Density and Production of Seeded Range Grasses in Southeastern Arizona (1970-1982)

JERRY R. COX AND GILBERT L. JORDAN

Abstract

Accessions A-68, L-11, L-19, L-28, and L-38 of Lehmann lovegrass (*Eragrostis lehmanniana* Nees); P-15608 Cochise lovegrass (*E. lehmanniana* Nees X *E. trichophora* Coss & Dur.); A-84 and Catalina boer lovegrass (*E. curvula* var. conferta Nees); Palar Wilman lovegrass (*E. superba* Peyr.) and P-15630 blue panicgrass (*Panicum antidotale* Retz.) were seeded at a study site near San Simon, Ariz., in spring 1970 and 1971. Seedbeds were prepared by root plowing and furrow pitting immediately before planting. Growing season precipitation was 136 mm in 1970 and 218 mm in 1971. Mean accession densities in the fall after the initial growing seasons were 18 plants/m² for both the 1970 and the 1971 plantings. Between fall 1971 and 1972 mean accession densities declined 44% and forage production was unchanged on the 1970 plantings. Accession densities declined 22% and forage production increased 250% on the 1971 plantings. Between fall 1972 and 1982 the majority of seeded plants died and forage production declined 90% on the 1970 plantings. Accession densities declined 78% and forage production declined 84% on the 1971 plantings.

Southeastern Arizona and southwestern New Mexico rangelands were overutilized and deteriorated rapidly between 1880 and 1900. Griffith (1901) documented the deterioration and corresponding livestock losses. Cooperative studies to restore these rangelands were initiated in the early 1900's by the Division of Agrostology (USDA) and State Experiment Stations at Tucson, Ariz., and Las Cruces, N. Mex.

Blount (1892), Griffith (1907), Keefer (1899), and Thornber (1905) seeded native and introduced grasses on irrigated and rangeland sites and evaluated emergence and survival. Teff [*Eragrostis abyssinica* (Jacq.) Link.] emerged on irrigated and nonirrigated sites, but long-term survival occurred only at irrigated sites.

Native grass either failed to emerge or to survive at southwestern revegetation sites between 1910 and 1934 (Barnes et al. 1958, Cassady 1938, Glendening 1937, and Hendricks 1936). Numerous grass, forbs, and shrub species were introduced after 1930 (Cox et al. 1982). These introduced species were screened for germination, drouth tolerance, and seed production potential at Soil Conservation Service Plant Materials Centers, and a few promising grasses were released for rangeland plantings. Among these were A-68 Lehmann lovegrass and A-84 boer lovegrass; both were introductions from southern Africa.

Lovegrass species and newly developed accessions were sown in summer (Bridges 1941 and Herbel et al. 1973) and fall (Bridges 1941) at desert sites in southern New Mexico. A-68 Lehmann and A-84 boer lovegrasses emerged in moist summers, and A-68 emerged in wet winters at lower elevations.

Jordan (1970) conducted studies for 9 years to determine the best combinations of mechanical brush control, seedbed preparation, and time of seeding for emergence and survival of forage grasses at 3 sites in southeastern Arizona. A-68 Lehmann lovegrass emergence and survival was optimized when root plowing and pitting were used to control brush and prepare the seedbed in spring, and when seed were sown immediately after a mechanical treatment. Comparative seedling trials were conducted to select adapted lovegrass and blue panicgrass accessions at a study site near San Simon, Ariz., in 1970 and 1971. The purpose of this paper is to quantitatively document and compare initial and long-term plant densities and forage production for these seeding trials.

Study Site and Methods

The study site is located 25 km southwest of San Simon, Ariz., near the Arizona-New Mexico State Line in southeastern Arizona. Average annual precipitation is 280 mm, and 30 to 40% occurs in winter. Winter months (November to March) are cold, dry, and windy, and typical of the Chihuahuan Desert (Mabry et al. 1977). Winter precipitation is either evaporated or transpired by shrubs, and apparently not used by seeded grasses (Jordan 1970).

