Seeding Rate and First-Year Stand Relationships for Six Native Grasses[1]

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Highlight

Average first-year plants per foot of row were .37, .64, 1.34, and 2.80 from pure live seed rates of 4, 12, 36, and 108, respectively. Average percent establishment in relation to seeding rate was 9.3, 5.3, 3.7, and 2.6 in the same order. Planting two-species mixtures in various proportions and at increasing rates did not significantly influence plant numbers compared with pure species plantings at similar rates.

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Seeding rate influences grass stands, but the effects have not been studied extensively. Savage (1939) stated that optimum rates of seeding depend on such a wide variety of conditions that few reliable suggestions could be offered. Generalized rate recommendations have suggested adequate quantities of seed be planted to produce a full stand of grass (Plummer et al., 1955; Rummell and Holscher, 1955). Planting excessive amounts of seed was not recommended, however, because of competition for moisture among seedlings (Rummell and Holscher, 1955; Hull, 1944).

Generally, only some of the viable grass seeds planted produce seedlings. Failure to emerge has been attributed largely to soil crusting, diseases, and alternate wetting and drying (Cook et al., 1967). Unfavor-

able seed-zone temperatures probably also contribute to poor emergence.

Although a wide range of seeding rates may result in stands of similar density and production after several years (McGinnies, 1960), initial forage yields are lower from light seeding rates than from heavy ones (McWilliams, 1955). Because grass plantings require one or more growing seasons to become suitable for grazing, optimum densities of initial plants are needed to minimize the length of time for stand establishment. Rapid ground coverage is desirable in all new grass plantings. Sparce seedling stands frequently do not develop adequate ground coverage until tillering gives rise to additional plants. Poor initial stands may never become dominant because of weed and undesirable grass competition.

Preliminary observations were made of grass plantings on silty clay loam soils at Hays, Kansas. Generally, native species with first-year densities of 1 to 2 plants per square foot were ready to be grazed the second growing season unless stand development was delayed by excessive weed competition or drought. It appeared important, therefore, to: (1) determine the relationship between increasing seeding rate and first-year plant stands and (2) compare effects of seeding mixtures in various proportions and at increasing total rates on individual and combined species plant numbers.

Methods

Seeding rates were 4, 12, 36, and 108 pure live seeds (PLS) per linear foot in rows one foot apart. Single species plantings of native grasses were made annually on April 15 for four years in forage sorghum (*Sorghum bicolor* (L.) Moench.) residue. Big bluestem (*Andropogon gerardi* Vitman), switchgrass (*Panicum virgatum* L.), sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.), and western wheatgrass (*Agropyron smithii* Rydb.) were planted each of the four years. Buffalograss (*Buchloe dactyloides* (Nutt.) Engelm.) and blue grama (*Bouteloua gracilis* (H.B.K.) Lag. ex Steud.) were included the last three years.

During the first year, mixtures as well as single species were planted. Two-species combinations of big bluestem, switchgrass, sideoats grama, and western wheatgass were planted at 4, 12, 36, and 108 total PLS per foot of row. All possible 1 to 0, ¾ to ¼, and ½ to ½ ratio combinations were planted at the four rates.

Seedbed preparation consisted of drilling high rates of forage sorghum on summer-fallowed, silty clay loam (Harney series) in late June the year prior to planting grass. The sorghum matured and lodged with no further treatment. Grass plantings were made with a plot drill at ½ to ¾ inch soil depth in the undisturbed residue. The drill, described by Launchbaugh (1965) was equipped with V-belts for measured seed distribution, double-disc furrow openers with depth bands, and positive packers. Grass plots were four 21-foot rows, one foot apart in a randomized block design with 6 replications.

Viable seed quantities for each seeding rate were calculated from indirect purity and germination tests for each planting. Known weights of 2- or 3-year-old seed material were germinated in covered petri dishes with double blotter substrates moistened as needed with a dilute solution of KNO_3. Germination temperatures were alternated on a schedule of 8 hours at 30 C and 16 hours at 20 C. Normal seedlings were counted and removed periodically during a 21-day germination test period. Mean viable seed weights were determined from four replications per germination test and used to calculate necessary weights of seed material for each seeding rate.

First-year grass stands were evaluated by plant counts during the summer each season. The necessary disturbance of seedbed mulch in order to find young grass plants precluded intensive sampling during the period of emergence and seedling development. Furthermore, previous studies showed that plants which emerged from April plantings and were alive late in the growing season had little or no mortality during the following winter and spring (Launchbaugh and Anderson, 1963). The counts, therefore, included living first-year plants, and did not consider any that may have died after seed germination. Sampling consisted of counting the seeded species in two 13-foot row segments of the two center rows of each plot. Statistical interpretations were from analysis of variance of count data, and from regressions of plant stands on seeding rates.

