Establishment, Production, and Protein Content of Four Grasses in South Texas

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Highlight: *Old World bluestem and Selection 75 Kleingrass established stands more rapidly and produced more topgrowth the year of seeding than did Bell Rhodesgrass or green sprangletop at three locations in South Texas. Based on crude protein content of foliage at maturity, the grasses ranked Selection 75 Kleingrass > Bell Rhodesgrass, green sprangletop > Old World bluestem. Old World bluestem foliage contained only slightly more than 6% crude protein at maturity. However, crude protein content of Old World bluestem, Bell Rhodesgrass, and green sprangletop decreased only slightly from maturity to dormancy. Selection 75 Kleingrass crude protein levels in foliage dropped from about 13% at maturity to less than 9% during dormancy.*

The South Texas Plains consists of over 8 million hectares, most of which is utilized as grazing lands (Gould, 1969). The area is characterized by growing seasons of longer than 300 days, an average rainfall of 75 to 90 cm, and droughty summers. Topography is level to gently rolling and soils are highly variable. Vegetation of the South Texas Plains is characterized by heavy stands of mixed brush (*Prosopis-Acacia*). Effective range improvement practices, especially brush control and revegetation, are required for conversion of this "brush country" to highly productive range.

Following disturbance from practices such as mechanical brush control, natural revegetation through secondary succession is usually too slow to provide the early competitiveness necessary to preclude reinvasion by brush species. Native grasses ordinarily return to cleared rangeland in 2 to 4 years depending upon rainfall and intensity of grazing use (Carter, 1958). Seeds of many native grass species are unavailable commercially. Some introduced grasses such as buffelgrass (*Cenchrus ciliaris* L.) and Bermudagrass (*Cynodon dactylon* (L.) Pers.) have proven superior to resident species in forage production and quality. Therefore, artificial revegetation using adapted introduced grasses with an available seed source is frequently the most economical alternative for the landowner. However, lack of cold-tolerant strains of buffelgrass limit its use in the northernmost portions of the South Texas Plains; and recent increases in cost of nitrogen fertilizer have reduced the advantage of Bermudagrass as pasture.

A limited number of species which do not require intensive management are available for artificial revegetation in South Texas. Before seeding expenses are incurred, adaptability and productivity of the species must be evaluated. Green sprangletop is a short-lived bunchgrass used as a filler-grass for range seeding mixtures. A native, it is apparently well adapted to a wide variety of soil and climatic conditions. Results from grazing trials indicate that Kleingrass offers promise for producing good gains in a normal growing season and for

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winter grazing of cattle in South Texas (Holt and Conrad, 1967). Bell Rhodesgrass is a vigorous, upright perennial developed specifically for South Texas (Anonymous, 1966). Old World bluestem ('PMT-587') is an introduced, warm-season bunchgrass which, although not yet released commercially, has been studied since the 1960's by the Soil Conservation Service. It is apparently adapted to many areas in Texas and has shown promise as a forage species in field studies.[1]

The objectives of this study were to compare the establishment success, production, and protein content of the introduced species, Kleingrass (*Panicum coloratum* L. cv. "Selection 75"), Rhodesgrass (*Chloris gayana* Kunth. cv. "Bell") and Old World Bluestem composite (*Dicanthium* sp.), and green sprangletop (*Leptochloa dubia* (H.B.K.) Nees), a native species in South Texas. Variables studied for comparison of the four grasses included (1) emergence and seedling development as influenced by various soil types; (2) oven-dry forage production on three range sites; and (3) the crude protein content of the first-year plants.

Materials and Methods

Site Descriptions

Seedling emergence and development of the grasses were evaluated during 1973 in South Texas on a Sarita fine sandy loam and a Lomalta clay loam site near San Perlita in Willacy County. Two experiments were established, one in 1973 and the other in 1974, on a Lakeland loamy fine sandy site on the Texas A&M University Range Research Area near College Station.