Effective summer precipitation falls in late July through October and varied from 98 to 230 mm at San Simon between 1972 and 1982 (National Oceanic and Atmospheric Administration, Annual Climatological Data Summaries 1972–1982). Mean summer precipitation was 165 mm over the 10 years. Figure 1 shows the departure of annual summer precipitation from the 10-year average. Average annual air temperature is 17°C and the frost-free period is 220 days. Soils are deep, well drained, and formed in old alluvium from mixed sources. Soils are classified as Eba gravelly sandy loam, mixed, thermic Typic Haplargids (Vogt 1980).

Native perennial grass forage production was 2.5 to 5.0 g/m² on

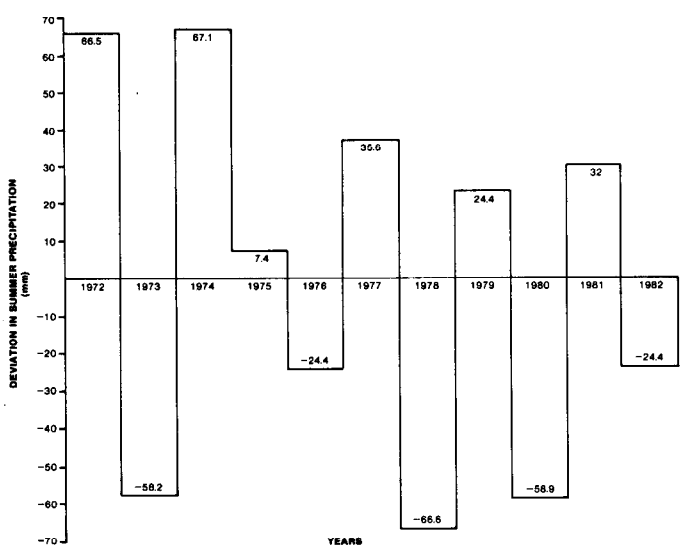

Fig. 1. *Deviation in summer precipitation totals (mm) between 1972 and 1982 at San Simon, Ariz. (National Oceanic and Atmospheric Administration, Annual Climatological Data Summaries).*

The authors are range scientist, USDA, Agr. Res. Serv., Arid Land Ecosystems Improvement, 2000 East Allen Road, Tucson, Ariz. 85719; and professor, range management, School of Renewable Natural Resources, University of Arizona, Tucson 85719.

This paper is published with approval of the Director, University of Arizona College of Agriculture, Agricultural Experiment Station, as Paper No. 3705. The paper reports on work supported by the U.S. Department of the Interior, Bureau of Land Management, and is a cooperative investigation of Agr. Res. Serv., USDA, and the Arizona Agr. Exp. Sta., University of Arizona.

Manuscript received January 20, 1983.

untreated and ungrazed areas within the fenced study site in 1982. The area was possibly a semidesert grassland (Humphrey 1958) but is now dominated by shrubs. Creosotebush [*Larrea tridentata* (DC.) Cov.], tarbush (*Flourensia cernua* DC.), dune mesquite (*Prosopis glandulosa* Torr. var. glandulosa), and fourwing saltbush [*Atriplex canescens* (Pursh) Nutt.] are found on uplands; catclaw (*Acacia greggii* A. Gray) is found in washes.

Root plowing at 45 to 55-cm depths and furrow pitting, in a single pass, were used to control shrubs and prepare a seedbed in March 1970 and 1971. The seedbed was divided into 14 × 30-m plots in 1970 and 14 × 45-m plots in 1971. The following grass accessions were broadcast seeded in March, immediately after seedbed preparation, on plots arranged in a completely randomized block design with 1 plot of each accession in each of 4 blocks: (1) A-68 and experimental accessions L-11, L-19, L-28, and L-38 Lehmann lovegrass; (2) A-84 and Catalina boer lovegrasses; (3) P-15608 Chochise lovegrass; (4) Palar Wilman lovegrass; and (5) P-15630 blue panicgrass. Lehmann, boer, and Cochise lovegrasses were seeded at 0.5 kg/ha P.L.S. (Pure Live Seed).

