass on his left with heavy clipping height on his right.*

The experimental design was a randomized block, and treatment differences were evaluated using standard analysis of variance techniques at the .05 level of significance.

Results and Discussion

Phenology and Growth Pattern

The growth patterns of the grasses were judged in the irrigated plots only. All species began fall growth by September 1. Each had a short growth period in early fall with the peak growth occurring in late spring (Fig. 3). Only western wheatgrass stopped growth completely during the winter under irrigation. This may be why this native species is able to survive the dry winters under dryland conditions in this region. Amur intermediate wheatgrass stopped growth and became completely dormant during the middle of the winter dry period under dryland conditions.

Both strains of orchardgrass and NM-384 tall fescue flowered twice during the year; once in the fall and once at the beginning of the summer. Fall flowering produced fewer flower stalks than the summer flowering. Seed shattered from orchardgrass and tall fescue as soon as they matured. This would probably cause difficulty in seed harvest of these species.

The tall wheatgrasses produced many viable seeds and vigorous seedlings. Seedlings from all three varieties invaded other plots. We believe this species easiest to establish of all species tested. Largo tall wheatgrass leafage appeared softer and more tender than that of the other two tall wheatgrasses.

Leaf width was relatively uniform for all species, although all were slightly smaller under dryland conditions. Maximum leaf widths were obtained about the time of most rapid growth in April.

Protein Content

Protein, on a dry matter basis, was determined for six varieties for both the proper level and the heavy level of clipping in 1968-69, but only for the proper level in 1969-70 (Table 2).

All species, though varying slightly in protein content, show similar patterns throughout the study period for both years. No obvious differences occurred in percent protein between the heavy and the proper height treatments. Generally the protein content was lowest at or just after the end of the flowering period

Table 2. Average crude protein content (%) of irrigated grasses by date of clipping.[1]

Grass	Oct. 1	Nov. 1	Dec. 1	Jan. 1	Feb. 1	Mar. 1	Apr. 1	May 1	June 1	July 1	Aug. 1[2]
A-12496 intermediate wheatgrass	26	23	21	18	18	21	28	19	14	16	21
Largo tall wheatgrass	23	21	20	18	21	21	25	16	13	15	17
Alkar tall wheatgrass	24	20	20	17	19	21	27	19	13	15	18
Jose tall wheatgrass	23	22	21	18	18	20	27	19	14	16	19
Luna pubescent wheatgrass	24	23	21	18	22	20	29	19	14	15	21
Western wheatgrass	22	20	24	(–)[2]	(–)[2]	(–)[2]	22	20	17	17	16

[1] Twenty-four samples for each species were composited for each sampling date through two seasons (1968-1969 and 1969-1970) except August data was collected only in 1969.
[2] No height growth occurred above clipping level.

when most of the species matured. The protein percentage generally reached peak amounts during the periods of most active growth. It was highest at the April clipping for all species except for western wheatgrass in 1968-69 season. Western wheatgrass did not reach its peak protein content until the May clipping in 1968-69. Its highest protein content was in the April, 1970, cutting, however. Protein content generally declined for all species after the April 1 clipping date. This coincides with the beginning of the spring flowering period for most of the species.

Effect of Clipping Height

The two clipping levels caused little difference in total annual forage production. Yields for the heavy use clipping height averaged slightly over 100 lb per acre more than for the level considered proper. Apparently the clipping levels selected did not detrimentally affect growth of the species for the 2 years of clipping. Observations made in June, 1971, indicated, however, that the vigor of the tall wheatgrasses was reduced by both clipping heights. General observations indicate that the intermediate and pubescent wheatgrasses may be able to withstand defoliation better than the tall wheatgrasses at the levels of clipping used. On the other hand, intermediate wheatgrass has been found to have little grazing resistance in Colorado (Dahl et al., 1967; and Currie and Smith, 1970). Because of this evidence and since little is gained at the low levels of clipping, we recommend the moderate clipping heights in judging proper grazing use of these species (Table 1). Because of the insignificant differences in production between clipping heights, the proper use height is used to discuss productivity.

Forage Yields

Three replications of each species were clipped at the proper level at monthly intervals under irrigated and nonirrigated conditions. The cumulated annual production was averaged for the 2-year period for species comparison (Table 3).