The Sarita fine sandy loam is classified as a deep sand range site. It is level to gently sloping with drainage primarily through the soil profile. Soils are deep with neutral, pale-brown, fine, sand surfaces and mottled, sandy clay subsoils. The fine sand surface ranges from 50 to 200 cm deep and averages about 100 cm. Potential vegetation should probably be open grassland or a honey mesquite (*Prosopis glandulosa* Torr. var. *glandulosa*) savannah characterized by mid- and tall-grasses. At the time of this study, the site supported a heavy brush cover dominated by honey mesquite, spiny hackberry (*Celtis pallida* Torr.), huisache (*Acacia farnesiana* (L.) Willd.), lime pricklyash (*Zanthoxylum fagara* (L.) Sarg.), and pricklypear (*Opuntia* sp.).

The Lomalta clay loam was classified as a salty prairie range site. This site occurs on low flat areas near the coast and usually ranges from 1 to 3 m above sea level. Soils vary from sandy loam to clay and are usually underlain with a slowly permeable clay subsoil. Soil salinity is variable but may create problems on some of the heavier-textured soils. Potential vegetation is probably open grassland dominated by gulf cordgrass (*Spartina spartinae* (Trin.) Merr.) with considerable amounts of seacoast bluestem (*Schizachyrium scoparium* (Michx.) Nash var. *littoralis* (Nash) Gould) in localized areas especially at the higher elevations. The area now supports a heavy brush canopy of species previously mentioned for the deep sand range site.

The Lakeland loamy fine sand is a deep or moderately deep soil with a dense claypan. This site near College Station was used to represent the northern extremity of the South Texas area. The sandy loam topsoil ranges from 15 to 30 cm deep. The surface soil takes in water readily but the tight clay subsoils are slowly permeable and restrict air movement and root growth. The slow permeability and shallow topsoil cause the site to be wet in winter, slow to warm up in summer, and droughty during the growing season. These soils are often referred to as "claypan" soils. The climax plant community is a post oak (*Quercus stellata* Wang.)-blackjack oak (*Quercus marilandica* Muenchh.) savannah. Grasses such as little bluestem (*Schizachyrium scoparium* Michx.), yellow Indiangrass (*Sorghastrum nutans* (L.) Nash), and brownseed paspalum (*Paspalum plicatulum* Michx.) dominate the herbaceous layer.

Plot Establishment

Bell Rhodesgrass and green sprangletop seeds were purchased from a commercial source near Uvalde in the Rio Grande Plains. Selection 75 Kleingrass and Old World bluestem were obtained from the Soil Conservation Service Plant Materials Center at Knox City, Texas. At each location during 1973, plots consisted of three rows about 5 m long and 53 cm apart. Plots were arranged in a randomized complete block design with two replications. Seedbeds were prepared by lightly discing or with a small garden tiller. Caryopses were hand-planted on May 15 near College Station and June 10, 1973, near San Perlita at a rate of 105 live caryopses/m of row. Plots were fenced to preclude grazing by domestic animals.

The number of seedlings emerged, average number of leaves per plant, and average height of 20 randomly selected plants of each species were recorded at monthly intervals near San Perlita and at weekly intervals near College Station for the first 4 months after planting. Seedling emergence was recorded from 0.3 m of the center of the middle row of each plot. Height (with uppermost leaves extended) change per unit time (cm/day) was utilized to develop comparative growth rates for the grasses.

Topgrowth from the entire plots near College Station was clipped to a 5-cm stubble height at 4- and 8-months after planting, oven dried, and weighed. Topgrowth production from plantings near San Perlita was estimated by clipping 50 cm in the center of the middle row in each plot 4 months after planting. Entire plots were harvested from each location in August, 1974.

Green tissue was sampled at maturity and at 4 and 8 months after planting near College Station for analysis of crude protein content. Fresh tissue was separated into leaves and culms immediately following harvest, placed in plastic bags, and frozen. The samples were analyzed by the Texas A&M University Agricultural Analytical Service using the Kjeldahl procedure (Ass. Offic. Agr. Chem., 1960) for nitrogen determination. Leaf:stem ratios of the grasses were determined using fresh weights to allow comparison of crude protein contents.

On May 6, 1974, each species was seeded in 5.5 by 15 m plots in rows 25 cm apart. A "Nesbit"[2] drill was used to plant the caryopses at 0.6 to 1.2 cm deep. The drill was calibrated but due to differential characteristics of the seeds, seeding rates [kg P.L.S. (pure live seed)/ha] varied with 2.25 for Bell Rhodesgrass, 2.21 for green sprangletop, 2.50 for Old World bluestem, and 3.02 for Selection 75 Kleingrass. Plots were arranged in a randomized complete design with three replications. Stand counts in six, 0.25-m^2 subsamples per plot were made on December 4, 1974. Percentage emergence was based on initial seeding rate, and analysis of covariance was used to adjust yield based on density due to the differential seeding rates.