Wilman lovegrass and blue panicgrass were seeded at 1.5 kg/ha (P.L.S.). A-68 Lehmann and A-84 boer lovegrasses have been seeded at many sites in southeastern Arizona, southern New Mexico, southwestern Texas, and northern Mexico (Cox et al. 1982) and were included for comparison standards.

Density and forage production were estimated in October or November by placing 20 0.3 × 1.5-m quadrats at random intervals on diagonal transects across each plot. Plants of seeded accessions in each quadrat were counted and harvested by clipping at 2.5 cm above the soil surface. Density and forage sampling was conducted in 1970, 1971, 1972, and 1982 on 1970 plantings and in 1971, 1972, and 1982 on 1971 plantings, forage samples were not collected in 1970. Forage samples were dried at 80°C for 48 h in a forced-air oven.

Density and forage production from the 20 quadrats in each plot were averaged, and the plot mean was considered a replication. Accession means were compared within each sampling date and planting date. Data were subjected to analysis of variance and accession means were compared using Duncan's new multiple range test when F values were significant at $P \leq 0.05$ (Steel and Torrie 1960).

Results and Discussion

1970 Plantings

Total precipitation during the July to October growing season was 136 mm and occurred in 12 storms during 1970. Five storms occurred between July 21 and July 27, but only 2 were measurable events (Fig. 2). Seedlings began to emerge on August 6 following a 28-mm storm on August 1, and 2 small storms on July 31 and August 1. Single storms occurred on August 16, September 1 and 11. A total of 34 mm fell on October 1 and 2.

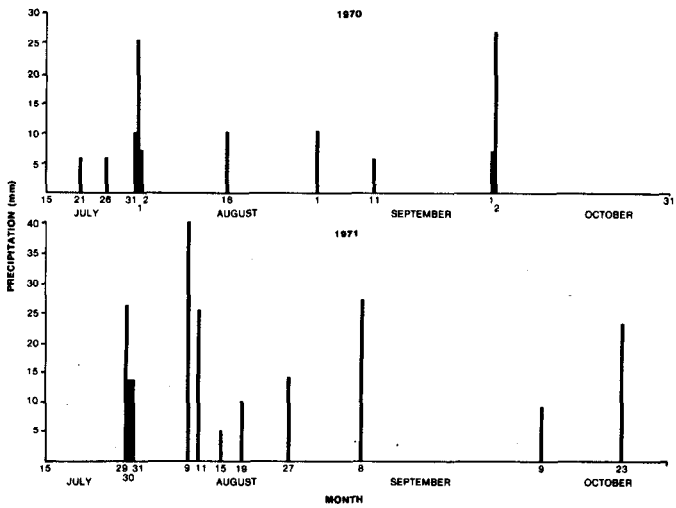

Fig. 2. *Summer precipitation (mm) distribution and amounts at the San Simon study site in 1970 and 1971.*

Acceptable stand densities were one plant/m² (Cox et al. 1982). A-68 Lehmann lovegrass, A-84 and Catalina boer lovegrass, Cochise lovegrass ,and Wilman lovegrass densities were superior to experimental Lehmann lovegrasses and blue panicgrass following the initial growing season (Table 1). Mean accession densities declined 44% by 1971. Only small reductions in density were observed from the experimental Lehmann lovegrass accessions with the exception of L-38, which increased in density between 1970 and 1971. Major density declines were observed for the remaining lovegrasses and blue panicgrass.