Although a first and second year comparison is not shown, production during 1968-1969 was approximately 50% higher than for 1969-70. The reduction in yields could be due to the residual effects of the clipping treatment, but we feel suboptimum irrigation and lack of natural precipitation (Fig. 1) caused the differences. Also, the average production used should better represent the conditions that occur under normal management situations. Under optimum irrigation and management conditions, species yields should be higher than reported here.

The yields under irrigation should reflect the species' relative productive potential. Under irrigation, Sandia orchardgrass and NM-384 tall fescue were the most productive species, while the two native species, Canada wildrye and western wheatgrass, were the least productive.

The tall wheatgrasses generally produced more than the intermediate and pubescent wheatgrasses, but the differences were not statistically significant. Largo tall wheatgrass produced as much

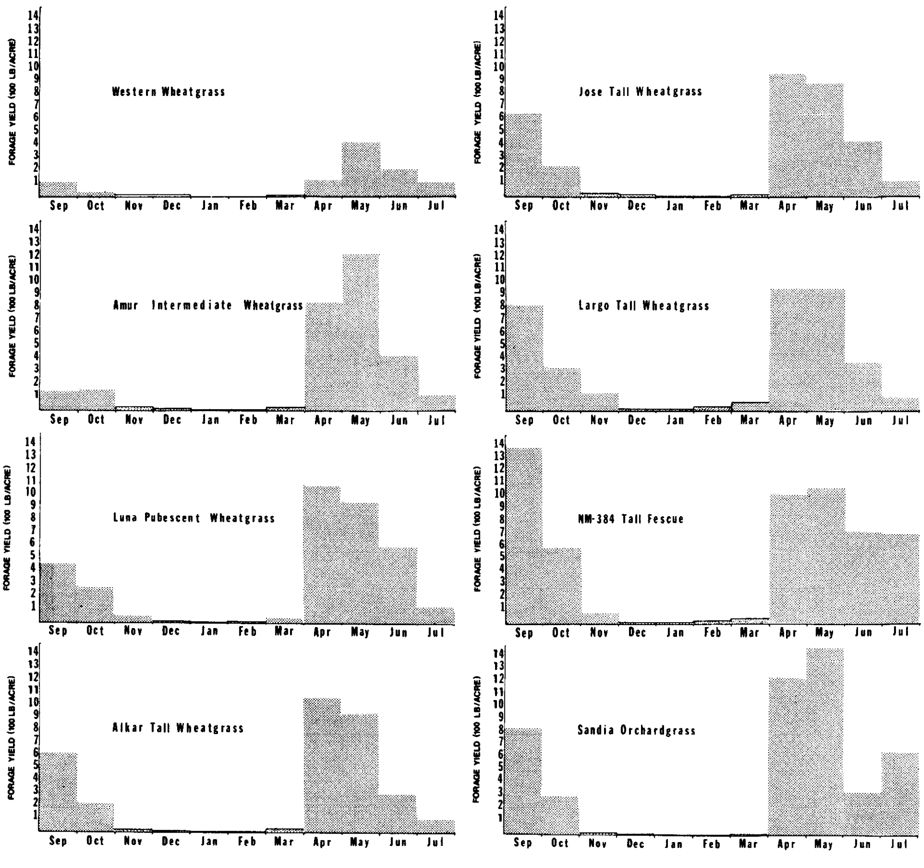

Fig. 3. *Growth pattern and average monthly forage yields for eight cool-season grasses under irrigation, Amarillo, Texas.*

Table 3. Average total annual forage yield (lb/acre, oven-dry) of grasses under irrigated and dryland conditions.[1]

Species	Irrigated production[2]	Dryland production[2]
Sandia orchardgrass	5341 a	1609 abed
NM-384 tall fescue	4817 ab	2127 a
Common orchardgrass	3777 bc	1029 defg
Largo tall wheatgrass	3699 bcd	1788 ab
Jose tall wheatgrass	3332 cd	1464 bcde
Alkar tall wheatgrass	3173 cd	1740 abc
Amur intermediate wheatgrass	2898 cd	1057 defg
Luna pubescent wheatgrass	2868 cd	1146 cdef
A-11701 pubescent wheatgrass	2691 cd	836 efg
A-12496 intermediate wheatgrass	2638 cd	1000 defg
A-1488-MC pubescent wheatgrass	2457 d	953 efg
Western wheatgrass	828 e	475 g
Canada wildrye	693 e	589 fg

[1] For each column, means not sharing a common symbol are significantly different ($P<0.05$) from all others.
[2] Represents herbage produced above a specified height of clipping considered proper to maintain productivity.