Results and Discussion

Seedling Emergence

Old World bluestem was the most successful species relative

[1] Personal communication with Arnold Davis, regional plant materials specialist, Southern Regional Technical Service, Center, Ft. Worth, Tex., and D. B. Polk, Sr., state resource conservationist, U.S. Dep. Agr., and Soil Conserv. Serv., Temple, Tex.

[2] Mention of a tradename does not necessarily imply endorsement by the Texas Agricultural Experiment Station of any proprietory product over others used for the same purpose.

Table 1. Average seedling emergence (%) 30 days after planting four selected grasses from soils of three range sites in the early summer of 1973 in South Texas.[a]

Species	Soil[b] Lakeland lfs	Sarita fsl	Lomalta cl	Avg
Old World bluestem	92 r	14 t	29 t	45 x
Selection 75 Kleingrass	63 s	23 t	14 t	33 x
Bell Rhodesgrass	3 t	3 t	0 u	2 y
Green sprangletop	27 t	1 u	0 u	9 y
Average	46 a	10 b	11 b	

[a]Means followed by the same letter are not significantly different at the 90% level.
[b]lfs = loamy fine sand, fsl = fine sandy loam, and cl = clay loam.

to seedling establishment in 1973 (Table 1). However, percentage emergence varied considerably among sites, from 14% on the Sarita fine sandy loam to 92% on the Lakeland loamy fine sand. Since the same seed lot and seedbed preparation techniques were used at all locations during 1973, the differences probably reflect site characteristics and planting date. Earlier plantings near College Station probably allowed maximum benefit of early moisture and milder temperatures. About 21 cm of rainfall was received on plots near College Station within 30 days after planting whereas only 2 cm was received near San Perlita. Near College Station, average high air temperature was about 23°C the month following seeding whereas it exceeded 28°C near San Perlita.

Mean emergence of Selection 75 Kleingrass, 33%, was not significantly different from that of Old World bluestem in 1973 (Table 1). Only on the Lakeland loamy fine sand site was Kleingrass emergence less than that of Old World bluestem. Selection 75 Kleingrass was the most successful species, based on seedling emergence in 1974 on the Lakeland loamy fine sand. Over 80% of the Kleingrass seedlings emerged by 85 days after planting as compared to 64% for Old World bluestem.

Bell Rhodesgrass and green sprangletop were the least successful species regardless of site or year of study. Seedling emergence of Bell Rhodesgrass averaged only about 2% in 1973 and was not significantly different from green sprangletop (Table 1). Although over 30% of the Bell Rhodesgrass live seeds emerged in 1974 on the same site, Selection 75 Kleingrass and Old World bluestem were more successful.

Emergence of all grasses averaged 35% higher on the Lakeland loamy fine sand than on sites near San Perlita in 1973 (Table 1). There were no differences within species in percentage seedling emergence on the Lakeland loamy fine sand between evaluations at 30 and 60 days after planting. Therefore, late seedling emergence or seedling mortality was not a factor in evaluation of early seedling establishment. However, production estimates the year after seeding (1974) indicated that fall emergence of Bell Rhodesgrass and green sprangletop occurred (Table 3).

Growth and Development

Selection 75 Kleingrass was the most rapidly growing of the species studied near College Station during 1973. Kleingrass was mature (caryopses fully developed) about 70 days after planting with an average height of about 63 cm. Near San Perlita, Selection 75 Kleingrass was mature about 85 days after planting.

Old World bluestem matured more slowly than the other species. It was not mature until 115 days after planting near College Station and 95 days after planting near San Perlita in 1973. This might be advantageous for extending grazing into the fall period when other species are mature. Old World bluestem reached an average height of 96 cm at maturity in 1973 near College Station. The stems appeared rather coarse as compared to the other grasses. Old World bluestem might be benefited by topgrowth removal the seedling year to reduce coarseness and promote leafiness.

At maturity, 70 days after planting in 1973, Bell Rhodesgrass had reached a mean height of 57 cm near College Station. Near San Perlita, Bell Rhodesgrass matured 85 days after planting, approximately the same time as Kleingrass. Green sprangletop reached maturity in 85 days at both locations in 1973.