Mean accession densities declined an additional 50% by fall 1972 on the 1970 plantings (Table 1) but all accessions had acceptable stand densities. A-68 Lehmann lovegrass had significantly greater density than all other accessions, and experimental Lehmann lovegrass accession densities were generally greater than boer, Cochise, and Wilman lovegrasses, and blue panicgrass; but differences were not always significant. The majority of plants sampled in fall 1972 had died by 1982. Only L-19 Lehmann lovegrass and A-84 boer lovegrass were still present in acceptable stands in 1982.

Mean accession forage production was 60 and 61 g/m² in fall 1971 and 1972, respectively, and declined 90% in 10 years (Table 1). L-11, L-28, and L-38 Lehmann lovegrass forage production was greatest in 1971, and L-28 and L-38 were greatest in 1982.

Table 1. Density and production of lovegrasses and blue panicgrass seeded in March 1970 at San Simon, Ariz. Evaluations were made in fall 1970, 1971, 1972, and 1982.

Species[1]	Accession	Density (Plants/m²)				Production (g/m²)		
		1970	1971	1972	1982	1971	1972	1982
Lehmann lovegrass	A-68	32^{a}	14^{a}	12^{a}	***	47^{b}	54^{c}	1^{b}
	L-11	6^{d}	5^{b}	5^{bc}	***	108^{a}	70^{b}	3^{b}
	L-19	12^{cd}	8^{b}	6^{b}	1	48^{b}	73^{b}	12^{a}
	L-28	14^{c}	14^{a}	7^{b}	*	114^{a}	117^{a}	7^{b}
	L-38	6^{d}	19^{a}	6^{b}	***	106^{a}	94^{a}	3^{b}
Cochise lovegrass	P-15608	22^{b}	8^{b}	4^{bc}	**	27^{c}	49^{c}	3^{b}
Boer lovegrass	A-84	24^{b}	5^{b}	3^{c}	1	23^{c}	51^{c}	14^{a}
	Catalina	29^{a}	6^{b}	2^{c}	*	27^{c}	29^{c}	5^{b}
Wilman lovegrass	Palar	25^{ab}	14^{a}	4^{c}	*	66^{b}	49^{c}	5^{b}
Blue panicgrass	P-15630	15^{c}	6^{b}	2^{c}	**	39^{c}	23^{c}	8^{ab}
	$\bar{X}$	18	10	5		60	61	6

[1]Means in columns followed by the same superscripts are not significantly different ($P \leq 0.05$).
*Density was 0.6 to 0.9 plants/m².
**Density was 0.2 to 0.5 plants/m².
***Density was less than 0.2 plants/m².

Table 2. Density and production of lovegrasses and blue panicgrass seeded in March 1971 at San Simon, Ariz. Evaluations were made in fall 1971, 1972, and 1982.

Species	Accession[1]	Density (Plants/m²)			Production (g/m²)		
		1971	1972	1982	1971	1972	1982
Lehmann lovegrass	A-68	25[a]	17a	4[a]	46[bc]	128[d]	7[c]
	L-11	22[a]	19[a]	2[b]	86[a]	181[ab]	5[c]
	L-19	14[b]	12[b]	2[b]	25[c]	104[d]	10[c]
	L-28	19[b]	14[b]	2[b]	81[a]	200[a]	8[c]
	L-38	17[b]	15[ab]	2[b]	86[a]	173[b]	12[c]
Chochise lovegrass	P-15608	21[ab]	16[b]	3[ab]	52[b]	177[b]	38[b]
Boer lovegrass	A-84	21[ab]	12[b]	5[a]	30[c]	89[e]	60[a]
	Catalina	24[a]	18[a]	5[a]	37[c]	147[c]	31[b]
Wilman lovegrass	Palar	13[b]	12[b]	2[b]	49[b]	116[d]	11[c]
Blue panicgrass	P-15630	7[c]	6[c]	4[a]	*	52[e]	38[b]
	$\bar{X}$	18	14	3	55	137	22

[1]Means in columns followed by the same superscripts are not significantly different ($P \leq 0.05$).
*Grazed.