Results and Discussion

Relationships between seeding rates and average first-year plants per foot of row are shown in Figure 1. Plant numbers increased significantly ($P < .05$) with increased seeding rates, but populations were low compared with rates planted. Big bluestem and western wheatgrass had similar linear increases in numbers with increased rate increments; blue grama and switchgrass also had similar, but lower linear increases in plant numbers with increased rates; and sideoats grama and buffalograss numbers had comparable curvilinear increases with increased seeding rates. Average numbers of all species per foot of row from the 4, 12, 36, and 108 pure live seed rates were .37, .64, 1.34, and 2.80 plants, respectively.

There were significant ($P < .05$) negative regressions of percent establishment on seeding rates. Curves in the right column of Figure 1 illustrate the average percentage of seed that developed into first-year plants under increasing seeding rates. The ratio of established plants per unit of seed planted was greatest at the 4 PLS per foot rate, but decreased sharply with concentration of seed in the row. Increasing the rate from 4 to 12 PLS/ft depressed the ratio more than did increasing the rate from 12 to 108 PLS per foot of row. Considering all six grasses, an average of 9.3% of the seed developed established plants at the 4 PLS rate. The aver-

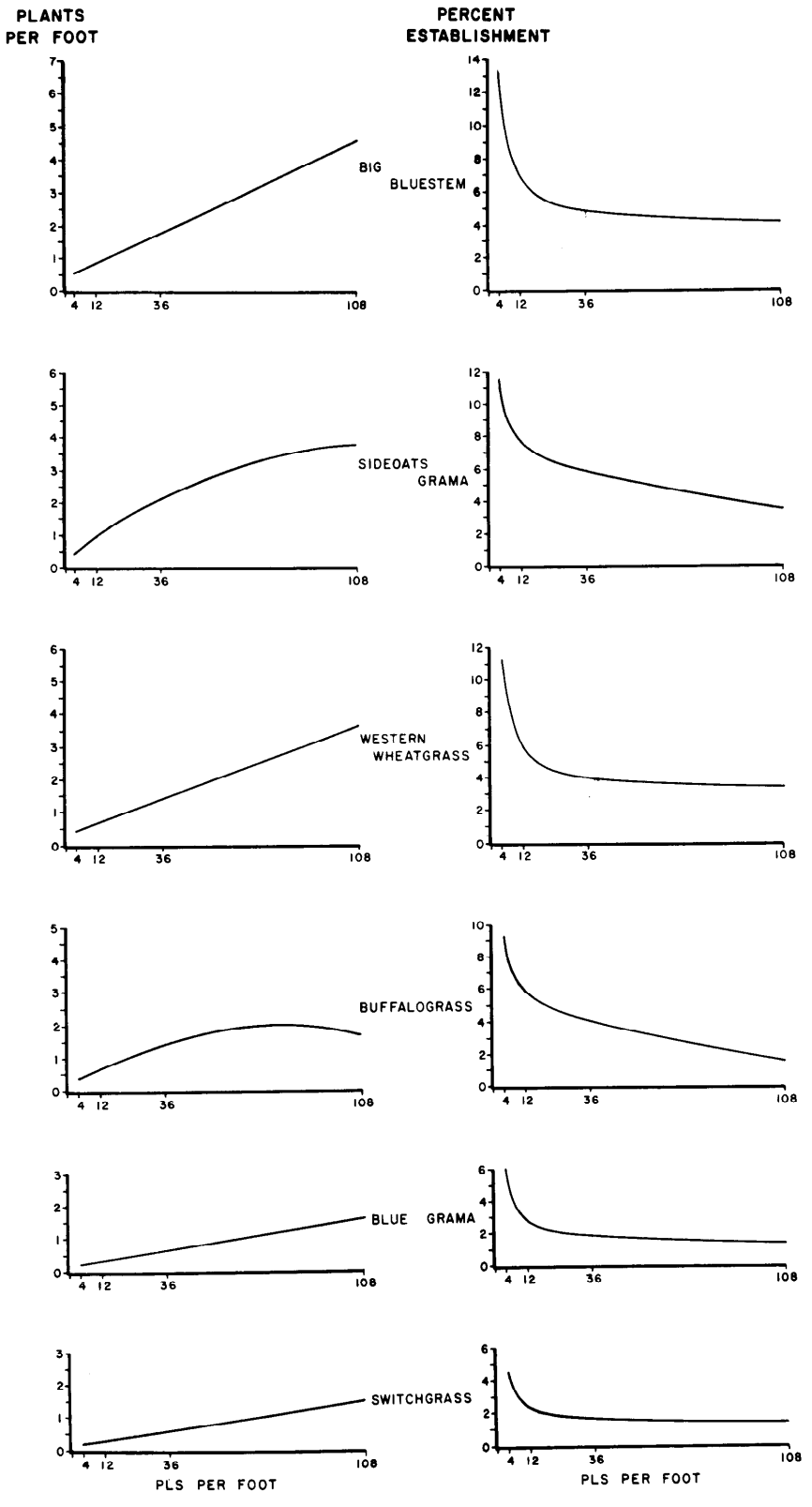

FIG. 1. Regressions of grass plant number on seeding rate (left) and percent established in relation to seeding rate (right) for six native grasses. Seeding rates are numbers of pure live seeds (PLS) per foot of row.

age decreased to 5.3% at the 12 PLS rate, 3.7% at the 36 PLS rate, and 2.6% at the 108 PLS/ft of row. Differences in plant stands among years were significant ($P < .05$), but average percentage success never exceeded 13% at the lowest seeding rate or 11% at the highest seeding rate.