All species produced caryopses within 80 days after clipping to a 5-cm stubble height at 120 days after planting (September) in 1973 near College Station. The grasses initiated new growth at about the same time in late February, 1974.

Topgrowth Production

Four months after planting in 1973, Old World bluestem produced the most topgrowth of the grasses studied regardless of location (Table 2). It was best adapted to the Lakeland loamy fine sand. Old World bluestem did not produce significantly more herbage than Selection 75 Kleingrass on the Sarita fine sandy loam and Lomalta clay loam sites near San Perlita. Near College Station, in the 1973 seedling year, Old World bluestem exceeded the second most productive species, Kleingrass, by 0.3 kg/m of row. Old World bluestem was the most productive species in 1974 near College Station, yielding 6,160 kg/ha in December after seeding in May.

Table 2. Topgrowth production (kg/m of row) 4 months after planting four species of grass in rows 53 cm apart on three rante sites in 1973 in South Texas.[a]

Species	Soil[c] Lakeland lfs	Sarita fsl	Lomalta cl	Avg
Old World bluestem	.52 a	.16 b	.13 b	.26 x
Selection 75 Kleingrass	.22 b	.08 b	.09 b	.13 y
Bell Rhodesgrass	.17 b	.01 c	T[b] c	.06 z
Green sprangletop	.09 b	T[b] c	T[b] c	.03 z
Average	.27 m	.06 n	.05 n	.13

[a]Means followed by the same letter are not significantly different ($p \geq .1$).
[b]T = trace amounts. Green sprangletop and Bell Rhodesgrass were not encountered in the samples but were noted in other portions of the plot.
[c]lfs = loamy fine sand, fsl = fine sandy loam, and cl = clay loam.

Selection 75 Kleingrass was the second most productive species based on mean yields across study sites in 1973 (Table 2) and near College Station in 1974. Only on the Lakeland loamy fine sand were differences in yields between Selection 75 Kleingrass, Bell Rhodesgrass, and green sprangletop not significant. Yields in 1974 for Selection 75 Kleingrass were 2,400 kg/ha, significantly less than that previously mentioned for Old World bluestem. On the Sarita fine sandy loam and Lomalta clay loam sites in 1973, Selection 75 Kleingrass produced 0.08 to 0.09 kg/m topgrowth, whereas green sprangletop and Bell Rhodesgrass did not establish successful stands (Table 2).

Green sprangletop stands were so sparse on the Sarita fine sandy loam and Lomalta clay loam sites that it was not present in the center row samples the fall after seeding in 1973 (Table 2). However, trace amounts were recorded since it was noted

in other portions of the plots. Also, green sprangletop produced less than 50 kg/ha topgrowth from 1974 plantings near College Station. Bell Rhodesgrass did not establish a stand on the Lomalta clay loam site in 1973 (Table 2). On the Lakeland loamy fine sand site, Bell Rhodesgrass exhibited extreme variation between replications and averaged 0.17 kg/m of row. Bell Rhodesgrass seeded in May, 1974, yielded 3,160 kg/ha topgrowth in December, which reflected better stands than those developed during 1973. Yield from 1974 plantings was no different from that of Selection 75 Kleingrass but less than that of Old World bluestem.

Near College Station, the grasses produced more forage during the summer (May to September) than during the fall (October to January) of 1973. However, forage production differed less among species during October to January than during early part of establishment, from May to September. Old World bluestem, Selection 75 Kleingrass and Bell Rhodesgrass produced from 0.05 to 0.06 kg/m of row during the period from October to January, 1973. Green sprangletop yielded only about 0.02 kg/m during the same period. Bell Rhodesgrass was the only species which yielded the same amount of topgrowth during October to January as during May to September.

The year after seeding in 1973, highest average topgrowth production occurred on the Lakeland loamy fine sand (Table 3). As it did during the seedling year, Old World bluestem produced more herbage than the other grasses the year after seeding. Bell Rhodesgrass and green sprangletop developed poor stands on the sites near San Perlita and stands were sparse near College Station in 1974 after seeding in 1973.