1971 Plantings

Total precipitation during the July to October growing season was 218 mm and occurred in 11 storms (Fig. 2). Storms of 26, 13, and 13 mm occurred on July 29, 30, and 31, and seedlings began to emerge on August 3. Storms of 40, 25, 5, 10, 14, and 27 mm occurred at 2 to 11-day intervals between August 9 and September 8; and 9 and 23-mm storms occurred on October 9 and 23, respectively.

A-68 and L-11 Lehmann lovegrasses, Catalina and A-84 boer lovegrasses, and Cochise lovegrass densities were greatest, and L-19, L-28 and L-38 Lehmann lovegrasses and Wilman lovegrass densities were lower but not significantly less than A-84 boer lovegrass and Chochise lovegrass in 1971 (Table 2). Mean accession densities were 18 plants/m² in 1971 and 14 plants/m² in 1972 on the 1971 plantings. Mean accession densities declined 78% between 1972 and 1982 on the 1971 plantings.

Comparisons of 1970 and 1970 Plantings

Mean accession densities were 18 plants/m² after the initial growing seasons on the 1970 and 1971 plantings (Tables 1 and 2). Moisture from the 5 early summer storms in 1970 (Fig. 2) had no effect on germination, but storm distribution and amount following emergence on August 6 did not influence plant size. Average accession heights were 10 cm on the 1970 plantings and 60 cm on the 1971 plantings at the end of the initial growing seasons. Field observations at San Simon in 1970 and 1971, and at San Simon and 2 other planting sites in southeastern Arizona between 1962 and 1969 (Jordan 1970) suggest that: (1) germination and emergence follow single storms or groups of closely spaced storms which deposit 20 mm or more and (2) emergence occurs in late July and August. Therefore, densities and seedling heights in 1970, following the March 1970 plantings, were a result of germination and emergence which occurred in August and September rather than October.

Mean accession forage production was 60 g/m² in 1971 and 61 g/m² in 1972 on the 1970 plantings (Table 1). In contrast, mean forage production increased 250% in the same period on the 1971 plantings (Table 2). Summer precipitation was the same on both planting areas in 1971 and 1972. Therefore, production in these years appears to be related to the summer of initial establishment.

Mean forage production declined 90% on the 1970 plantings and 84% on the 1971 plantings between 1972 and 1982 (Tables 1 and 2), but there was approximately 4 times more aboveground production on the 1971 plantings in 1982. A-84 boer lovegrass production was almost 2 times greater than A-68 Lehmann lovegrass.

Accessions L-11, L-19, L-28, and L-38 Lehmann lovegrass and Catalina boer lovegrass were selected for seedling drouth tolerance and potential forage production (Wright and Dobrenz 1970 and 1973). The results of this study do not suggest that the persistance and production of these accessions are superior to A-68 Lehmann lovegrass and A-84 boer lovegrass, over time.

Densities and forage production in 1982 may have been influenced by growing season precipitation and rodent grazing in the previous 10 years. The regular occurrence of above- and below average summer precipitation totals between 1972 and 1982 (Fig. 1) are typical of what has occurred over the past 50 years in the San Simon Valley (Sellers and Hill 1974). Therefore, the declines in density and forage production measured between 1972 and 1982 are probably typical for the area. Rodent trails and grazing were particularly evident in Cochise lovegrass and A-84 and Catalina boer lovegrass plots seeded in 1971.