Average percent of seed that developed first-year plants for all seeding rates by years was: 3.04 in 1963, 2.23 in 1964, 6.56 in 1965, and 7.02 in 1966. Seed of similar origin for each species, but of different harvest dates, was used. It was not possible to test year effects on identical seed; however, the various species showed similar relative responses to seeding rate each year. Big bluestem, sideoats grama, and western wheatgrass were generally superior to buffalograss, blue grama, and switchgrass in percent establishment annually. Year differences could not be correlated with conventional weather data recorded near the plots, *viz.* frequency and amount of precipitation, evaporation from a free-water surface, and air temperature. However, average depth to moist soil at planting time appeared to be an indicator of seeding success. Plantings during 1963 and 1964 were in soil dried approximately ¾ inch deep. Seed was placed almost entirely in dry soil and first-year plant numbers were relatively low. Plantings during 1965 and 1966 were in soil moistened within ¼ to ½ inch below the surface, so seed placement was largely in moist soil. Overall first-year success was significantly ($P < .05$) better those years even though seedlings did not start emerging until May, generally after additional precipitation had moistened the soil to seeding depth.

Based on a one-year trial, planting two-species seed mixtures did not significantly influence individual plant numbers compared with pure species plantings at similar rates. In both cases percentage establishment of total plants in relation to number of seeds planted diminished with increasing seeding rate; however, there were no significant

Table 1. Average number of pure live seeds (PLS) per foot of row required to produce first-year stand densities of 0.5, 1, and 1.5 plants per foot.

Stand densities	PLS rates/ft						
	Big bluestem	Western wheatgrass	Sideoats grama	Switchgrass	Blue grama	Buffalograss	Mean
0.5	4	5	4	29	23	7	12
1.0	16	22	14	68	62	20	34
1.5	29	38	23	106	100	38	56

combination × rate interactions. Thus it appears that any of the grasses tested may perform the same the first year whether planted alone or in mixtures. That does not dismiss the probability of differential mortality or spreading as the plants develop tillers and the stand matures. Competition studies of cool-season grasses by Launchbaugh (1964), showed that ultimate stand dominance did not depend solely on seeding rate or initial stands in mixtures.

The many factors that influence germination and emergence under field conditions preclude hypothesizing seeding rates of mixtures or single species that would result in a given number of plants every year. However, these findings suggest that relatively high rates of viable seeds generally will be required to produce stands of one or more plants per square foot of the native grasses studied (Table 1). Combining species, an average of 12 PLS per foot of row were required to yield an average of .5 plant per square foot under the conditions of this study. Nearly three times as many viable seeds (34) were required to produce one plant per square foot. Increasing the average plant number to 1.5/ft^2 required an average of 56 viable seeds, or nearly five times as many as were required to produce .5 plant. Average viable seed requirements for individual species varied between and within species, but in each case increases in plant numbers were disproportionately lower than increases in seeding rates.

The consistent relative behavior of species and their independent performance in mixtures suggest first-year stand composition may be controlled to a large extent by compounding seed mixtures in terms of viable seed numbers rather than arbitrarily proportioning pounds per acre in seeding mixtures. Table 2 shows empirical PLS proportions for desired plant stand percentages based on the average number of viable seeds required to obtain one plant per square foot. A plant stand composition of 50% big bluestem, 40% switchgrass, and 10% sideoats grama, for example, would require PLS proportions of 8 big bluestem, 27 switchgrass, and 1 sideoats/ft^2 in a mixture. Pounds PLS per acre may be computed by multiplying PLS/ft × 43,560 and dividing by the number of seed units per pound of pure seed.

Table 2. Empirical viable seed rates to achieve various plant stand percentages in mixtures. Pure live seed (PLS) rates (per foot) are based on average numbers of viable seeds to obtain 1 plant per foot.

Percent desired in stand	PLS rates/ft					
	Big bluestem	Western wheatgrass	Sideoats grama	Switchgrass	Blue grama	Buffalograss
10	2	2	1	7	6	2
20	3	4	3	14	12	4
30	5	7	4	20	19	6
40	6	9	6	27	25	8
50	8	11	7	34	31	10
60	10	13	8	41	37	12
70	11	15	10	48	43	14
80	13	18	11	54	50	16
90	14	20	13	61	56	18
100	16	22	14	68	62	20

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