Discing and Seeding Effects on Sod Bound Mixed Prairie

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Abstract

A silty range site (720 mm average annual precipitation) in the Mixed Prairie of south-central Nebraska dominated by Kentucky bluegrass (*Poa pratensis* L.), blue grama [*Bouteloua gracilis* (H.B.K.) Lag.], western wheatgrass (*Agropyron smithii* Rydb.), and buffalograss [*Buchole dactyloides* (Nutt.) Englem.] was protected from grazing, disced, seeded and/or treated with glyphosate to increase tall and midgrasses. Discing did not stimulate western wheatgrass yield or cover. After 2 growing seasons, yields and cover were similar on untreated and disced areas. However, species composition data indicated a treatment × year interaction between the second and third growing season for proportion of warm-season shortgrass sod to dominant cool-season vegetation. Warm-season shortgrasses increased on the disced area and decreased on the control during that period. Lo-till sod-seeding using glyphosate [*N*-(phosphonomethyl glycine)] as a sod suppressant provided rapid establishment of desirable warm-season grasses: big bluestem (*Andropogon gerardii* Vitman), indiangrass [*Sorghastrum nutans* (L.) Nash], switchgrass (*Panicum virgatum* L.) and sideoats grama [*Bouteloua curtipendula* (Michx.) Torr.].

Seeding with a rangeland drill into a disced area or an area disced and then sprayed with glyphosate resulted in slower stand establishment compared to sod seeding. All seeding treatments had similar stand frequency during the third growing season and similar yield at the end of the fourth growing season. All seeding methods provided adequate stands.

The Loess Hills of south-central Nebraska are dominated by a warm-season shortgrass community consisting of blue grama [*Bouteloua gracilis* (H.B.K.) Lag.] and buffalograss [*Buchloe dactyloides* (Nutt.) Engelm.]. Cool-season codominants include Kentucky bluegrass (*Poa pratensis* L.) and western wheatgrass (*Agropyron smithii* Rydb.). This shortgrass community is generally considered a disclimax caused by long-term, excessive grazing pressure; the climax vegetation is Mixed Prairie dominated by big bluestem (*Andropogon gerardii* Vitman) (Nicholson and Hulett 1969).

Remnants of desirable vegetation gain vigor and increase when competition from short grasses is reduced or removed. Disc plowing in eastern Wyoming increased production 100% where remnant midgrasses existed (Thatcher 1966). When disced areas were protected, from grazing, midgrasses became dominant. Similar areas, protected from grazing but not disced, produced no change in relative species composition after 5 years. Western wheatgrass increased on areas either disced or disced and spring tooth harrowed in an ungrazed Montana Mixed Prairie (Heady 1952). However, listing a shortgrass range in Texas removed or covered approximately 90% of the existing sod and production did not increase during a 5-year period (Dudley and Hudspeth 1964).

Natural revegetation following mechanical disturbance occurs quickly on grassland that has well-distributed rhizomatous or stoloniferous species. Western wheatgrass was usually the first midgrass to respond (Barnes 1950; Barnes et al. 1958; Ryerson et al. 1970; Rauzi 1974, 1975; Houston 1971; Heady 1952; Rauzi et al. 1962). Nichols (1969) reported that rhizomes of western wheatgrass plants spread several meters in 1 favorable growing season, and recolonized bare areas. Changes in species composition are relatively slow but stimulation of vegetation vigor is much faster. Annuals are common the first and second year after soil disturbance but are quickly replaced by perennial grasses (Rauzi 1974, 1975; Barnes et al. 1958; Dudley and Hudspeth 1964; Brown and Everson 1952). Vegetation responses have been attributed to an increase in available soil moisture (Rauzi et al. 1962, Rauzi and Lang 1956, Barnes 1950, Barnes et al. 1958). However, the increase of available nutrients resulting from the disturbance of the soil and sod is also important in explaining vegetation response (Ryerson et al. 1970, Rauzi 1975).

Remnants of desirable climax species may be very sparse or absent from the plant community. Seeding can be an effective way of revegetating depleted rangelands with desirable plants. Power-tillage seeders seed into established vegetation with minimal disturbance. Plant competition can be reduced with herbicides (Samson and Moser 1982). The use of selective herbicides maintains adequate species diversity of the existing vegetation without destroying the existing ground cover.