Summer precipitation totals and distribution occurring at San Simon in 1971 can be expected in 1 of 10 years, totals and distribution in 1970 in 4 of 10 years as much less total and a more sporadic distribution in 5 of 10 years (Smith 1956, Sellers and Hill 1974). These probabilities are similar for other low precipitation zones in the Chihuahuan Desert (Herbel et al. 1973). Therefore, a successful rangeland seeding could be expected in 1 of 10 years, and densities and forage production could be expected to decline for possibly 10 years even without grazing. If precipitation probabilities, potential forage production, and the costs associated with mechanical brush control, seedbed preparation, and seed production are related only to the expected gain in livestock numbers, then seeding in low precipitation zones in the Chihuahuan Desert should be discontinued (Jordan 1981). Seeding values based on environmental indicators such as erosion control, water quality, wildlife habitat, and resource stability may be important in the long-term but are not currently considered as economic values.

Literature Cited

Barnes, O.K., D. Anderson, and A. Heerwagen. 1958. Pitting for range improvement in the Great Plains and southwest desert regions. USDA, Production Res. Rep. No. 23.

Blount, A.E. 1982. Cereals, forage plants, grasses, clovers, textile plants and sorghums. New Mexico Exp. Sta. Bull. No. 6.

Bridges, J.O. 1941. Reseeding trials on arid range. New Mexico Agr. Exp. Sta. Bull. No. 278.

Cassady, J.T. 1938. Transplanting grass. Cattleman 24:18-19.

Cox, J.R., H.L. Morton, T.N. Johnsen, Jr., G.L. Jordan, S.C. Martin, and L.C. Fierro. 1982. Vegetation restoration in the Chihuahuan and Sonoran deserts of North America. USDA-Agr. Res. Serv. ARM-W-28.

Glendening, G.E. 1937. Improving depleted ranges through artificial revegetation. Western Livestock J. 11:2-4.

Griffith, D. 1901. Range improvement in Arizona. USDA-Bureau of Plant Industry Bull. No. 67.

Griffith, D. 1907. The reseeding of depleted range and native pasture. USDA-Bureau of Plant Industry Bull. No. 117.

Hendricks, B.A. 1936. Vine mesquite for erosion control in southwestern ranges. USDA Leaflet No. 114.

Herbel, C.H., G.H. Abernathy, C.C. Yarbrough, and D.K. Gardner. 1973. Rootplowing and seeding arid rangelands in the southwest. J. Range Manage. 26:193-197.

Humphrey, R.R. 1958. The desert grassland; A history of vegetational changes and an analysis of causes. Botanical Review 24:193-252.

Jordan, G.L. 1970. Effective use of available moisture on the San Simon Watershed. Bureau of Land Management Progress Report.

Jordan, G.L. 1981. Range seeding and brush management. Arizona Agr. Exp. Sta. Bull. No. T81121.

Keefer, C.A. 1899. Grasses and forage crops. New Mexico Agr. Exp. Sta. Bull. No. 32.

Mabry, T.J., J.H. Hunziker, and D.R. Difeo. 1977. Creosotebush: biology and chemistry of Larrea in New World deserts. US/IBP Synthesis Series 6. Dowden, Hutchinson and Ross, Inc. Stroudsburg, Pa.

Sellers, W.D., and R.H. Hill. 1974. Arizona Climate (1931-1972). University of Arizona Press, Tucson.

Smith, H.V. 1956. The climate of Arizona. Arizona Exp. Sta. Bull. No. 279.

Steel, R.G.D., and J.H. Torrie. 1960. Principles and procedures of statistics. McGraw Hill, New York. p. 107-110.

Thornber, J.J. 1905. Range improvement. Arizona Agr. Exp. Sta. 16:17-22.

Vogt, K.D. 1980. Soil Survey of San Simon area Arizona. National Cooperative Soil Survey USDA-Soil Conserva. Serv. and Arizona Agr. Exp. Sta.

Wright, L.N., and A.K. Dobrenz. 1970. Efficiency of water use and seedling drouth tolerance of boer lovegrass, *Eragrostis curvula* Nees. Crop Sci. 10:1-2.

Wright, L.N., and A.K. Dobrenz. 1973. Efficiency of water use and associated characteristics of Lehmann lovegrass. J. Range Manage. 26:210-212.