Table 3. Topgrowth production (kg/m of row) in July, 1974, after seeding 4 species of grasses in rows 53 cm apart in late spring and early summer of 1973 at three locations in Texas.[a]

Species	Soil[c] Lakeland lfs	Sarita fsl	Lomalta cl	Avg
Old World bluestem	0.73 d	0.55 c	0.55 c	0.50 r
Selection 75 Kleingrass	0.64 cd	0.02 a	0.16 ab	0.27 s
Bell Rhodesgrass	0.24 b	0.02 a	0.01 a	0.09 c
Green sprangletop	0.13 ab	T[b] a	T[b] a	0.05 t
Average	0.44 x	0.15 y	0.10 y	

[a]Means followed by the same letter are not significant at the 90% level.
[b]T = trace amounts, less than 0.01 kg/m.
[c]lfs = loamy fine sand, fsl = fine sandy loam, and cl = clay loam.

Crude Protein

Crude protein content was determined only during the seedling year from 1973 plantings. Mature Selection 75 Kleingrass foliage contained higher levels of crude protein than other species studied (Fig. 1). Foliage of Bell Rhodesgrass and green sprangletop contained less crude protein than Selection 75 Kleingrass but almost twice the amount of that in mature foliage of Old World bluestem. As expected, mature culms of all species contained less crude protein than did the foliage. Both culms and foliage of Old World bluestem contained less crude protein than did those of the other species. Culms of green sprangletop were higher in crude protein than those of other species, improving overall forage value.

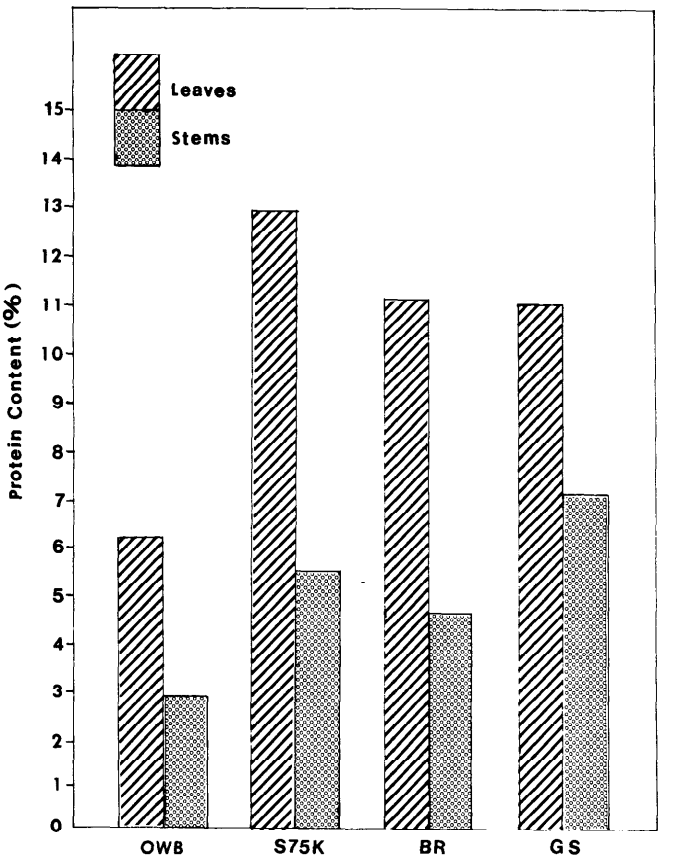

Fig. 1. *Crude protein content (%) of leaves and stems of Old World bluestem (OWB), Selection 75 Kleingrass (S75K), Bell Rhodesgrass (BR), and green sprangletop (GS) at maturity the year of seeding a Lakeland loamy fine sand near College Station, Tex.*

Crude protein levels of Old World bluestem, Bell Rhodesgrass, and green sprangletop plants from dormant samples collected in January were about the same as at maturity. However, protein content of Selection 75 Kleingrass dropped to less than 9%, due to weathering from September to January.

Generally, it is expected that the greater the degree of leafiness, the greater the percentage of crude protein in grasses. Old World bluestem and Bell Rhodesgrass exhibited the lowest leaf:stem ratio and crude protein content in September, while Kleingrass and green sprangletop contained the highest amount of crude protein and the highest leaf:stem ratio. Although the other grasses contained about the same amount of crude protein, Bell Rhodesgrass had the highest leaf:stem ratio relative to crude protein content.

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