The objectives of this study were to determine the inherent capacity of deteriorated Mixed Prairie to increase the relative abundance of (1) existing desirable, native species following a grazing rest and/or mechanical disturbance and () seeded desirable, native species with grazing rest and mechanical and chemical treatments.

Study Area

The study area was in Nuckolls County, located in south central Nebraska on the Loess Plains (Pollock and Davis 1978). Native range in this area is restricted to scattered pastures of several hundred hectares or less. The climate of the area is typically continental with temperatures ranging from 38° C in the summer to −18° C in winter. The average growing season is 145 to 165 frost-free days per year or about May 1 to October 8. Normally, more than 75% of the average annual precipitation (720 mm) falls during the growing season.

The May–September growing season precipitation of 1979 (373 mm) was 80% of normal (471 mm) as measured at Nelson, Neb., approximately 16 km from the study area. May precipitation (47 mm) was 50% of normal. The October 1979—May 1980 cool-season precipitation (445 mm) for the 1980 vegetative year was 40% higher than normal while the summer 1980 (June–September) was 48% lower. Cool-season precipitation was 18 and 68% higher than normal in 1981 (374 mm) and 1982 (530 mm), respectively, while summer precipitation was slightly lower than normal both years (344 mm and 332 mm, respectively).

Topographic features are dominated by nearly level to steeply rolling upland plains, with smooth broad valleys (Pollock and

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Davis 1978). The study area soil is classified as Hastings silt loam (fine to montmorillonitic, mesic, Udic Argiustoll) with 1 to 3% slope and is well drained with moderate permeability and good water holding capacity. The range site is classified as silty.

The vegetation type is Mixed Prairie (Bose 1977); however, the study area was typical of an overgrazed pasture in southern Nebraska. Western wheatgrass and Kentucky bluegrass were the common cool-season grasses. Blue grama and buffalograss were the most abundant warm-season grasses. Less abundant grasses were smooth brome (*Bromus inermis* Leyss.), sand dropseed [*Sporobolus cryptandrus* (Torr.) Gray], tall dropseed [*Sporobolus asper* (Michx.) Kunth], downy brome (*Bromus tectorum* L.), Wilcox's dichanthelium [Dichanthelium oligosanthes (Schult.) Gould var. *wilcoxianum* (Vasey) Gould and Clark], Scribner's dichanthelium [*Dichanthelium oligosanthes* (Schult.) Gould var. *Scribnerianum* (Nash) Gould.] Various species of sedges (*Carex* sp.) were observed throughout. Common forbs were upright prairie coneflower [*Ratibida columnifera* (Nutt.) Woot. and Standl.], snow-on-the-mountain (*Euphorbia marginanata*) Pursh), purple poppy-mallow [*Callirhoe involucrata* (Torr. and Gray) Gray], verbena (*Verbena* sp.) and western ragweed (*Ambrosia psilostachya* DC.).

Materials and Methods

Plots were arranged in a randomized complete block with 4 replications. Slope was the blocking criterion. Each plot was 23 × 11 m and was separated from adjoining plots by a 3-m untreated strip. The area was fenced to exclude grazing.

Discing

One plot in each block was disced 1 May 1979, using a 6-m disc. Plots were disced once at a depth of 8–10 cm. The estimated ground cover disturbance was 30%.

Cover was determined in late May of 1979, 1980, and 1981 using an inclined 10-point frame. Only green plant bases in contact with a point were considered vegetation hits. All other hits were classified as ground cover (litter) or bare ground.

Plots were hand-clipped at ground level in May, July, and October, 1979 and 1980 to determine total standing biomass. Four quadrats, 30 × 60 cm, were clipped within each plot. Material was separated into green biomass by species, standing dead or litter. Forage was oven-dried at 70° C for 48 hours and weighed. Total herbage yield was the sum of all above-ground, green vegetation.

Results for each year were subjected to analysis of variance. A multivariate analysis of variance using Wilks' λ was used to determine treatment × time interactions for cover (Stroup and Stubbendieck 1983).