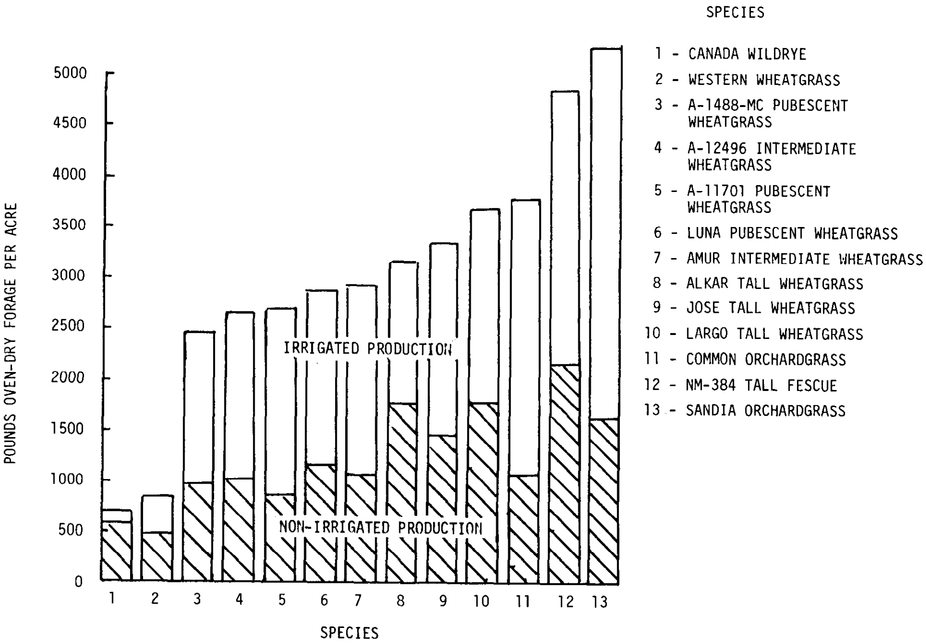

Fig. 4. *Forage yields of 13 cool-season grasses under irrigated and dryland conditions.*

as common orchardgrass and NM-384 tall fescue but not as much as Sandia orchardgrass under irrigation. Under dryland conditions, however, common orchardgrass produced little more than the two native species and less than the tall wheatgrasses.

The three tall wheatgrasses and common orchardgrass produced similar amounts of forage. Although Largo tall wheatgrass produced over 300 lb more than Jose and 500 lb more than Alkar, the difference was not statistically significant.

The three intermediate wheatgrasses and two pubescent wheatgrasses produced similar amounts of forage. They produced 1600 to 1800 lb more forage under irrigation than the two native species.

Sandia orchardgrass and NM-384 fescue show a greater potential for production than the wheatgrasses and the two native species. Their increase in production due to irrigation was relatively much greater than the other species' (Fig. 4). Therefore, if forage production is the criterion for selection, these two species are recommended over the others.

All species were limited by lack of moisture under dryland conditions. They showed differential adaptability to drought conditions, however. Common orchardgrass, which was highly productive under irrigation, produced little more than the two native species under dryland conditions (Fig. 4). Of even more significance is the reaction of the orchardgrass and NM-384 tall fescue under limited irrigation. Irrigation was continued at infrequent intervals during the third season, but clipping was discontinued on all plots. By June 1971 no species survived under dryland conditions, while common orchardgrass, Sandia orchardgrass, and NM-384 tall fescue died out under limited irrigation. On the other hand, the wheatgrasses survived under limited irrigation. Luna pubescent wheatgrass and Largo tall wheatgrass appeared most productive and most resistant to limited moisture of all the species. Because of their productivity and phenological behavior, these species would fit well into a forage system which combines irrigated winter cereals with irrigated cool-season grasses in this region.

These grasses could be used for grazing in late September to November until wheat grazing is ready about December 1. They would again be ready to furnish high protein forage from April, when wheat must be rested for grain production, to June, when summer range would be ready for grazing. With proper proportions of wheat fields, native pasture, and these cool-season perennial grasses under irrigation, a year-round green forage system could be developed.

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