Seeding

Discing and Rangeland Drill

Plots were disced once on 1 May 1979 with a 6-m tandem disc to a depth of 8 to 10 cm. Plots were seeded the same day using a John Deere Rangeland Drill[1]. The seed mixture (30 PLS/0.1 m) consisted of 'Kaw' big bluestem (25%), 'Aldous' little bluestem [*Schizachrium scoparium* (Michx.) Nash] (30%), 'Osage indiangrass [*Sorghastrum nutans* (L.) Nash] (10%), 'Blackwell' switchgrass (*Panicum virgatum* L.) (10%), and 'El Reno' sideoats grama [*Bouteloua curtipendula* (Michx.) Torr.] (25%).

Discing, Glyphosate, and Rangeland Drill

Plots were disced on 1 May 1979 and sprayed with glyphosate (*N*-phosphonomethyl glycine) (1.1 kg a.i./ha) 7 May 1979. The herbicide was applied at the volume of 374 l/ha. The reduction of standing green biomass was about 90% 10 days following spraying. These plots were seeded 12 May 1979 with a John Deere Rangeland Drill using the seeding mixture previously described.

Herbicide and Lo-Till Sod Seeding

Glyphosate (1.1 kg a.i./ha) was applied to undisturbed plots on 7 May 1979. Leaf length of the dominant cool-season grasses was 10 to 15 cm whereas that of warm-season grasses was less than 2 cm. Plant growth suppression was estimated to be 60 to 70%. A modified John Deere Powr-till Seeder was used 12 May 1979 to sod seed the plots. The power driven (PTO) cutter wheels in front of each seed boot opened 1-cm wide trenches, 1–2 cm deep. A soil flap was attached behind the cutter wheels to increase the amount of soil that fell back onto the seed. Spring-loaded press wheels firmed the soil around the seed insuring uniform seed placement and good seed-to-soil contact. Disturbance of the soil was minimal. Rows were on 18-cm centers. The seed mixture (30 PLS/0.1 m^2), consisted of 'Kaw' big bluestem (35%), 'Nebraska 54' indiangrass (15%), 'Blackwell' switchgrass (15%), and 'El Reno' sideoats grama (35%). Big bluestem and indiangrass had to be hand rubbed to remove seed pubescence in order for the seed to be properly fed through the seeding tubes of the Power-till seeder.

Frequency of occurrence (%) was used to evaluate seedling establishment. Frequency was determined using 160 frames (30 × 30 cm) located randomly within each plot during August 1980 and July 1981. Total above-ground standing crop (kg/ha) was also determined in September 1982 to document the success of stand establishment. Yield was determined from 5 randomly located quadrats (0.2 m^2) within each seeded and untreated plot. Preplanned, orthogonal contrasts were used to delineate treatment responses for both yield and seedling frequency (Steel and Torrie 1960).

All plots were shredded in March 1980. Fall grazing was permitted in 1980 and in 1981. Utilization of the standing dead material was about 70% each fall.

Results and Discussion

Discing

Cover

Vegetation cover of the control in 1979 was dominated by Kentucky bluegrass and blue grama (Table 1). Discing reduced total vegetation and ground cover over 50% while bare ground increased.

By May 1980 (1 year following treatment), cool-, warm-season,

[1]Mention of product names in this paper does not constitute a recommendation by the Nebraska Agricultural Experiment Station.

Table 1. Cover ($\bar{x}$ ± SD, %) characterized by vegetation, ground cover and bare ground for untreated and disced areas determined in late May. Vegetation cover was partitioned into selected cool-season (western wheatgrass and Kentucky bluegrass) and warm-season grasses (blue grama and buffalograss).

	1979		1980		1981	
Species/Category	Control	Disced	Control	Disced	Control	Disced
Vegetation	26.4 ± 0.8	12.0 ± 0.6	31.2 ± 4.5	17.4 ± 1.7	14.8 ± 3.6	11.1 ± 3.3
Western wheatgrass	2.5 ± 1.3	1.4 ± 0.9	3.8 ± 1.1	1.7 ± 0.9	2.0 ± 0.7	0.4 ± 0.4
Kentucky bluegrass	6.8 ± 2.0	5.4 ± 1.1	10.0 ± 1.9	6.6 ± 3.1	5.6 ± 0.9	4.3 ± 0.3
Buffalograss	1.2 ± 1.0	0.6 ± 0.8	3.2 ± 2.4	0.7 ± 0.4	0.4 ± 0.3	0.9 ± 0.3
Blue grama	7.2 ± 4.6	2.2 ± 0.9	10.3 ± 6.5	3.2 ± 1.5	3.2 ± 2.0	2.2 ± 1.7
Ground cover (litter)	64.4 ± 2.1	33.0 ± 1.3	63.1 ± 4.3	45.3 ± 2.7	81.3 ± 3.5	71.2 ± 2.8
Bare ground	9.2 ± 2.5	55.0 ± 1.3	5.6 ± 1.2	37.4 ± 2.1	3.9 ± 0.5	17.6 ± 4.9

and total vegetation cover tended to increase on untreated areas while bare ground was reduced (Table 1). Similar trends occurred in the disced area between 1979 and 1980; however, increases in litter reduced bare ground rather than large changes in vegetation. Generally, untreated areas had more vegetation cover than disced areas. There was no significant treatment × year interaction between 1979 and 1980 for the proportion of western wheatgrass to Kentucky bluegrass, (P = .28) buffalograss to blue grama (P = .50) or warm- to cool-season components (P = .31).

Cool-, warm-season, and total vegetation cover declined from 1980 to 1981 on the untreated area (Table 1). This same trend occurred on the disced areas indicating response to climatic variables as well as build up in litter on both areas. Bare ground decreased on both areas from 1980 to 1981. Both untreated and disced were similar in vegetation cover while litter was higher on control and bare ground greater on disced areas. There was no treatment × year interaction on the proportion of western wheatgrass to Kentucky bluegrass (P=.27) or buffalograss to blue grama (P=.28); however, there was a treatment × year interaction for the proportion of warm- to cool-season vegetation (P<.01).

During the period between treatment (1979) and May 1981 there was no treatment × year interaction for the proportion of western wheatgrass to Kentucky bluegrass (P = .51) buffalograss to blue grama (P = .33) or the relationship of all 4 species (P = .48). There was a treatment × year interaction for the relationship of warm to cool-season vegetation (P = .08) resulting from an increase in the proportion of warm-season vegetation cover on disced areas and a decrease on untreated areas between 1980 to 1981.

During the first growing season, forb increases were conspicuous on the disced plots. Annual sunflowers (*Helianthus annus* L.), snow-on-the-mountain, and western ragweed were the major species. Although weed control would be desirable, it was not applied during the growing season. The standing dead was shredded the following spring. Perennial forbs remained prevalent during the second growing season.

Forage Yield

Discing reduced forage yield of warm-season, cool-season, and total vegetation compared to untreated areas 3 weeks after discing (Fig. 1). Decreases in western wheatgrass and blue grama accounted for the major losses in forage yield. Total forage yield on disced areas was only 35% of the untreated areas.

Cool- and warm-season grass yields remained lower on the disced areas in July than on the untreated areas (Fig. 1). However, total vegetation was not different on untreated and disced areas at this time, primarily due to increased production of annual forbs (660 kg/ha) on the disced plots.

By the end of September there was no difference in production of dominant cool-season species or total vegetation in untreated and disced areas (Fig. 1). There was a trend, although nonsignificant, of reduced yield of the dominant warm-season species. Cool-season species were more resistant to discing than warm-season and/or

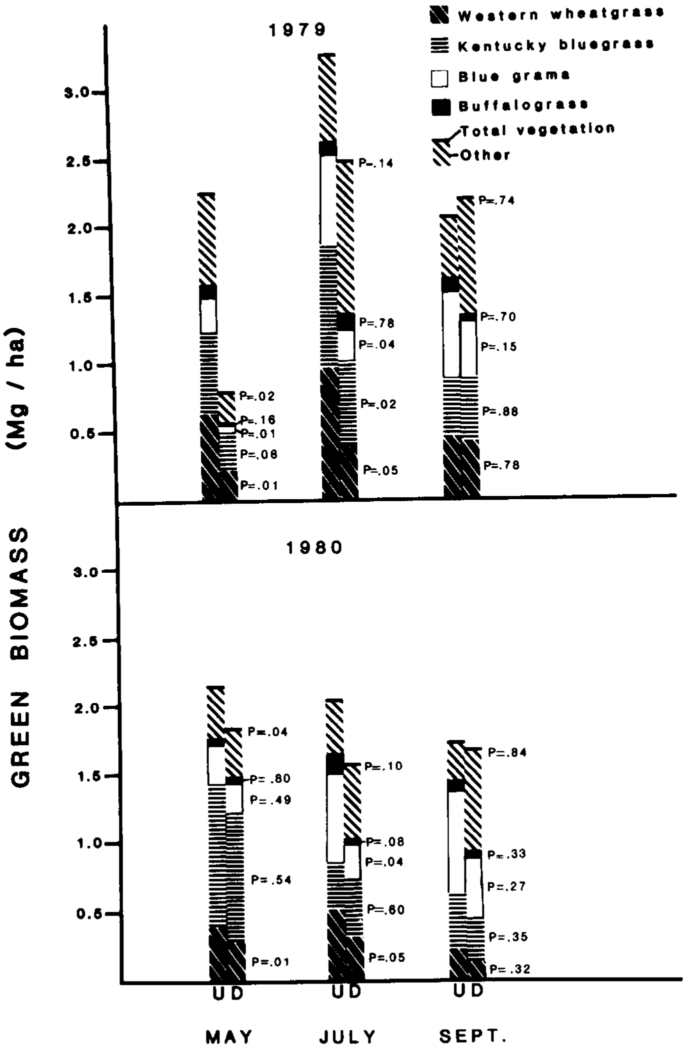

Fig. 1. *Effect of discing (D) on the green biomass yield of selected species and total vegetation at 3 harvest dates the year of treatment (1979) and the year following compared to untreated areas (U). Treatments are compared using an F test* (P>F).

Table 2. Effect of seeding treatment on seeded species and stand frequency (%). Treatment comparisons are made using orthogonal contrasts.

	1980					1981				
	Treatment Means			Contrast (P>F)		Treatment Means			Contrast (P>F)	
Species/category	Disc-drill w/o herbicide	Disc-drill w/herbicide	Sod-seed	Disc-drill w/o herbicide Disc-drill w/herbicide	Disc-drill vs. Sod-seed	Disc-drill w/o herbicide	Disc-drill w/herbicide	Sod-seed	Disc-drill w/o herbicides vs. Disc-drill w/herbicide	Disc-drill vs. Sod-seed
Big bluestem	9	18	30	.03	.01	11	16	28	.03	<.01
Indiangrass	8	11	27	.34	.01	8	18	34	.03	<.01
Little bluestem	14	14	—[1]	.85	—	23	24	—	.89	—
Switchgrass	17	2	25	.05	.02	20	7	24	.07	.08
Sideoats grama	11	16	14	.06	.90	12	20	15	.06	.73
Stand[2]	42	43	59	.72	.01	53	60	66	.25	.11

[1]Not included in seeding mixture
[2]Any seeded species.

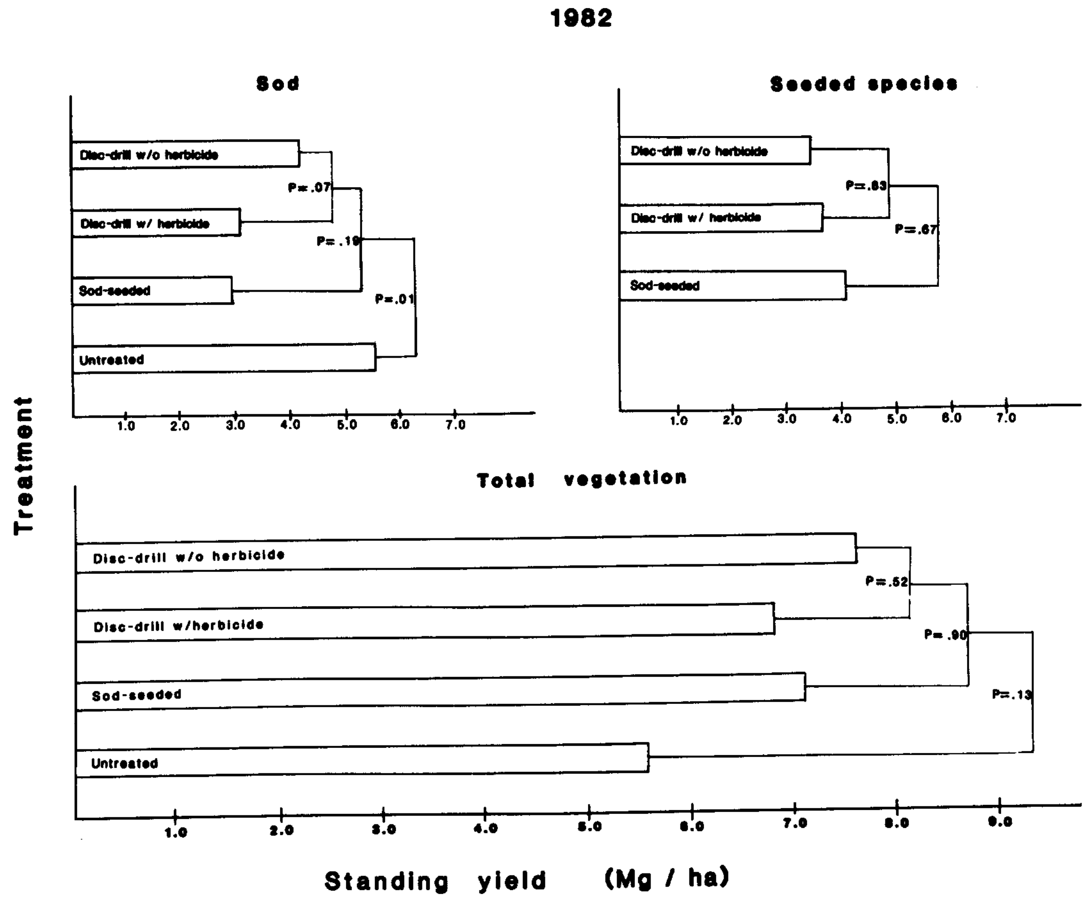

Fig. 2. *Effect of seeding treatments on the standing yield of sod, seeded species, and total vegetation harvested in September 1982 (4 years following seeding). Orthogonal contrasts were used to compare the disc-drill treatments, average of disc-drill response to sod seeding, and average seeding response to an untreated area* (P>F).

made a faster recovery.

Yield of Kentucky bluegrass was 68% greater on untreated areas in May 1980 than May 1979 while yields of western wheatgrass were 37% lower (Fig. 1). This indicated the magnitude of response of Kentucky bluegrass during periods with greater than average cool-season precipitation. In May 1980 western wheatgrass was the only major species to produce less above-ground biomass on disced than on untreated areas. This does not support the findings of Barnes (1950), Barnes et al. (1958), Lang (1958), Rauzi and Lang (1956), Rauzi (1974), Houston (1971), and Heady (1952) which indicated improvement in western wheatgrass stands. Kentucky bluegrass apparently was very opportunistic and successfully competed with western wheatgrass for cool-season precipitation. With favorable cool-season precipitation and normal warm-season precipitation, Kentucky bluegrass could provide a cool-season component of the dominant shortgrass sod which was unlike conditions reported in other studies. Thus, competitive balance between Kentucky bluegrass and western wheatgrass could have been influenced more by precipitation patterns than by the discing treatment.

In July, 1980, western wheatgrass yields remained lower on disced plots than control; and yields on the control were about 50% of the previous year (Fig. 1). Kentucky bluegrass yield was about 60% less on the control in 1980 compared to 1979. This data indicated the unfavorable summer precipitation of 1980 compared to 1979. Blue grama yielded less on the disced plots, while buffalograss yield was not altered. This would be expected since a species that tillers (blue grama) should not perform as well as stoloniferous species (buffalograss) following a disturbance. However, there was no apparent stimulation of any grass species with vegetative reproduction, as might be expected. In September, 1980, two growing seasons after discing there was no difference between untreated and disced plots for cool-, warm-season, and total vegetation.

Seeding

Range seeding is necessary when grazing management or mechanical treatment does not renovate shortgrass sod. Methods other than complete seedbed preparation are desirable alternatives to minimize erosion and maximize species diversity of the renovated range. Lo-till sod seeding had a higher average frequency of occurrence for seeded species (59%) at the end of the first growing season than treatments using a rangeland drill (Table 2). The disc, chemical and rangeland drill treatment and the disc and rangeland drill treatment were not different (43% and 42%, respectfully).

The highest frequency of establishment of big bluestem, indiangrass, and switchgrass was on the lo-till sod seeded treatments (Table 2). This was different than treatments using the rangeland drill. The rough soil surface resulting from discing often resulted in poor seed-to-soil contact. Big bluestem establishment in areas seeded with the rangeland drill, using discing and chemical treatment for sod suppression, was higher than discing alone. However, discing without herbicide application provided a greater switchgrass establishment while there was no difference between rangeland drill seedbed preparation for indiangrass.

Sideoats grama had the highest frequency for establishment using discing and glyphosate prior to the rangeland drill (Table 2). However, there was no difference between the lo-till sod seeding and treatments using the rangeland drill. Little bluestem was seeded only in treatments using the rangeland drill. Establishment was not different between areas disced for sod suppression and those disced and sprayed for sod suppression.

Disc-drill treatments had improved distribution in 1981 compared to 1980 (Table 2). There was a significant year effect for total seeded species between 1980 and 1981. However, the difference in stand distribution was reduced between disc-drill and sod seeding treatment ($P = .11$) while the disc-drill with herbicide treatment was numerically greater than the disc-drill without herbicide treatment ($P = .25$).

Increases in seeded plant frequency were documented in 1981 for little bluestem on both disc-drilled treatments. Indiangrass also improved on the disc-drill with herbicide treatment. The increased distribution of these species and the resultant impact on total stand distribution on the disc-drill treatments probably reflected new shoots from vegetative reproduction rather than dormant seed or seed produced the seeding year. However, sod seeding remained higher in frequency of occurrence for indiangrass. This implied that the initial lower seeding year establishment for the disc-drill treatment was improved by second year spread of seeded species into the disturbed areas. Data indicated that spread on the sod seeded areas was much more restricted.

Yields collected in 1982 indicated that areas seeded with a conventional drill following discing and glyphosate application had a lower sod yield than areas disced and drilled without any further sod suppression resulting from herbicide application (Fig. 2). Due to the higher sod yield from plots that were seeded following discing without herbicide compared to those that received the herbicide, there was not a difference in sod yield between plots that were sod seeded and those that were disced and drilled. However, there was a greater sod yield for untreated areas compared to the average sod yield of seeded plots. The effect of glyphosate was still apparent 4 years following application. However, there was no difference in the yield of seeded species between areas seeded following discing and those seeded following discing and glyphosate application. In addition, areas that were sod seeded did not have higher yields of seeded species than the average of those seeded with the conventional drill.

Total vegetation yields were higher on the seeded areas compared to the untreated areas (Fig. 2). There was no difference between areas following discing and those seeded following discing and glyphosate application. Total yield averaged over disc-drill treatments was not different than that of sod seeded areas. Comparisons to the untreated area must be interpreted with regard to the influence of 4 grazing seasons of deferment. This grazing management has also enhanced the spread of seeded species on the areas that were seeded with the conventional drill. It is apparent that the advantage in sod seeding compared to the disc-drill treatments is associated with the rate of development.

Conclusions

At the end of the second growing season there was little difference in cover or yield of the dominant shortgrass species due to discing. Discing did not stimulate western wheatgrass. Changes in production were a reflection of above-average cool-season precipitation rather than a response to discing. Under environmental conditions which promote vigorous Kentucky bluegrass sod, discing is not an alternative to reseeding on this site.

All seeding treatments resulted in adequate stands. Sod-seeding provided the most rapid stand establishment. Disc-drill seedings were slower to establish but were comparable in yield after 4 growing seasons.

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